

# City of Roseville

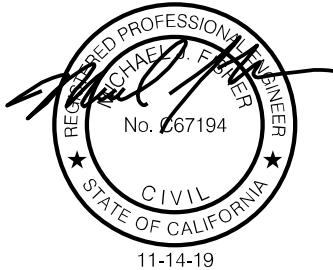
## CONTRACT DOCUMENTS FOR DESIGN-ASSIST AND CONSTRUCTION OF

### WEST SIDE TANK AND PUMP STATION PROJECT (PHASE 2)

## VOLUME 3 OF 4: SPECIFICATIONS (DIVISIONS 1-16)

November 2019

### Final Design Submittal Not for Construction



ENGINEER:



**WATERWORKS**  
ENGINEERS

**WATER WORKS ENGINEERS, LLC.**

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## SECTION 01110

### SUMMARY OF WORK

#### **PART 1 - GENERAL**

##### **1.1 DEFINITIONS AND CONTRACT PROVISIONS**

- A. The term "Contract Documents" used throughout the Specifications and Drawings is equivalent to "Agreement" as defined in the Design-Assist Construction Agreement.
- B. The term "Construction Manager" used throughout the Specifications and Drawings is as defined in the Agreement.
  - 1. As it pertains the Specifications and Drawings, the Construction Manager may assign part of the Construction Manager's duties, rights and responsibilities to "Architect/Engineer".
- C. The term "Drawings" used throughout the Specifications and Drawings is equivalent to "Plans" as defined in the Agreement.
- D. The term "Engineer" or "ENGINEER" used throughout the Specifications and Drawings is equivalent to "Architect/Engineer" as defined in the Agreement.
- E. The "Final Design Submittal" refers to the Specifications and Drawings included as attachments to the Request for Proposals to describe the Work. These documents will be modified during the Design-Assist process to produce Construction Documents.
- F. The term "Owner" or "OWNER" used throughout the Specifications and Drawings is equivalent to "CITY" as defined in the Agreement.
- G. Refer to the Agreement for definitions and contract provisions not included in the Specifications or Drawings.

##### **1.2 LOCATION AND DESCRIPTION OF WORK**

- A. The Work is located at 4501 Westpark Drive in Roseville, California 95747.
- B. The Work covers the construction of the West Side Tank and Pump Station as generally described below and as shown on the Drawings and Specifications:
  - 1. Water Storage Tanks:
    - a. Over excavation beneath tanks and installation of mechanical stabilized earth (MSE) foundation improvement system to provide suitable subgrade conditions for tank construction.
    - b. Construction of two (2) 6.0 MG at-grade pre-stressed concrete water storage tanks with flat concrete roofs. Each tank will be identically sized at 170 ft diameter with 40 ft sidewall height.
    - c. Installation of two access hatches, roof vent, interior and exterior access ladders, and electric davit cranes at each tank.
    - d. Installation of leak detection system with PVC liner and perforated piping.
    - e. Installation of wall drain piping.
    - f. Installation of downspouts from roof of each tank for rainwater collection.
    - g. Installation of hydrodynamic tank mixing system in each tank.

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- h. Installation of internal and external overflow piping and supports at each tank.
- i. Installation of sump in floor of each tank with drain piping and valves.
- j. Installation of water sample station at each tank.
- 2. Tank Valve Vault:
  - a. Construction of new cast-in-place concrete valve vault with structural supports and grating.
  - b. Installation of seven (7) butterfly valves and two (2) check valves associated with tank inlet and outlet. This piping and valve arrangement allow the two tanks to be operated in parallel, in series, or independently taken offline for maintenance.
- 3. Booster Pump Station:
  - a. Construction of 2,537 sq. ft CMU block Booster Pump Station building to house booster pumps, sodium hypochlorite storage and feed system, and electrical and control equipment.
  - b. Installation of architectural canopies over exterior electrical switchgear and valve vault.
  - c. Installation of coiling overhead door for vehicle access into pump room.
  - d. Installation of evaporative cooling for pump room and air conditioning for electrical room.
  - e. Installation of trench drains for building drainage and small diameter pipe routing.
  - f. Installation of roof hatches over all pumps with winch operated rigging to allow operators to open hatches from ground level.
  - g. Construction of valve vault outside of building for suction-side pump isolation valves.
  - h. Installation of four (4) 250 hp vertical turbine booster pumps (3 duty plus 1 standby) set in below-grade suction barrels. Each pump shall have a design capacity of 3,800 gpm at 170 ft TDH.
  - i. Installation of 16-inch electronic control valve for tank filling and pressure relief.
  - j. Installation of piping, pipe supports, valves and appurtenances associated with pumping system.
  - k. Installation of sample pump for tank outlet chlorine residual analyzer.
  - l. Installation of 500-gallon dual contained sodium hypochlorite storage tank.
  - m. Installation of skid-mounted progressive cavity sodium hypochlorite metering pumping system.
  - n. Installation of two (2) emergency eyewash and shower systems with tepid water system.
  - o. Installation of 2,000-gallon bladder-style hydropneumatic tank and associated piping, pipe supports, valves and foundation.
- 4. Electrical:
  - a. All Electrical Contractor work, including coordination with electric utility and installation of electric service to site including transformer, conduit and wiring.
  - b. Installation of 1,500 kW standby diesel generator, dual-contained fuel tank, load bank and access stairs and platforms.
  - c. Installation of exterior switchboard at Booster Pump Station.
  - d. Installation of interior automatic transfer switch, distribution sections, panelboard, transformer, control panel and security panel in electrical room of Booster Pump Station.
  - e. Installation of two (2) 250 hp variable frequency drives and two (2) reduced voltage soft starters in electrical room of Booster Pump Station.
  - f. Installation of light fixtures on and in the Booster Pump Station and light poles throughout the site.
  - g. Installation of all conduit, wire, supports, pullboxes, etc. to support the new system.

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5. Instrumentation and Controls:
  - a. All System Integrator work, including coordination and installation of programmable logic controller (PLC) and control panel to monitor and control the new system. Programming of PLC and SCADA will be provided by OWNER Application Programmer.
  - b. Installation of level measurement devices, ladder and hatch intrusion switches and power supply to davit cranes at each water storage tank.
  - c. Installation of level measurement devices in tank valve vault.
  - d. Installation of free chlorine residual analyzers for tank inlet and outlet sampling.
  - e. Installation of pressure transmitter on pump discharge header.
  - f. Installation of bi-directional 24-inch magnetic flowmeter for tank fill and pump discharge flow measurement.
  - g. Installation of site access and security system, including fiber optic network tied into Pleasant Grove WWTP Administration Building.
  - h. Installation of miscellaneous instrumentation.
6. Miscellaneous Site Work:
  - a. Installation of valve vault to tie into existing water distribution system with new 30-inch piping.
  - b. Installation of 30-inch tank fill, 42-inch tank outlet and miscellaneous yard piping, including sewer and storm drain manholes and catch basins.
  - c. Contractor design and installation of cathodic protection system, including all anodes, test stations, insulating flanges, etc.
  - d. Site grading and construction of curbs, gutters and paving.
  - e. Construction of lined bioretention basins for stormwater treatment prior to discharge to existing storm drain system.
  - f. Construction of CMU block wall and chain-link fencing around site perimeter.
  - g. Construction of steel fencing at main site entrance with automatic gate and single-leaf gate for pedestrian access.
  - h. Connecting to existing recycled water distribution system, installation irrigation system between Westpark Drive and new CMU block wall, planting shrubs and installing mulch.
  - i. Installation of and maintenance of site erosion control measures.
7. Project Management and Administration:
  - a. Preparing and providing submittals.
  - b. Maintaining project schedule.
  - c. Maintaining As-Built Contract Drawings on a continuous basis.
  - d. Preparing Requests for Information.
  - e. Startup, testing, training and project closeout tasks to provide a complete and functional system.

### 1.3 PROJECT DOCUMENTS

- A. The Work is described in the following project documents:
  1. Volume 1 – Request for Proposals
  2. Volume 2 – Sample Contract
  3. Volume 3 – Technical Specifications
  4. Volume 4 – Drawings
- B. Refer to the Request for Proposals for the following supplemental information referenced from the Drawings and Specifications:
  1. Geotechnical Report
  2. Stormwater Pollution Prevention Plan

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#### 1.4 COORDINATION

- A. The CONTRACTOR shall be solely responsible for coordination of all of the Work of this Contract.
- B. The CONTRACTOR shall supervise, direct and cooperate fully with all Subcontractors, manufacturers, fabricators, suppliers, distributors, installers, testing agencies and all others whose services, materials or equipment are required to ensure completion of the Work within the Contract Time.
- C. Work of Others:
  - 1. The CONTRACTOR shall generally perform the Work according to the suggested sequence of construction as described in Section 01130, Special Project Constraints.
  - 2. The CONTRACTOR shall cooperate with and coordinate CONTRACTOR's Work with the work of any other contractor, utility service companies, or OWNER's representatives performing work at the site.
  - 3. The CONTRACTOR shall also coordinate their Work with the work of others to assure compliance with schedules.
  - 4. The CONTRACTOR shall attend and participate in all project coordination or progress meetings and report on the progress of all Work and compliance with schedules.
  - 5. If any part of the work depends upon the work of others for proper execution or results, the CONTRACTOR shall inspect and promptly report to the ENGINEER any apparent discrepancies or defects in such work of others that render it unsuitable for such proper execution and results.
  - 6. Failure of the CONTRACTOR to so inspect and report shall constitute an acceptance of the work of others as fit and proper except as to defects which may develop in the work of others after execution of the work by the CONTRACTOR.
- D. Interference with work on utilities:
  - 1. The CONTRACTOR shall cooperate fully with all utility forces of the OWNER or forces of other public or private agencies engaged in the relocation, altering, repair, or otherwise rearranging of any facilities which interfere with the progress of the work.
  - 2. The CONTRACTOR shall schedule the work so as to minimize interference with said relocation, altering, repair, or other rearranging of facilities.
- E. Responsibility for Damage:
  - 1. The CONTRACTOR shall not be responsible for damage done by CONTRACTORs not under their jurisdiction.
  - 2. The CONTRACTOR will not be liable for any such loss or damage, unless it is through the negligence of the CONTRACTOR.

#### 1.5 WORK BY OTHERS

- A. OWNER will perform the following work:
  - 1. Operation of all existing system valves and equipment, unless specified otherwise.
  - 2. PLC and SCADA programming by CITY.
- B. Other contracts as follows:
  - 1. Construction of the future Operations Building will be under a separate contract following completion of this project.

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## 1.6 SITE CONDITIONS

### A. Site Investigation and Representation

1. The CONTRACTOR acknowledges that it has satisfied itself as to the nature and location of the work, the general and local conditions, particularly those bearing upon availability of transportation, disposal, handling and storage of materials, availability of labor, water, electric power, roads, and uncertainties of weather, tide stages, or similar physical conditions at the site, the conformation and conditions of the ground, the character of equipment and facilities needed preliminary to and during the prosecution of the work and all other matters which can in any way affect the work or the cost thereof under this Contract.
2. The CONTRACTOR further acknowledges that it has satisfied itself as to the character, quality, and quantity of surface and subsurface materials to be encountered from inspecting the site and from evaluating information derived from exploratory work that may have been done by the OWNER or included in these Contract Documents. Any failure by the CONTRACTOR to become acquainted with all the available information will not relieve the CONTRACTOR from responsibility for properly estimating the difficulty or cost of successfully performing the work or for properly installing the Work.
3. Field Verification:
  - a. Before undertaking each part of the work, the CONTRACTOR shall carefully study and compare the Contract Documents and check and verify pertinent figures shown thereon and all applicable field measurements.
  - b. As the work proceeds, the CONTRACTOR shall field verify the depth and location of all buried utilities, and existing systems, and location of hazardous waste and contaminants.
  - c. The CONTRACTOR shall promptly report in writing to the ENGINEER any conflict, error, or discrepancy which the CONTRACTOR may discover and shall obtain a written interpretation or clarification from the ENGINEER before proceeding with any work affected thereby.

### B. Existing Utilities and Improvements

1. Location of Underground Utilities:
  - a. Known existing underground conduits, pipelines and other utilities have been shown on the contract drawings in their approximate locations (within 3 feet of actual location). However, the accuracy or completeness of utilities indicated on the drawings is not guaranteed.
  - b. It shall be the responsibility of the CONTRACTOR to determine the exact location of all utilities and their service connections.
  - c. All potholing or other procedures for verifying utility location shall be performed by the CONTRACTOR as necessary to prepare for excavation at least 4 working days in advance of scheduled excavation.
  - d. The CONTRACTOR shall immediately notify the ENGINEER as to any utility located by him which has been incorrectly shown or omitted from the drawings.
  - e. If the CONTRACTOR cannot locate an underground utility whose presence is indicated on the Drawings, the ENGINEER shall be notified in writing.
  - f. The CONTRACTOR shall ascertain the exact locations of underground utilities whose presence is indicated on the Drawings, the locations of their service laterals work and of service laterals or appurtenances of any other underground utilities which can be inferred from the presence of visible facilities such as buildings, meters and junction boxes prior to doing work that may damage such utilities or interfere with their service.
  - g. Utilities Not Shown on Drawings:

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- 1) Attention is directed to the possible existence of underground utilities not indicated on the Drawings and to the possibility that underground utilities may be in a location different from that indicated on the Drawings.
  - 2) If the ENGINEER determines that the underground utility for which such notice has been given has not been depicted on the Drawings with reasonable accuracy (within 3 feet of actual location), the additional cost incurred in locating the utility will be paid for as extra work as provided in the Agreement.
  - 3) If the CONTRACTOR discovers underground an utility not indicated on the Drawings, the CONTRACTOR shall immediately give the ENGINEER and the Utility Company written notification of the existence of such utility.
  - 4) Such utilities shall be located and protected from damages as directed by the ENGINEER and the cost of such work will be paid for as extra work as provided in the Agreement.
2. Utility Coordination:
- a. The CONTRACTOR shall notify Underground Service Alert (USA) at least 4 days prior to excavation, telephone (800) 642-2444.
  - b. The CONTRACTOR shall also contact all utility owners not registered with USA but known to have utilities in the project area to field locate underground utilities at least 4 days prior to excavation.
  - c. The CONTRACTOR shall notify all owners of utilities when the Work is in progress and shall make arrangements as are necessary to coordinate outages or make any emergency repairs.
  - d. Existing utilities that are shown or that are made known and located to the CONTRACTOR prior to excavation, and that are to be retained; and all utilities that are constructed during excavation operations shall be properly supported and protected from damage during the progress of the work.
3. Utility Protection and Damage:
- a. Existing utilities that are shown or that are made known and located to the CONTRACTOR prior to excavation, and that are to be retained, and all utilities that are constructed during excavation operations shall be properly supported and protected from damage during the progress of the work.
  - b. Should any damage to a utility occur during the progress of the work, the CONTRACTOR shall notify the OWNER or the utility at once and render all assistance possible to repair the damage and restore the service.
  - c. No extra compensation will be made for the repair of any services or utility damaged by the CONTRACTOR nor for any damage incurred through neglect or failure to provide adequate protection to existing utilities.
  - d. The provisions of this Section shall not be abated even in the event such damage occurs after backfilling or is not discovered until after completion of the backfilling.
  - e. Damage Report:
    - 1) If the CONTRACTOR damages any underground utilities not shown on the Drawings or not depicted on the Drawings with reasonable accuracy (within 3 feet of actual location) or any lateral service the location of which could not be inferred by the CONTRACTOR, a written report thereof shall be made immediately to the ENGINEER by CONTRACTOR.
    - 2) The CONTRACTOR's report shall also advise the ENGINEER of any schedule delays. Compensation for such delays will be determined in accordance with the Agreement. The CONTRACTOR shall be entitled to no other compensation for any such damage.
4. All utilities encountered along the line of the work shall remain continuously in service during all work under the Contract, unless otherwise shown on the drawings,

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or unless other arrangements satisfactory to the ENGINEER are made with the owner of said utilities.

C. CONTRACTOR's Responsibility for Utility Facilities and Service

1. Where the CONTRACTOR's operations could cause damage or inconvenience to railway, telephone, television, power, oil, gas, water, sewer, or irrigation systems, the CONTRACTOR shall make all arrangements necessary for the protection of these utilities and services.
2. The CONTRACTOR shall be solely and directly responsible to the owner and operators of such properties for any damage, injury, expense, loss, inconvenience, delay, suits, actions, or claims of any character brought because of any injuries or damage which may result from the construction operations under this Contract.
3. Neither the OWNER nor its officers or agents shall be responsible to the CONTRACTOR for damages because of the CONTRACTOR's failure to protect utilities encountered in the work.
4. In no event shall interruption of any utility service be allowed outside working hours unless granted by the owner of the utility.
5. No sand, mud, rocks or other construction debris shall be disposed of in the sanitary sewers or storm sewers.
6. Any discharge of construction water to the sewer or storm drain systems requires a City of Roseville discharge permit a minimum of 7 calendar days prior to planned discharge, as approved by ENGINEER.
7. Where bypassing of sewage is required to perform sewer repairs or service relocations and where temporary pumps are required to bypass any sewage across traffic lanes, the discharge lines crossing the traffic lanes shall be buried a minimum of 4 inches below the pavement surface and backfilled with temporary asphalt concrete surfacing. The CONTRACTOR shall take all necessary steps to assure continuous flow of sewage. Bypassing of untreated wastewater to surface waters or courses will not be permitted.
8. The CONTRACTOR shall replace, at its own expense, any and all existing utilities or structures removed or damaged during construction, to their existing condition unless otherwise provided for in these Contract Documents.
9. The CONTRACTOR shall repair or replace, at its own expense, all pavement damaged during the construction, to its existing condition unless otherwise provided for in these Contract Documents.

D. Names of Known Utilities Serving the Area

1. The following is a list of the known public utilities serving the area:
  - a. City of Roseville:
    - 1) Water – (916) 774-5750.
    - 2) Recycled Water – (916) 774-5750.
    - 3) Sewer – (916) 774-5750
    - 4) Electric – (916) 797-6937
  - b. Pacific Gas and Electric (PG&E):
    - 1) Gas – (800) 743-5000

E. Railroads

1. The CONTRACTOR shall not perform work or occupy any part of railroad property without a permit authorizing the same.

F. Interfering Structures

1. The CONTRACTOR shall take necessary precautions to prevent damage to existing structures whether on the surface, aboveground, or underground. An attempt has

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been made to show major structures on the Drawings. While the information has been compiled from the best available sources, its completeness and accuracy cannot be guaranteed, and it is presented as a guide to avoid possible difficulties.

2. The CONTRACTOR shall protect all existing structures, trees, shrubs, and other items on the project site that are to be preserved, by substantial barricades or other devices commensurate with the hazard, from injury or destruction by vehicles, equipment, workmen, or other agents.
3. Where existing fences, gates, buildings, or any other structure must be removed to properly carry out the work, or are damaged during the work, they shall be restored at the CONTRACTOR's expense to their original condition or better.
4. Without additional compensation, the CONTRACTOR may remove and replace in a condition as good as or better than original, any small structures such as fences, and signposts that interfere with the CONTRACTOR's operations.

G. Field Relocation

1. During the progress of construction, it is expected that minor relocations of the work will be necessary.
2. Such relocations shall be made only by direction of the ENGINEER.
3. If existing structures are encountered that will prevent construction as shown, notify the ENGINEER before continuing with the work in order that the ENGINEER may make such field revisions as necessary to avoid conflict with the existing structures.
4. If the CONTRACTOR shall fail to notify the ENGINEER when an existing structure is encountered, and shall proceed with the work despite this interference, CONTRACTOR shall do so at their own risk.
5. Any CONTRACTOR request(s) for additional compensation or contract time resulting from necessary field relocations will be considered as set forth in the Agreement.
6. If the CONTRACTOR fails to notify the ENGINEER when a structure which interferes with construction is encountered, and proceeds with the work despite this obstruction, the CONTRACTOR shall do so at their own risk and at no additional cost to the OWNER.

## 1.7 REFERENCE POINTS AND SURVEYS

- A. Location and elevation of bench marks are shown on Drawings.
- B. Dimensions for lines and elevations for grades of structures, appurtenances, and utilities are indicated on Drawings, together with other pertinent information required for laying out Work. If conditions vary from those indicated, notify OWNER immediately, who will make or approve minor adjustments, as required.
- C. OWNER may perform checks to verify accuracy of CONTRACTOR's layout Work and that completed Work complies with Contract Documents.
- D. Any existing survey points or other control markers destroyed without proper authorization will be replaced by owner of the survey points or control markers at CONTRACTOR's expense.
- E. CONTRACTOR's Responsibilities:
  1. Provide all survey and layout required.
  2. Locate and protect reference points prior to starting site preparation.
  3. Notify OWNER at least 3 working days in advance when grade and line surveying will be performed by CONTRACTOR

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4. Check and establish exact location of existing facilities prior to construction of new facilities and any connections thereto.
5. In event of discrepancy in data provided by OWNER, request clarification before proceeding with Work.
6. Provide cut sheets for all staking.
7. Preserve and leave undisturbed control staking until ENGINEER has completed checks it deems necessary.
8. Re-establish reference points resulting from destruction by CONTRACTOR's operations.
9. Cooperate with ENGINEER so that checking and measuring may be accomplished with least interference to CONTRACTOR's operations.

#### 1.8 SEQUENCE AND PROGRESS OF WORK

- A. The CONTRACTOR shall submit a Construction Schedule covering the entire Work in accordance with Section 01320, Progress Schedule.
- B. The CONTRACTOR shall incorporate the requirements of Section 01130, Special Project Constraints, into the Construction Schedule.
- C. Alternate Sequence:
  1. The CONTRACTOR's schedule may use a different sequence from that shown or specified, if techniques and methods known to the CONTRACTOR will result in cost and time savings to the OWNER, still achieve the required objective and maintain the same or greater level of treatment.
  2. The ENGINEER's determination on the acceptability of any alternative sequence from that shown or specified shall be final.

#### 1.9 CONTRACTOR'S USE OF PREMISES

- A. The CONTRACTOR shall coordinate use of the premises, for the CONTRACTOR's storage and the operations of the CONTRACTOR's workmen, with OWNER and utility service companies.
- B. Restriction of Work Area:
  1. The full use of the premises for storage, the operations of workmen and for all other construction activities will not be available to the CONTRACTOR.
  2. The CONTRACTOR must operate entirely within the space allowed to the CONTRACTOR.
  3. The Drawings defines the area allocated to the CONTRACTOR.
- C. The CONTRACTOR shall be solely responsible for obtaining and paying all costs in connection with any additional work area, storage sites, access to the site or temporary right-of-way, which may be required for proper completion of the Work.
- D. Limitations on Use of Work Area:
  1. It shall be understood that responsibility for protection and safe-keeping of equipment and materials on or near the site will be entirely that of the CONTRACTOR and that no claim shall be made against the OWNER or their authorized representatives by reason of any act.
  2. It shall be further understood that should any occasion arise necessitating access to the sites occupied by these stored materials or equipment, the ENGINEER shall direct

the CONTRACTOR owning or responsible for the stored materials and equipment to immediately move the same.

3. No materials or equipment may be placed upon the property of the OWNER, other than in the designated areas as shown on the Drawings, unless the ENGINEER has agreed to the location contemplated by the CONTRACTOR to be used for storage.
  4. All stored materials shall be labeled according to the appropriate contractor or Subcontractor with the manufacturer's label as well.
  5. Appropriate material safety data sheets (e.g., MSDS) shall be provided.
- E. The CONTRACTOR shall be required to share use of the premises with other Contractors whose services the OWNER has obtained or will obtain for construction of other facilities on the site.

#### 1.10 USE OF OWNER'S FACILITIES

- A. The CONTRACTOR may use existing facilities or equipment in the Work for construction purposes, only if the OWNER's written permission is obtained.
- B. Restore existing facilities and equipment used for temporary purposes to original condition in a manner satisfactory to OWNER.

#### **PART 2 - PRODUCTS (NOT USED)**

#### **PART 3 - EXECUTION (NOT USED)**

++ END OF SECTION ++

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## SECTION 01130

### SPECIAL PROJECT CONSTRAINTS

#### **PART 1 - GENERAL**

##### 1.1 LIMIT OF CONSTRUCTION ACTIVITIES ON WORK SITE

- A. Traffic Control:
  - 1. During non-work hours, the CONTRACTOR shall keep all lanes of traffic open and clear. All trenches shall be backfilled or covered with suitable steel plates and open to traffic.
  - 2. No equipment, construction material or excavated material that will interfere with traffic shall be stored on streets or roadways at any time.

##### 1.2 SEQUENCE OF WORK

- A. General:
  - 1. The CONTRACTOR shall schedule and sequence their work to complete the Work by the specified completion date.
  - 2. The OWNER's water distribution, recycled water, sewer collection and storm drain systems must remain operational at all times, with scheduled shutdowns as necessary to complete the Work and with prior approval of Owner, as described herein.
  - 3. Re-vegetation of graded areas shall take place as quickly as possible as weather permits.

##### 1.3 PROJECT CONSTRAINTS

- A. Maintenance of OWNER's Operations:
  - 1. Constraints listed herein involve limits on activities during construction. These limits relate to the critical nature of the existing water system.
  - 2. Continuous operation of OWNER's facilities is of critical importance. Schedule and conduct activities to enable existing facilities to operate continuously, unless otherwise specified.
  - 3. Work Plan:
    - a. The CONTRACTOR shall submit a detailed Work Plan and time schedule for all construction activities that will make it necessary to remove a tank, pipeline, electrical circuit, equipment, structure, road or other facilities from service, including the critical outages identified herein.
    - b. The Work Plan shall, at a minimum, identifying:
      - 1) the date and time when each activity will occur;
      - 2) what equipment will be present including standby equipment;
      - 3) what assistance will be required by OWNER's operating personnel;
      - 4) an emergency backup plan identifying what action will be taken if Work cannot be completed within the allotted time; and
      - 5) what individual will be in charge of the activity.
    - c. Submit Work Plan 10 working days prior to the scheduled activity.
  - 4. Perform Work continuously during critical connections and changeovers, and as required to prevent interruption of OWNER's operations.
  - 5. Shutdowns:

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- a. Coordinate proposed Work with OWNER and facility operations personnel before affecting unit shutdowns. The CONTRACTOR shall provide written confirmation of the shutdown date and time five (5) working days prior to the actual shutdown.
  - b. Under no circumstances shall the CONTRACTOR cease Work at the end of a normal working day or at the end of a working week if such actions may inadvertently cause a cessation of any facility operating process, in which case, remain onsite until necessary repairs are complete.
- 6. Do not close lines, open valves or gates, shut down equipment, or take other action which would affect the operation of existing systems, except as specifically required by the Contract Documents and after approval of OWNER.
- 7. Do not proceed with Work affecting a facility's operation without obtaining OWNER's advance approval of the need for and duration of such Work.
- B. Relocation of Existing Facilities:
  - 1. During construction, it is expected that minor relocations of Work will be necessary.
  - 2. Provide complete relocation of existing structures and Underground Facilities, including piping, utilities, equipment, structures, electrical conduit wiring, electrical duct bank, and other necessary items.
  - 3. Use only new materials for relocated facility. Match materials of existing facility, unless otherwise shown or specified.
  - 4. Perform relocations to minimize downtime of existing facilities.
  - 5. Install new portions of existing facilities in their relocated position prior to removal of existing facilities, unless otherwise accepted by OWNER.
- C. Hours of Work and Overtime:
  - 1. Normal working hours at the Construction Site for the project shall be 7A.M. to 5P.M., weekdays, no work during the weekend nor during City observed holidays.
    - a. Conduct Work outside normal working hours only after obtaining prior written consent and approval from the OWNER.
      - 1) Contractor shall request work-hour variations in writing, a minimum of ten (10) days prior to the start of the proposed work period.
      - 2) Contractor shall not rely on approval of work outside of normal working hours without prior consent of the OWNER. Approval shall be at the sole discretion of the OWNER.
    - b. Contractor will develop Project Schedule assuming work during normal working hours only.
  - 2. All overtime Work by the CONTRACTOR necessary to conform to the requirements of this Section and related Sections shall be performed by the CONTRACTOR, at no cost to the OWNER and shall be performed in accordance with the Agreement. The CONTRACTOR shall make no claims for extra compensation as a result thereof.

#### 1.4 CONSTRUCTION SEQUENCING CONSTRAINTS

- A. No specific construction sequencing constraints other than those listed in this or other Specification section have been determined at the time of Final Design.
- B. Construction sequencing constraints will be developed by Design-Assist Team as necessary.

#### 1.5 PROJECT STAFFING

- A. Project superintendent (Job Superintendent, serving as resident Superintendent and Contractor's authorized representative), employed by the Contractor, shall be on-site five

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days per week for 8 hours a day and in responsible charge of all work, quality control, subcontractors, permit compliance, and the site.

- B. Qualified Storm Water Pollution Prevention Plan (SWPPP) Practitioner (QSP) , employed by Contractor, must be on call to come to the site when a Rain Event Action Plan (REAP) needs to be prepared.

#### 1.6 STORMWATER MANAGEMENT

- A. CONTRACTOR responsible for stormwater management for the duration of the project.

### **PART 2 - PRODUCTS (NOT USED)**

#### 2.1 PRODUCTS

- A. All material that contacts potable water shall be "lead free" to the extent defined in the California Assembly Bill 1953 Chapter 853 and NSF 61 approved.

### **PART 3 - EXECUTION (NOT USED)**

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## SECTION 01140

### WATER POLLUTION CONTROL

#### **PART 1 - GENERAL**

##### **1.1 DESCRIPTION**

###### A. Scope:

1. Provide all labor, materials and resources to fully comply with applicable local, State and Federal regulations and requirements for water pollution prevention and control.
2. The preliminary SWPPP has been prepared and posted to the City of Roseville's Public Purchase website. It is made available for the convenience of the CONTRACTOR. The CONTRACTOR shall develop, update, revise and finalize as needed to comply with all requirements.
3. CONTRACTOR to comply with the City's municipal separate storm sewer system (MS4) Stormwater Management Program.

##### **1.2 SUBMITTALS**

###### A. Stormwater Pollution Prevention Plan (SWPPP) Information:

1. Within 10 business days of the contract being signed, the CONTRACTOR shall provide the following information:
  - a. Provide project SWPPP to comply with Construction General Permit Requirements and all other requirements of the Contract Documents;
  - b. Provide the Prime CONTRACTOR's company name, address, contact person (with office phone and emergency/cell phone) for Sections 100.1 and 500.1;
  - c. Provide the Qualified SWPPP Practitioner's (QSP) name, company name, address, office phone and emergency/cell phone for Section 500.1. Provide a copy of their current QSP certification from California Stormwater Quality Association (CASQA) including the license expiration date. If a SMARTs certified QSD is being used then provide documentation from SMARTs;
  - d. Provide a Subcontractor List (with names, addresses, phone numbers, areas of responsibility, etc.);
  - e. Provide a Project Schedule.
2. Provide Storm Water Quality Construction Site Inspection Checklist to be used by CONTRACTOR during construction.

##### **1.3 REGULATORY REQUIREMENTS**

###### A. Laws and Regulations:

1. The CONTRACTOR is responsible for complying with the Clean Water Act Section 401, Stormwater Pollution Prevention Plan (SWPPP) for all anticipated construction activities.
2. The OWNER shall submit a Notice of Intent (NOI) to the State Water Resources Control Board to obtain coverage under the National Pollution Discharge Elimination System (NPDES) and pay all filing fees associated with the NOI.
3. The Contractor shall perform construction operations to comply, and ensure subcontractors comply, with applicable Federal, State, and local laws, orders, regulations and water quality standards concerning control and abatement of water pollution, and terms and conditions of applicable permits issued by permit issuing

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authority. If conflict occurs between Federal, State, and local laws, regulations, and requirements, the most stringent shall apply.

4. The CONTRACTOR shall know and fully comply with applicable provisions of the Permits and all modifications thereto, and Federal, State, and local regulations and requirements that govern the CONTRACTOR's operations and stormwater and non-stormwater discharges from both the project site and areas of disturbance outside the project limits during construction.

B. Permit

1. As part of the water pollution control work, a Storm Water Pollution Prevention Plan (SWPPP) is required for this contract. The SWPPP and amendments shall be considered to fulfill the provisions in this section, "Water Pollution Control," of the Standard Specifications for development and submittal of a Water Pollution Control Program.
2. Approval shall not constitute a finding that the SWPPP complies with applicable requirements of the Permit, the Manuals and applicable Federal, State and local laws, regulations, permits, and requirements, nor does approval supersede the requirements and provisions of these special provisions, the Permit, or any other federal, state, or local regulations or permit in the event of a conflict.
3. The SWPPP shall identify the Qualified SWPPP Practitioner (QSP) as required by the Permit.
4. A Preliminary SWPPP will be provided to the CONTRACTOR. The CONTRACTOR will be required to revise and finalize the SWPPP as needed to comply with Construction General Permit Requirements and all other pertinent laws, rules, and regulations. Only a Qualified SWPPP Developer (QSD) is allowed to revise or amend the SWPPP. All revisions and Amendments must be accepted by Legally Responsible Person (LRP). The CONTRACTOR shall provide all Permit Registration Documents (PRDs). PRDs consist of:
  - a. Notice of Intent (NOI)
  - b. Risk assessment
  - c. Site Map
  - d. Storm Water Pollution Prevention Plan (SWPPP)
  - e. Annual Fee
  - f. Signed Certification Statement
  - g. Notice of termination (NOT)
  - h. Changes of Termination
  - i. Annual Reporting
  - j. Other Compliance Documents
5. The OWNER will submit the PRDs electronically to the State Water Resources Control Board (State) website, entitled Stormwater Multi Application Reporting and Tracking System (SMARTS). For the purposes of the Permit, the City of Roseville is the owner of the Permit and is the Legally Responsible Person (LRP). The LRP will retain authority for assigning the Approved Signatories and Data Submitters in SMARTS. The CONTRACTOR's QSP and/or QSD will be designated as Data Submitters in SMARTS, including the responsibilities thereof, as required by the Permit. LRP will submit the appropriate fee to the State and obtain a certified NOI and Waste Discharge Identification Number (WDID) for the project
6. No ground disturbing work shall occur until the PRD and SWPPP have been uploaded to the State website. The ENGINEER will notify the CONTRACTOR in writing upon completion of the document upload which will allow ground disturbing work to begin. The SWPPP shall apply to the areas within or immediately outside of the right-of-way that are directly related to all construction activities including, but not limited to, material borrow or disposal areas, staging areas, storage yards, and access roads,

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- including those on-site areas developed by the CONTRACTOR with third parties for use during the project.
7. The CONTRACTOR shall develop a Water Pollution Control Schedule that describes the timing of grading or other work activities that could affect water pollution. The Water Pollution Control Schedule shall be updated by the CONTRACTOR to reflect changes in the CONTRACTOR's operations that would affect the necessary implementation of water pollution control practices.
  8. Water pollution control practices include the "Minimum Requirements" and other CONTRACTOR-selected water pollution control practices from the "SWPPP" and the "Project-Specific Minimum Requirements" identified in the Water Pollution Control Cost Break-Down of this section. Listing of these minimum requirements shall not relieve the Contractor of meeting all permit requirements.
  9. The requirements described herein are considered minimum requirements. Additional BMPs may be required to meet the requirements set forth in the SWPPP and the Permit. All BMPs shall be designed, installed, maintained, and otherwise managed pursuant to the provisions set forth in the most stringent and most recent of the following: the City of Roseville Stormwater Quality BMP Guidance Manual for Construction, West Placer Storm Water Quality Design Manual, California Department of Transportation (Caltrans) Stormwater Quality Handbook - Construction Site BMP Manual or the California Stormwater Quality Association (CASQA) - California Stormwater BMP Handbook for Construction. The CONTRACTOR shall prepare an amendment to the SWPPP as required by the Permit, such as when there is a change in construction activities or operations which may affect the discharge of pollutants to surface waters, ground waters, storm drain systems; when the CONTRACTOR's activities or operations violate a condition of the Permit; when there is a change in the schedule that affects the discharge of pollutants; when there is a change in the schedule that affects the Risk Level required by the Permit; or when directed by the ENGINEER. Amendments shall identify additional water pollution control practices or revised operations, including those areas or operations not identified in the initially approved SWPPP. Amendments to the SWPPP shall be prepared and submitted for review and approval within the time required by the Permit and approved by the ENGINEER, but in no case longer than the time specified for the initial submittal and review of the SWPPP. Approved amendments shall be submitted electronically to the ENGINEER within 24 hours of approval. At a minimum, the SWPPP shall be amended annually as required by the Permit, and an electronic copy submitted to the ENGINEER.
  10. The CONTRACTOR shall keep one copy of the approved SWPPP and approved amendments at the project site. The SWPPP shall be made available upon request by a representative of the Regional Water Quality Control Board, State Water Resources Control Board, United States Environmental Protection Agency, or the local storm water management agency. Requests by the public shall be directed to the ENGINEER.
  11. The CONTRACTOR shall notify the ENGINEER immediately upon request from the regulatory agencies to enter, inspect, sample, monitor, or otherwise access the project site or the CONTRACTOR's records pertaining to water pollution control work.
  12. Cost Break-down
    - a. The CONTRACTOR shall include a Water Pollution Control Cost Break-Down which itemizes the water pollution control work portion of the GMP. The CONTRACTOR shall use the Water Pollution Control Cost Break-Down provided in this section (See attached supplement) as the basis for the cost break-down submitted with the SWPPP information. The CONTRACTOR shall use the Water Pollution Control Cost Break-Down to identify items, quantities and non-adjustable values for water

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pollution control work, excluding water pollution control practices for which are separated in the Schedule of Values. The CONTRACTOR shall be responsible for the accuracy of the quantities and non-adjustable values used in the cost break-down submitted with the SWPPP. Partial payment for the item of water pollution control will not be made until the Water Pollution Control Cost Break-Down is approved by the ENGINEER.

- b. Line items indicated in the Water Pollution Control Cost Break-Down in this section with a specified Estimated Quantity shall be considered "Project-Specific Minimum Requirements." The CONTRACTOR shall incorporate Project-Specific Minimum Requirements with CONTRACTOR-designated quantities and values into the Water Pollution Control Cost Break-Down submitted with the SWPPP.
- c. Line items indicated in the Water Pollution Control Cost Break-Down in this section without a specified Estimated Quantity shall be considered by the CONTRACTOR for selection to meet the applicable requirements for water pollution control work required in the SWPPP. In the Water Pollution Control Cost Break-Down submitted with the SWPPP, the CONTRACTOR shall list only those water pollution control practices selected for the project, including quantities and non-adjustable values required to complete the work for those items.
- d. The sum of the amounts for the items of work listed in the Water Pollution Control Cost Break-Down shall be equal to the value for water pollution control include in the GMP. Overhead and profit shall be included in the individual items listed in the cost break-down.
- e. No adjustment in compensation will be made to the GMP for water pollution control due to differences between the quantities shown in the approved cost break-down and the quantities required to complete the work as shown on the approved SWPPP. No adjustment in compensation will be made for ordered changes to correct SWPPP work resulting from the CONTRACTOR's own operations or from the CONTRACTOR's negligence.
- f. The approved cost break-down will be used to determine partial payments during the progress of the work and as the basis for calculating the adjustment in compensation for the item of water pollution control due to increases or decreases of quantities ordered by the ENGINEER. When an ordered change increases or decreases the quantities of an approved cost break-down item, the adjustment in compensation will be determined in the same manner specified for increases and decreases in the quantity of a contract item of work in conformance with the Agreement. If an ordered change requires a new item which is not on the approved cost break-down, the adjustment in compensation will be determined in the same manner specified for Changes In the Work in the Agreement.

## **PART 2 - PRODUCTS**

- A. Provide all materials in accordance with provisions set forth in the most stringent and most recent of the following: City of Roseville Stormwater Quality BMP Guidance Manual for Construction, West Placer Storm Water Quality Design Manual, California Department of Transportation (Caltrans) Stormwater Quality Handbook, Construction Site BMP Manual or of the California Stormwater Quality Association (CASQA), California Stormwater BMP Handbook for Construction.
- B. Only biodegradable wattles containing no plastic can remain on a site when applying for a Notice of Termination (NOT). Wattles containing plastic netting (including plastic specified as biodegradable) are not permitted on this project.

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## **PART 3 - EXECUTION**

### **3.1 THIRD PARTY SWPPP OVERSIGHT AND PRACTITIONER SUBCONSULTANT**

- A. CONTRACTOR shall retain a third-party firm to provide SWPPP oversight and QSP services including:
  - 1. Print out daily weather report
  - 2. Read and record rain gauge daily
  - 3. Prepare REAPs
  - 4. Perform all inspections (pre-and post-storm, quarterly, non-stormwater inspections)
  - 5. Write inspection reports to document inspections
  - 6. Prepare annual report for OWNER to certify
  - 7. Perform and document all sampling (stormwater, non-stormwater, and discharge)
    - a. Sampling must occur every business day that runoff or discharges are leaving the site
  - 8. Provide staff trainings as needed and keep records of trainings
  - 9. Organize all paperwork for project closeout
  - 10. Maintain the pH meter and turbidimeter, perform calibration of equipment and provide calibration records.
- B. All weather reports, rain gauge log, inspection reports, sampling records, REAPs, and training records shall be maintained daily in the SWPPP binder at the project site.
- C. SWPPP subconsultant shall be a QSP and responsible for development and maintenance of SWPPP throughout construction and post-construction until acceptance of NOT by Board.
- D. The SWPPP subconsultant shall be registered on SMARTS and linked to the project as Data Submitters.
- E. CONTRACTOR shall be responsible for all means and methods related to implementation of SWPPP throughout construction and post-construction until acceptance of NOT by Board.
- F. SWPPP subconsultant shall attend all weekly construction progress meetings in person.
- G. SWPPP subconsultant shall prepare and submit on a monthly basis a certification that the site is in compliance with all SWPPP requirements and all documentation related to the site has been prepared and submitted in accordance with the General Permit Requirements. Certification shall be made by signing the certification form and submitting it to the CONTRACTOR, with a copy sent to the OWNER.
- H. SWPPP subconsultant shall be responsible for the following:
  - 1. Prepare ad hoc reports and exceedance reports as needed;
  - 2. Submit such reports to SMARTS, as needed; and,
  - 3. Prepare and upload on SMARTS change of information applications, annual reports and Notice of Termination, as needed.
- I. Signed certification shall be submitted with all Monthly Pay Requests by CONTRACTOR. Failure to submit Certification signed by SWPPP subconsultant shall result in rejection of monthly pay request.

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### 3.2 IMPLEMENTATION

- A. If there is a discrepancy between the project Permit and these special provisions, the Permit language shall supersede. If there is a discrepancy between the SWPPP and these special provisions, the special provisions shall supersede. Unless otherwise specified, upon approval of the SWPPP, the CONTRACTOR shall be responsible throughout the duration of the project for installing, constructing, inspecting, maintaining, replacing, removing, and disposing of temporary water pollution control practices, and installing, constructing, inspecting, maintaining, and replacing permanent water pollution control practices specified in the SWPPP and in the amendments. The duration of work includes that time period between initial mobilization to the site and acceptance of the work. Unless otherwise directed by the ENGINEER, the CONTRACTOR's responsibility for SWPPP implementation shall continue throughout temporary suspensions of work. Requirements for installation, construction, inspection, maintenance, replacement, removal, and disposal of water pollution control practices shall conform to the requirements in these special provisions and to project permits.
- B. Installing, inspecting and maintaining water-pollution control practices on areas outside the designated work area not specifically arranged and provided for by the City for the execution of this contract, will not be paid for.
- C. If the CONTRACTOR or the ENGINEER identifies a deficiency in the implementation of the approved SWPPP or amendments, the deficiency shall be corrected immediately unless requested by the CONTRACTOR and approved by the ENGINEER in writing but shall be corrected prior to the onset of precipitation. If the CONTRACTOR fails to correct the identified deficiency by the date agreed or prior to the onset of precipitation, the project shall be in nonconformance with this section, "Water Pollution Control."
- D. If the CONTRACTOR fails to conform to the provisions of this section, the ENGINEER may order the suspension of construction operations and/or may hire a third party to correct the deficiency. Additional project costs will be deducted from the CONTRACTOR's retention until the CONTRACTOR complies with the requirements.

### 3.3 YEAR-ROUND IMPLEMENTATION REQUIREMENTS

- A. The CONTRACTOR shall have a year-round program for implementing, inspecting and maintaining water pollution control practices for wind erosion control, tracking control, non-storm water management, and waste management and materials pollution control.
- B. The National Weather Service weather forecast shall be monitored and used by the CONTRACTOR on a daily basis. If 50 percent or greater precipitation is predicted, the necessary water pollution control practices shall be deployed prior to the onset of the precipitation. If there is less than a 50 percent chance of precipitation, the CONTRACTOR shall still be responsible for ensuring the project site does not result in a discharge of pollutants off-site. Regardless of the chances of precipitation, the CONTRACTOR shall allow adequate time to properly install all required BMPs prior to precipitation.
- C. Disturbed soil areas shall be considered active whenever the soil disturbing activities have occurred, continue to occur or will occur during the ensuing 14 days. Non-active areas shall be stabilized with water pollution control practice within 14 days of cessation of soil disturbing activities or prior to the onset of precipitation, whichever occurs first.

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### 3.4 MAINTENANCE

- A. To ensure the proper implementation and functioning of water pollution control practices, the CONTRACTOR shall regularly inspect and maintain the construction site for the water pollution control practices identified in the SWPPP. The construction site shall be inspected by the CONTRACTOR as follows:
  - 1. Prior to a forecast storm.
  - 2. After a precipitation event which causes site runoff.
  - 3. At 24 hour intervals during extended precipitation events.
  - 4. Routinely, a minimum of once every week
- B. The CONTRACTOR shall use a Storm Water Quality Construction Site Inspection Checklist approved by the ENGINEER. One copy of each site inspection record shall be submitted to the ENGINEER within 24 hours of completing the inspection.

### 3.5 CONTRACTOR VIOLATIONS:

- A. If noncompliance occurs, immediately (verbally) report noncompliance to the ENGINEER. Submit specific information within 2 days.
- B. Consistent violations of applicable Federal, State, or local laws, orders, regulations, or Water Quality Standards may result in the ENGINEER stopping all site activity until compliance is ensured.
- C. The CONTRACTOR shall not be entitled to extension of time, claim for damage, or additional compensation by reason of such a work stoppage.
- D. Corrective measures required bringing activities into compliance, or fines imposed by a regulating authority, shall be at the CONTRACTOR's expense.

### 3.6 REPORTING REQUIREMENTS

- A. Report of Discharges, Notices or Orders
  - 1. If the CONTRACTOR identifies discharges from the project site, regardless of source, in a manner causing, or potentially causing, a condition of pollution in surface waters or drainage systems, the CONTRACTOR shall immediately inform the ENGINEER. In addition, the CONTRACTOR shall submit a written Notice of Discharge report to the ENGINEER within 24 hours of the discharge event. The report shall include the following information:
    - a. The date, time, location, nature of the operation, and type of discharge, including the cause or nature of the notice or order.
    - b. The water pollution control practices deployed before the discharge event.
    - c. The date of deployment and type of water pollution control practices deployed after the discharge event, including additional measures installed or planned to remediate and clean-up the discharge, and/or reduce or prevent reoccurrence.
    - d. An implementation and maintenance schedule for affected water pollution control practices.
- B. Report of First-Time Non-Storm Water Discharge
  - 1. The CONTRACTOR shall notify the ENGINEER at least 3 days in advance of first-time non-storm water discharge events, excluding exempted discharges. The CONTRACTOR shall notify the ENGINEER of the operations causing non-storm water discharges and shall obtain field approval for first-time non-storm water discharges.

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Non-storm water discharges shall be monitored at first-time occurrences and routinely thereafter.

2. If the CONTRACTOR receives a written Notice, Order, or other non-compliance action letter from a regulatory agency as a result of storm water or other discharges from the project site, the CONTRACTOR shall immediately notify the ENGINEER. The CONTRACTOR shall be solely responsible for responding to and complying with the Notice, Order, or action letter, unless otherwise directed by the ENGINEER.
3. Unless otherwise directed in this Section, and in addition to the requirements of the Permit, the CONTRACTOR shall submit for approval, all required inspection reports, monitoring reports, action plans, notices, amendments, and other documentation required to satisfy requirements of the Permit, to the ENGINEER within 3 days of their completion. The ENGINEER will have 3 days to approve the documents as complete and sufficient to satisfy the Permit or other agency requirements. If the documents are not complete and sufficient, the ENGINEER will return them to the CONTRACTOR for resubmittal. The CONTRACTOR shall be responsible for submitting complete, accurate, and detailed reporting documents sufficient to satisfy all conditions of the Permit and regulatory agency requirements.

C. Annual Report

1. The CONTRACTOR shall maintain all records for use in the annual report.
2. The CONTRACTOR should prepare the annual report using the SMARTS system by no later July 30. The OWNER will certify and submit the report.

### 3.7 CONSTRUCTION SITE MANAGEMENT

A. CONTRACTOR Construction Operations:

1. Perform construction activities by methods that will prevent entrance, or accidental spillage, of solid matter, contaminants, debris, or other pollutants or wastes into streams, flowing or dry watercourses, wetlands, or underground water sources.
2. Pollutants and wastes include, but are not restricted to: refuse, garbage, cement, sanitary waste, industrial waste, hazardous materials, radioactive substances, oil and other petroleum products, aggregate processing tailings, mineral salts, and thermal pollution.
3. Discharge of cement fines, drilling fluids, contaminated water, and other construction byproducts will not be allowed on site.
4. Discharge from dewatering and unwatering operations shall be contained in an onsite tank or containment/infiltration basin. Discharge to infiltration basins shall be limited to water and groundwater only.

B. Stockpiled or Deposited Materials:

1. Do not stockpile or deposit excavated materials or other construction materials, near or on, stream banks or other watercourse perimeters where they can be washed away by high water or storm runoff, or can in any way encroach upon the watercourse.

C. Oil Storage Tanks Management:

1. Place oil or other petroleum product (hereinafter referred to collectively as oil) storage tanks at least 150 feet from the edge of any water body.
2. Do not use underground storage tanks.
3. Construct storage area dikes at least 12 inches high or graded and sloped to permit safe containment of leaks and spills equal to the capacity located in each area plus a sufficient amount of freeboard to contain the 25-year rainstorm.
4. Line diked areas with an impermeable barrier at least 50 mils thick.

D. Refueling Operations:

1. Provide areas used for refueling operations with an impermeable liner at least 10 mils thick buried under 2 to 4 inches of soil.

3.8 PAYMENT

A. General

1. No additional payment will be made to correct deficiencies in the SWPPP or Amendments.
2. The contract GMP shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in installing, constructing, removing, and disposing of water pollution control practices, including non-storm water management, and waste management and materials for water pollution control practices as provided for in the approved SWPPP, except those for which there is a contract item of work as specified in the Standard Specifications and these special provisions, and as directed by the ENGINEER.
3. Full compensation for Permit reporting and compliance, including all monitoring, preparation of inspection reports, and stormwater sampling and analysis, and maintenance costs of Water Pollution Control Practices, Amendments, and Implementation of Amendments as specified in this section, "Water Pollution Control," shall be considered as included in the contract lump sum price paid for water pollution control and no additional compensation will be allowed therefore.
4. No additional payment will be made for Water Pollution Control Practices necessary to correct deficiencies in the approved SWPPP or Amendments.
5. Water pollution control practices, for which there is a contract item of work, will be measured and paid for as that contract item of work.

B. Retention of Funds:

1. Notwithstanding any other remedies authorized by law, the CITY may retain money due the CONTRACTOR under the contract, in an amount determined by the CITY, up to and including the entire amount of Penalties proposed, assessed, or levied as a result of the CONTRACTOR's violation of the Permit, or Federal or State law, regulations or requirements. Funds may be retained by the CITY until final disposition has been made as to the Penalties. The CONTRACTOR shall remain liable for the full amount of Penalties until such time as they are finally resolved with the entity seeking the Penalties.
2. Retention of funds for failure to conform to the provisions in this section, "Water Pollution Control," shall be in addition to the other retention amounts required by the contract. The amounts retained for the CONTRACTOR's failure to conform to provisions in this section will be released for payment on the next monthly estimate for partial payment following the date when an approved SWPPP has been implemented and maintained, and when water pollution has been adequately controlled, as determined by the ENGINEER.
3. When a regulatory agency identifies a failure to comply with the Permit and modifications thereto, or other Federal, State or local requirements, the CITY will retain money due the CONTRACTOR, in the amount of 10 percent of the work done to date or any fine whichever is greater, this amount is in addition to the retention specified in Section 9-3.2, Partial and Final Payment, subject to the following. The CITY will give the CONTRACTOR written notice of the CITY's intent to retain funds from partial payments which may become due to the CONTRACTOR prior to recording of the Notice of Completion.

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4. During the first estimate period that the CONTRACTOR fails to conform to the provisions in this section, "Water Pollution Control," the CITY may retain an amount equal to 25 percent of the estimated value of the contract work performed.
5. The CONTRACTOR shall notify the ENGINEER immediately upon request from the regulatory agencies to enter, inspect, sample, monitor, or otherwise access the project site or the CONTRACTOR's records pertaining to water pollution control work. The CONTRACTOR shall provide copies of correspondence, notices of violation, enforcement actions or proposed fines by regulatory agencies to the requesting regulatory agency.

### 3.9 REMOVAL

- A. Remove temporary works in accordance with Section 01810, Cleaning.

### 3.10 SUPPLEMENTS

- A. Water Pollution Control Cost Break-Down
- B. Certification Form

+ + END OF SECTION + +

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<b>Section 01140</b> <b>Water Pollution Control Cost Break-down</b>				
<b>Item Description</b>	<b>Unit</b>	<b>Estimated Quantity</b>	<b>Value</b>	<b>Amount</b>
Erosion Control (Temporary)	ACRE			
Erosion Control (Permanent)	ACRE			
Straw Mulch	ACRE			
Geotextiles, Plastic Covers & Erosion Control Blankets/Mats	SQYD			
Wood Mulching	SQYD			
Earth Dikes/Drainage Swales & Lined Ditches	LF			
Outlet Protection/Velocity Dissipation Devices	EA			
Slope Drains	EA			
Silt Fence	LF			
Desilting Basin	EA			
Sediment Trap	EA			
Gravel Check Dam	TON			
Fiber Rolls	LF			
Gravel Bag Berm	LF			
Street Sweeping and Vacuuming	LS			
Sandbag Barrier	LF			
Straw Bale Barrier	LF			
Storm Drain Inlet Protection	EA			
Wind Erosion Control	LS			
Stabilized Construction Entrance/Exit	EA			
Stabilized Construction Roadway	EA			
Entrance/Outlet Tire Wash	EA			
Water Conservation Practices	LS			
Dewatering Operations	EA			
Paving and Grinding Operations	LS			
Temporary Stream Crossing	EA			
Clear Water Diversion	EA			
Illicit Connection/Illegal Discharge Detection and Reporting	LS			
Potable Water/Irrigation	LS			
Vehicle and Equipment Cleaning	LS			
Vehicle and Equipment Fueling	LS			
Vehicle and Equipment Maintenance	LS			
Material Delivery and Storage	LS			
Material Use	LS			
Stockpile Management	LS			
Spill Prevention and Control	LS			
Solid Waste Management	LS			
Hazardous Waste Management	LS			
Contaminated Soil Management	LS			

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<b>Item Description</b>	<b>Unit</b>	<b>Estimated Quantity</b>	<b>Value</b>	<b>Amount</b>
Concrete Waste Management	LS			
Sanitary/Septic Waste Management	LS			
Liquid Waste Management	LS			
<b>TOTAL:</b>				

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## SWPPP COMPLIANCE FORM

As the QSP for the Project, I hereby certify the project site is in full compliance with applicable local, State and Federal regulations and requirements for water pollution prevention and control.

---

Printed Name

---

Signature

---

Date

---

QSP Number

01140-13

City of Roseville  
West Side Tank and Pump Station Project (Phase 2)  
17-083

November 2019  
Final Design Submittal

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## SECTION 01145

### ENVIRONMENTAL PROTECTION

#### **PART 1 - GENERAL**

##### **1.1 SECTION INCLUDES**

- A. Requirements for Environmental Protection. During the progress of the work, keep Contractor occupied work areas in a neat and clean condition and protect the environment both onsite and offsite, throughout and upon completion of the construction project.

##### **1.2 SUBMITTALS**

- A. Develop a detailed Environmental Protection Plan and submit to the Engineer for review and approval prior to the beginning of construction. Distribute the favorably reviewed plan to all employees and to all subcontractors and their employees. The Environmental Protection Plan shall include, but not be limited to, the following items:
  - 1. Copies of required permits.
  - 2. Proposed disposal sites.
  - 3. Copies of any agreements with public or private landowners regarding equipment, materials storage, borrow sites, fill sites, or disposal sites. Any such agreement made by the Contractor shall be invalid if its execution causes violation of local or regional grading or land use regulations.

##### **1.3 MITIGATION OF CONSTRUCTION IMPACTS**

- A. All operations shall comply with federal, state and local regulations pertaining to water, air, solid waste and noise pollution.
- B. Definitions of Contaminants:
  - 1. Sediment: Soil and other debris that have been eroded and transported by runoff water.
  - 2. Solid Waste: Rubbish, debris, garbage and other discarded solid materials resulting from construction activities, including a variety of combustible and non-combustible wastes, such as ashes, waste materials that result from construction or maintenance and repair work, leaves and tree trimmings.
  - 3. Chemical Waste: Includes petroleum products, bituminous materials, salts, acids, alkalis, herbicides, pesticides, disinfectants, organic chemicals and inorganic wastes. Some of the above may be classified as "hazardous."
  - 4. Sanitary Wastes:
    - a. Sewage: That which is considered as domestic sanitary sewage.
    - b. Garbage: Refuse and scraps resulting from preparation, cooking, dispensing and consumption of food.
  - 5. Hazardous Materials: As defined by applicable laws and regulations. Undisclosed hazardous material contamination, if encountered will constitute a changed site condition. In the event that occurs, Contractor shall coordinate with Owner consistent with final EIR Mitigation Measure 4.9-1 as described in Section 1.3.D of this Specification.
- C. Protection of Natural Resources:

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1. General: It is intended that the natural resources within the project boundaries and outside the limits of grading performed under this Contract be preserved in their existing condition or be restored to an equivalent or improved condition upon completion of the work. Confine construction activities to areas defined by the public roads, easements, and work area limits shown on the Drawings. Return construction areas to their preconstruction elevations except where surface elevations are otherwise noted to be changed. Maintain natural drainage patterns except where surface drainage is otherwise noted to be changed. Conduct construction activities to avoid ponding stagnant water conducive to mosquito breeding.
2. Land Resources:
  - a. Do not remove, cut, deface, injure or destroy trees or shrubs outside the work area limits. Do not remove, deface, injure or destroy trees within the work area without permission from the Engineer.
  - b. Temporary Construction:
    - 1) Obliterate all signs of temporary construction facilities such as haul roads, work areas, structures, foundations of temporary structures, stockpiles of excess or waste materials, or any other vestiges of construction as directed by the Engineer.
    - 2) Level all temporary roads, parking areas and any other areas that have become compacted or shaped.
    - 3) Any unpaved areas where vehicles are operated shall receive a suitable surface treatment or shall be periodically wetted down to prevent construction operations from producing dust damage and nuisance to persons and property, at no additional cost to the Owner.
    - 4) Keep haul roads clear of any object which creates an unsafe condition.
    - 5) Promptly remove any contaminants or construction material dropped from construction vehicles.
    - 6) Do not drop mud and debris from construction equipment on public streets.
    - 7) Sweep clean turning areas and pavement entrances as necessary.
    - 8) Ensure no tracking occurs on City streets.
3. Water Resources:
  - a. Investigate and comply with all applicable federal, state and local regulations concerning the discharge (directly or indirectly) of pollutants to the City storm drain system and waters of the United States. Perform all work under this Contract in such a manner that any adverse environmental impacts are reduced to a level that is acceptable to the Engineer and regulatory agencies.
  - b. Oily Substances:
    - 1) Special measures shall be taken to prevent oily or other hazardous substances from entering the ground, drainage areas or local bodies of water in such quantities as to affect normal use, aesthetics or produce a measurable impact upon the area.
    - 2) Any soil or water which is contaminated with oily substances due to the Contractor's operations shall be disposed of in accordance with applicable regulations consistent with final EIR Mitigation Measure 4.9-1 as described in Section 1.3.D of this Specification.
  - c. Chlorinated Water:
    - 1) Take special measures to prevent chlorinated water from entering the ground or surface waters.
    - 2) De-chlorinate chlorinated water prior to discharge.
4. Cultural Resources:
  - a. The project does not pass through any known archaeological sites. However, it is conceivable that unrecorded archaeological sites could be discovered during the construction.

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- b. In the event that artifacts, human remains, or other cultural resources are discovered during excavations at locations of the Work, the Contractor shall protect the discovered items, notify the Engineer, and comply with applicable law consistent with final EIR Mitigation Measure 4.8-1 as described in Section 1.3.D of this Specification.
- 5. Dust Control, Air Pollution and Odor Control:
  - a. Employ measures to prevent the creation of dust, air pollution and odors consistent with final EIR Mitigation Measure 4.4-1 and 4.4-3 as described in Section 1.3.D of this Specification.
  - b. Comply with Placer County Air Pollution Control District's (PCAPCD) rules and regulations.
  - c. Unpaved areas where vehicles are operated shall be periodically wetted down or given an equivalent form of treatment, to eliminate dust formation.
  - d. Store all volatile liquids, including fuels or solvents in closed containers and provide secondary containment as needed.
  - e. No open burning of debris, lumber or other scrap will be permitted.
  - f. Properly maintain equipment to reduce gaseous pollutant emissions.
- 6. Construction Storage Areas:
  - a. It is the responsibility of the Contractor to secure a storage area for Contractor use. Storage of construction equipment and materials shall be limited to the designated Contractor's storage area.
  - b. Oil wastes (from equipment, etc.) shall not be allowed to flow onto the ground or into surface waters.
  - c. Containers shall be required at the construction site for the disposal of materials such as paint, paint thinner, solvents, motor oil, fuels, concrete wash water, resins and other environmentally deleterious substances.
  - d. No dumping of surplus concrete or grout on the site will be permitted.
- 7. Sanitation:
  - a. During the construction period, provide adequate and conveniently located chemical sanitation facilities, properly screened, for use of construction crews.
  - b. Facilities shall be placed behind sidewalks and at least fifty (50) feet from any drainage ditch, drain inlet, or water way.
  - c. Facilities shall be regularly maintained.
- 8. Fire Prevention:
  - a. Take steps to prevent fires including, but not limited to:
    - 1) Provide spark arrestors on all internal combustion engines.
    - 2) Store and handle flammable liquids in accordance with the Flammable and Combustible Liquids Code, NFPA 30.
    - 3) Provide fire extinguishers at hazardous locations or operations, such as welding.
- 9. Erosion and Sediment Transport Control:
  - a. Keep disturbed areas to the minimum necessary for construction.
  - b. Keep runoff away from disturbed areas during construction.
  - c. rap sediment before it leaves the site, using such techniques as check dams, sediment ponds, or siltation fences.
  - d. Confine earthwork operations to dry periods, whenever possible. If earthwork needs to be scheduled for a wet period, ensure that erosion and sediment transport control measures are ready for implementation prior to the onset of the storm.
  - e. Stabilize disturbed areas as quickly as possible.
  - f. Note that waterways under the jurisdiction of governmental agencies other than the City of Roseville may be subject to additional erosion and sediment control

measures or criteria and it is the responsibility of the Contractor to obtain and adhere to these additional requirements.

D. Environment Impact Report (EIR) Mitigation Measures

1. The following West Roseville Specific Plan (WRSP) EIR Mitigation Measures shall be implemented:
  - a. 4.4-1 Dust Control
    - 1) After review and approval by the PCAPCD, the developer, if required, shall apply approved chemical soil stabilizers according to manufacturer's specifications, to all inactive construction areas (previously graded areas which remain inactive for 96 hours).
    - 2) Reduce traffic speeds on all unpaved surfaces to 15 miles per hour or less.
    - 3) Create a dust control plan.
    - 4) No open burning of vegetation during project construction.
    - 5) Reestablish ground cover as soon as possible after construction.
    - 6) Suspend grading activities when winds exceed 25 mph.
  - b. 4.4-3 Reduction of Construction Emissions
    - 1) The prime contractor shall submit to the PCAPCD a comprehensive inventory (i.e., make, model, year, emission rating) of all the heavy-duty off-road equipment (50 horsepower or greater) that will be used an aggregate of 40 or more hours for the construction project. District personnel, with assistance from the California Air Resources Board, will conduct initial Visible Emission Evaluations of all heavy-duty equipment on the inventory list.
    - 2) An enforcement plan shall be established by the contractor in conjunction with the air district to weekly evaluate project-related on-and-off- road heavy-duty vehicle engine emission opacities, using standards as defined in California Code of Regulations, Title 13, Sections 2180–2194. An Environmental Coordinator, CARB-certified to perform Visible Emissions Evaluations (VEE), shall routinely evaluate project related off-road and heavy-duty on-road equipment emissions for compliance with this requirement. Operators of vehicles and equipment found to exceed opacity limits will be notified and the equipment must be repaired within 72 hours.
    - 3) Contractors shall provide a plan for approval by the PCAPCD demonstrating that the heavy-duty (>50 horsepower) off-road vehicles to be used in the construction project, including owned, leased and subcontractor vehicles, will achieve a project-wide fleet average 30 percent NO<sub>x</sub> reduction and 45 percent particulate reduction compared to the most recent CARB fleet average. Acceptable options for reducing emissions may include use of late model engines, low-emission diesel products, alternative fuels, engine retrofit technology, after-treatment products, and/or other options as they become available.
    - 4) Minimize idling time to 10 minutes.
    - 5) Use low sulfur fuel for stationary construction equipment, if feasible.
    - 6) Utilize existing power sources (e.g., power poles) or clean fuel generators rather than temporary power generators.
    - 7) Use low emission on-site stationary equipment.
  - c. 4.7-6 Avoid Nesting Sites
    - 1) To ensure that fully protected bird and raptor species are not injured or disturbed by construction in the vicinity of nesting habitat, implement the following measures:
      - a) When feasible, all tree removal shall occur between August 30 and February 15 to avoid the breeding season of any raptor species that could be using the area, and to discourage hawks from nesting in the vicinity of

- an upcoming construction area. This period may be modified with the authorization of the California Department of Fish and Wildlife (CDFW); or
- b) Prior to the beginning of mass grading, including grading for major infrastructure improvements, during the period between February 15 and August 30, all trees and potential burrowing owl habitat within 350 feet of any grading or earthmoving activity shall be surveyed by the City for active raptor nests or burrows by a qualified biologist no more than 30 days prior to disturbance. Biologist will be hired by the City. If active raptor nests or burrows are found, and the site is within 350 feet of potential construction activity, a fence shall be erected around the tree or burrow(s) at a distance of up to 350 feet, depending on the species, from the edge of the canopy to prevent construction disturbance and intrusions on the nest area. The appropriate buffer shall be determined by the City in consultation with CDFW.
  - c) No construction vehicles shall be permitted within restricted areas (i.e., raptor protection zones), unless directly related to the management or protection of the legally protected species.
  - d) In the event that a nest is abandoned, despite efforts to minimize disturbance, and if the nestlings are still alive, the City shall contact CDFW and, subject to CDFW approval, fund the recovery and hacking (controlled release of captive reared young) of the nestling(s).
  - e) If a legally protected species nest is located in a tree designated for removal, the removal shall be deferred until after August 30th, or until the adults and young of the year are no longer dependent on the nest site as determined by a qualified biologist.
  - f) The City will conduct a pre-construction survey within the phases of the project site that are scheduled for construction activities. The survey shall be conducted by a qualified biologist to determine if burrowing owls are occupying the project site. The survey shall be conducted no more than three weeks prior to grading of the project site. If the above survey does not identify burrowing owls on the project site, then no further mitigation would be required. However, should burrowing owls be found on the project site, the following measures shall be required:
  - g) Avoid all potential burrowing owl burrows that may be disturbed by project construction during the breeding season between February 15 and August 30 (the period when nest burrows are typically occupied by adults with eggs or young). Avoidance shall include the establishment of a 350-foot diameter non-disturbance buffer zone around any occupied burrows. The buffer zone shall be delineated by highly visible temporary construction fencing. Disturbance of any occupied burrows shall only occur outside of the breeding season (August 30 through February 15). Based on approval by the CDFW, preconstruction and nonbreeding season exclusion measures may be implemented to preclude burrowing owl occupation of the project site prior to project related disturbance (such as grading). Burrowing owls may be passively excluded from burrows in the construction area by placing one-way doors in the burrows according to current CDFW protocol. The one-way doors must be in place for a minimum of three days. All burrows that may be occupied by burrowing owls, regardless of whether they exhibit signs of occupation, must be cleared. Burrows that have been cleared through the use of the one-way doors shall then be closed or backfilled to prevent owls from entering the burrow. The one-way doors shall not be used more than two weeks before

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construction to ensure that owls do not recolonize the area of construction.

- d. 4.8-1 Cease Work and Consult with Qualified Archaeologist
  - 1) Should any cultural resources, such as structural features, any amount of bone or shell, artifacts, human remains, or architectural remains be encountered during any subsurface development activities, work shall be suspended within 100 feet of the find, and the City of Roseville shall be immediately notified. At that time, the City shall coordinate any necessary investigation of the site with qualified archaeologists as needed to assess the resource and provide proper management recommendations.
- e. 4.8-9 Provide Proper Management Recommendations
  - 1) Possible management recommendations for important resources could include resource avoidance or data recovery excavations. The Contractor shall implement any measures deemed necessary for the protection of the cultural resources.
  - 2) In addition, pursuant to section 5097.98 of the State Public Resources Code, and section 7050.5 of the State Health and Safety Code, in the event of the discovery of human remains, the County Coroner shall be immediately notified. If the remains are determined to be Native American, guidelines of the Native American Heritage Commission shall be adhered to in the treatment and disposition of the remains.
- f. 4.8.10 Cease Work Until Review Conducted by Qualified Paleontologist and Recommendations Implemented.
  - 1) Should any evidence of paleontological resources (e.g., fossils) be encountered during grading or excavation, work shall be suspended within 100 feet of the find, and the City of Roseville shall be immediately notified. At that time, the City shall coordinate any necessary investigation of the site with a qualified paleontologist to assess the resource and provide proper management recommendations.
  - 2) Possible management recommendations for important resources could include resource avoidance or data recovery excavations. The contractor shall implement any measures deemed necessary by the paleontologist for the protection of the paleontological resources.
- g. 4.9-1 Identify and Remediate Soil Contamination
  - 1) If evidence of soil contamination is encountered in previously unidentified locations in the WRSP Area, work shall cease until the area can be tested, and, if necessary, remediated.
  - 2) Remediation activities could include removal of contaminated soil and/or on-site treatment.
  - 3) As part of this process, the City shall ensure that any necessary investigation and/or remediation activities conducted in the WRSP Area are coordinated with the Roseville Fire Department, Placer County Division of Environmental Health, and, if needed, other appropriate state and/or local agencies.
  - 4) Once a site is remediated, construction may continue. The City shall also continue to update its records concerning contamination or hazards that could be present at facilities or sites adjacent to WRSP Area and take necessary action to ensure that the health and safety of the public is protected.

#### 1.4 RESPONSIBLE PARTY

- A. The Contractor shall comply with all environmental pollution control rules, regulations, ordinances and statutes which apply to any work performed pursuant to the Contract (Refer to General Conditions Section 5 and Section D. Environmental Impact Report

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Mitigation Measures for additional requirements). In the event of any violations, Contractor shall be fully responsible for all fines, citations, penalties and all other judgements that shall be imposed.

## **PART 2 - PRODUCTS**

### **2.1 INLET FILTERS**

- A. Drain inlet filters may be employed.
- B. Horizontal mesh filters attached to the top of or below the drain inlet grate shall not be allowed.
- C. Only high flow volume, bag type filters or others as approved by the City of Roseville, Construction Inspector shall be used.

### **2.2 EROSION CONTROL BLANKETS**

- A. Straw or curled wood fiber blanket between jute netting
- B. Biodegradable, containing no plastic
- C. Contains no weed seeds

### **2.3 STRAW WATTLES**

- A. 100% biodegradable, containing no plastic
- B. Wrapped in medium weight natural burlap

### **2.4 HYDROMULCH**

- A. Mixture of shredded wood fiber, water and tackifier.
  - 1. Wood fiber
    - a. Thermally processed and free of weed or plant seeds.
    - b. Colored with green dye tracer so applied mulch is easily visible
    - c. Produce a uniform slurry when mixed with water and not be toxic to plants or wildlife.
    - d. Apply at 2000 pounds per acre.
  - 2. Tackifier
    - a. Water soluble and, upon drying, will form a stable, nonflammable plastic film with a one-year effective life.
    - b. Non-toxic to plants and wildlife.
    - c. Apply at 150 pounds per acre.

## **PART 3 - EXECUTION**

### **3.1 DISPOSAL OPERATIONS**

- A. Solid Waste Management:
  - 1. Supply solid waste transfer containers. Daily remove all debris such as spent air filters, oil cartridges, cans, bottles, combustibles and litter. Take care to prevent trash and papers from blowing onto adjacent property. Encourage personnel to use refuse containers. Convey contents to a sanitary landfill.

2. Washing of concrete containers without Contractor having a washout facility or system in place will not be permitted. Concrete on bare soil is prohibited. Remove any excess concrete to the sanitary landfill.
- B. Chemical Waste and Hazardous Materials Management:
1. Furnish containers for storage of spent chemicals used during construction operations. Provide secondary containment. Dispose of chemicals and hazardous materials in accordance with applicable regulations.
- C. Garbage:
1. Store garbage in covered containers, pick up daily and dispose of in a sanitary landfill.
- D. Dispose of vegetation, weeds, rubble, and other materials removed by the clearing, stripping and grubbing operations off site at a suitable disposal site in accordance with applicable regulations.
- E. Excavated Materials:
1. Native soil complying with the requirements of Section 02300, Earthwork, may be used for backfill, fill and embankments as allowed by that section.
  2. Spoil Material:
    - a. Remove all material which are excavated in excess of that required for backfill, and such excavated material which is unsuitable for backfill, from the site and dispose of offsite in accordance with applicable regulations.
    - b. No additional compensation will be paid to the Contractor for such disposal. Include all such costs in the lump sum prices bid for the project.
    - c. Remove rubbish and materials unsuitable for backfill immediately following excavation. Remove material in excess of that required for backfill immediately following backfill operations.
    - d. Rubbish shall consist of all materials not classified as suitable materials or rubble and shall include shrubbery, trees, timber, trash and garbage.

#### **PART 4 - PRODUCTS (NOT USED)**

#### **PART 5 - EXECUTION (NOT USED)**

++ END OF SECTION ++

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**SECTION 01310**  
**PROJECT MEETINGS**

**PART 1 - GENERAL**

**1.1 PRE-CONSTRUCTION CONFERENCE**

- A. Upon receipt of the Notice to Proceed, or at an earlier time if mutually agreeable, the ENGINEER will arrange a preconstruction conference to be attended by the CONTRACTOR's superintendent or other project representative authorized to commit on the behalf of the CONTRACTOR and to direct the performance of the work by others, the OWNER, the ENGINEER or ENGINEER's representative, and representatives of utilities, major subcontractors, and others involved in the execution of the work.
- B. The purpose of this conference will be to establish a working relationship and understanding between the parties and to discuss subjects as may be pertinent for the execution of the work.
- C. CONTRACTOR shall be prepared to discuss the following subjects, as a minimum:
  - 1. Required schedules.
  - 2. Status of Bonds and insurance.
  - 3. Sequencing of critical path work items.
  - 4. Progress payment procedures.
  - 5. Project changes and clarification procedures.
  - 6. Use of site, access, office and storage areas, security and temporary facilities.
  - 7. Major product delivery and priorities.
  - 8. CONTRACTOR's safety plan and representative.

**1.2 PROGRESS MEETINGS**

- A. The ENGINEER will arrange and conduct progress meetings. The ENGINEER will prepare and circulate a draft agenda of each meeting. The CONTRACTOR may add items as appropriate to the draft agenda.
- B. Progress meetings will be conducted on a regular basis, at such frequency as the OWNER and CONTRACTOR may mutually agree. Progress meetings shall be attended by the ENGINEER, OWNER Operations personnel, CONTRACTOR's superintendent or other project representative, and representatives of all subcontractors involved in the work at the time of the meeting, required by the CONTRACTOR, or requested by the OWNER.
- C. The purpose of the meetings will be to facilitate the work of the CONTRACTOR and any subcontractor or other organization that is not up to schedule, resolve conflicts, identify and resolve any potential delays or necessary changes in the work and in general, coordinate and facilitate the execution of the work.
- D. The agenda of progress meetings shall include review of work progress, the latest Construction Schedule submittal (monthly), potential project delays, the status of key shop drawings, submittal reviews, information requests, safety concerns, record drawings, and extra work items.

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### 1.3 CONSTRUCTION SCHEDULE REVIEW

- A. The Construction Schedule will be reviewed monthly during an agreed upon progress meeting to verify at a minimum:
  - 1. Actual start and finish dates of completed activities since the last progress meeting.
  - 2. Durations and progress of all activities not completed.
  - 3. Critical submittals/materials delivery problems.
  - 4. Potential project delays.
  - 5. Any activity behind schedule and CONTRACTOR's plan to bring it back on schedule.
  - 6. Reason, logic, time, and cost data for Change Order work that is to be incorporated into the Construction Schedule or payment request form.
  - 7. Payment due to the CONTRACTOR based on percentage complete of items in the submittal payment request form.
- B. At the progress meeting, the CONTRACTOR shall provide an update of the Construction Schedule as described in Section 01320, Progress Schedule.

### **PART 2 - PRODUCTS (NOT USED)**

### **PART 3 - EXECUTION (NOT USED)**

++ END OF SECTION ++

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**SECTION 01320**  
**PROGRESS SCHEDULE**

**PART 1 - GENERAL**

**1.1 WORK INCLUDED**

- A. The work specified in this Section includes the preparation and submittal of a computerized Critical Path Method (CPM) Construction Schedule and of updates and revisions to the Construction Schedule.
- B. The computerized CPM schedule shall be completed using Microsoft Project for Windows or Primavera Project Planner scheduling system and software.
- C. The requirements specified under Section 01330, Submittal Procedures, also apply to the Construction Schedule initial submittal(s) and subsequent updates and revisions.

**1.2 REFERENCE**

- A. General:
  - 1. Applicable Reference shall be the Associated General Contractors of America (AGC) Publication No. 1107.1, "Construction Planning and Scheduling", latest edition.
  - 2. The preparation of the Construction Schedule, its principles, definitions and terms shall be as set forth in that reference.
  - 3. In case of conflict, the provisions specified in this Section shall govern and supersede conflicting provisions in such reference.

**1.3 PREPARATION AND SUBMITTAL PROCEDURE**

- A. Responsible Person:
  - 1. Within five days after Notice to Proceed, the CONTRACTOR shall designate, in writing, the person responsible for the preparation of the Construction Schedule.
  - 2. Such person shall have the authority to act on behalf of the CONTRACTOR and be knowledgeable in the preparation of CPM schedules of similar complexity.
  - 3. This person shall meet with the Engineer, within 10 days of the Notice to Proceed for a joint review and approval of the CONTRACTOR's approach.
- B. Initial Schedule Submittal:
  - 1. The Construction Schedule shall be completed and submitted to the Engineer within 30 days after Notice to Proceed.
  - 2. If the initial Construction Schedule submittal is not acceptable to the Engineer, it shall be revised in coordination with observations and comments from the Engineer and resubmitted within 7 days of the return of the schedule to the CONTRACTOR.
- C. By preparing and submitting the Construction Schedule the CONTRACTOR represents that the CONTRACTOR can and intends to execute the work and portions thereof within the specified times and constraints and that the CONTRACTOR's bid covers the costs associated with the execution of work in accordance with the Construction Schedule.
- D. Submittal package.
  - 1. Submittal of the Baseline Construction Schedule shall include the following:

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- a. Network Diagram:
  - 1) A graphic network diagram with legible letters with individual sheets sized approximately 24" by 48".
  - 2) Each activity shall be shown on the diagram with the activity number, description and duration in working days.
  - 3) Five copies and one reproducible shall accompany the submittal.
- b. Five sets of supporting data, if not indicated on the graphic network diagram, including:
  - 1) Number of work days per week.
  - 2) Holidays that will be observed during construction.
  - 3) Number of shifts per day.
  - 4) Major construction equipment used, identifying the time period and activity of use.
  - 5) Average manpower for each week and for each trade.
  - 6) Lost time allowance for weather or other conditions that can be anticipated or projected based on the requirements herein.
    - a) Contractor schedule shall include a minimum of 20 working days total, of lost time allowance.
- c. Five computer printouts as follows:
  - 1) Listing of all activities sorted by total float including early start (ES), late start (LS), early finish (EF), late finish (LF) and Total Float duration for each activity or work item. Each activity or work item will not take more than two lines.
  - 2) Lists of all activities sorted numerically including ES, LS, EF, LF, Total Float.
  - 3) List of all activities sorted numerically with Predecessor/Successor information of precedence network.
- 2. Submittals of updated Construction Schedules shall include, in addition to the items specified in the preceding subparagraph 1a, 1c, and 1d, the following:
  - a. Changes in the schedule due to approved Change Order or Change Directives or Force Account work.
  - b. CONTRACTOR elected changes in schedule logic, activity duration, or activity start or stop dates.
  - c. A narrative report as needed to define:
    - 1) Changes in logic, activity duration, and manpower and equipment utilization.
    - 2) Problem areas, anticipated delays, and the impact on the schedule.
    - 3) Corrective action recommended and its effect.
    - 4) The effect of changes on schedules of other contractors involved with the work.
    - 5) Coordination of work with others.
  - d. Percentage completion for each activity as agreed to for the monthly progress payments.
- E. If the Construction Schedule, its updates or its revisions, reflect anything not accepted by the Engineer, such Construction Schedule, update, or revision shall be considered as not having been accepted by the Engineer.

#### 1.4 CONSTRUCTION SCHEDULE CONTENT

- A. The Construction Schedule shall be calendar-based, time-scaled, manpower and cost-loaded, using a precedence method diagram in the Critical Path Method (CPM) format indicating the critical path for the execution of the work utilizing the entire contract time.

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1. In the preparation of the Construction Schedule, the CONTRACTOR shall take into account all constraints and requirements specified.
2. Allowance in the Construction Schedule shall be made for Excusable Delays, as defined in the Agreement. These days shall be included as part of the 20 days of lost time allowance specified herein.
3. The diagram shall be clear, legible, and accurate, and show complete sequence of construction by activity and interdependence of activities. Separate discrete lines shall connect linked activities.
4. Activities related to the same physical areas of the work shall be grouped in the same area of the diagram.
5. Activities within each area of the work shall be numbered in separate sequential series, with no overlap of activity numbers between different areas of the work.
6. The diagram shall clearly show a continuous critical path, all constraints, and all required project milestones.
7. The schedule shall describe work activities in appropriate segments so that work in specific areas can be assessed for progress and completion. Activities labeled "start", "continue", or "completion" without measurable increments of work will not be acceptable.
8. The individual work activities in the schedule shall:
  - a. Identify major submittals and submittals for long-lead time Critical Path items and associated review times. Twenty (20) working days shall be used for OWNER review times, unless otherwise specified.
  - b. For equipment with a cost in excess of \$20,000 and all control systems the CONTRACTOR shall allow adequate time for an initial submittal and OWNER review plus (at a minimum) a second (re) submittal and associated OWNER review.
  - c. Identify at a minimum, the execution of the following as separate items for each area of work.
    - 1) Notice to Proceed.
    - 2) Mobilization.
    - 3) Dewatering.
    - 4) Shoring.
    - 5) Excavation.
    - 6) MSE.
    - 7) Backfill.
    - 8) Grading, subbase, base, paving, and curb and gutters.
    - 9) Other site work.
    - 10) Concrete, including installation of forms and reinforcement, placement of concrete, curing, stripping, patching and finishing.
    - 11) Masonry.
    - 12) Metal fastenings, framing structures, and fabrications.
    - 13) Wood structures, finish carpentry, architectural woodwork, and plastic fabrications.
    - 14) Waterproofing and dampproofing, insulation, roofing and flashing, and sealants.
    - 15) Doors and windows (including glass walls), including hardware and glazing.
    - 16) Finishes including coating and painting, flooring, ceiling, and wall covering.
    - 17) Building specialties including furnishings, equipment, and toilet and bath accessories.
    - 18) Process equipment, including separate activities for manufacturing, delivery, and installation.
    - 19) Pumps and drives, including separate activities for manufacturing, delivery, and installation.

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- 20) Conveying equipment including hoists and cranes, conveyor systems, and materials handling equipment, including separate activities for manufacturing, delivery and installation.
- 21) Other mechanical equipment including fans and heating, ventilating, and air conditioning equipment, with separate activities for manufacturing, delivery and installation.
- 22) Case work, including separate activities for fabrication, delivery and installation.
- 23) Storage shelving, including separate activities for fabrication, delivery and installation.
- 24) Trenching and pipe laying.
- 25) Piping, including a separate activity for ordering lead time.
- 26) Valves and gates, including a separate activity for ordering lead time.
- 27) Plumbing specialties.
- 28) Electrical transmission, service, and distribution equipment, including separate activities for ordering, manufacturing, delivery, installation.
- 29) Other electrical work including lighting, heating and cooling, and special systems, including separate activities for ordering, manufacturing, delivery and installation.
- 30) Instrumentation and controls, including separate activities for ordering lead time, manufacturing, delivery and installation.
- 31) Separate activities for functional, performance, and operational testing, for each major system.
- 32) Separate activities for operation and maintenance training for each major system.
- 33) Site cleanup.
- 34) Demobilization.
- 35) Procurement of critical (long lead time) equipment.
- 36) Separate activities for design, ordering, delivery and installation of turn key systems.
- 37) Separate activities for Operational Completion, Contract Completion and other contractually required milestones.
- 38) Any items to be OWNER-furnished which are to be incorporated into the work as part of these Contract Documents.
- d. Provide a monthly activity for preparation of Contract Record Drawings, in accordance with Section 01330, Submittal Procedures with a minimum monthly cost of \$5,000.
- e. Have a duration of not more than 5 working days.
- 9. Information on each activity shall include:
  - a. Concise description of the activity.
  - b. Duration in working days.
  - c. The dates for the beginning and completion of each activity.
  - d. Total float.
  - e. Numerical designation of work items.
  - f. Cost with a breakdown by labor (by man-hours by trade), materials (by type and quantity), equipment (by type and hours) and overhead and profit.
  - g. Reference to associated Scope Area as described in Breakdown of Guaranteed Maximum Price.
- 10. The schedule shall be referenced to calendar dates, and the beginning of the contract time shall be the date of receipt of the Notice to Proceed.
- 11. The schedule shall indicate for every month the total dollar amount of work planned in such month. The sum of monthly amounts shall equal the total bid amount.

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- B. Failure to include an activity required for the execution of the work shall not excuse the CONTRACTOR from completing the work and portions thereof within the specified times and at the price specified in the Contract Documents, and from meeting the constraints specified for sequence of work and control dates.

#### 1.5 UPDATING THE CONSTRUCTION SCHEDULE

- A. The CONTRACTOR shall update the Construction Schedule prior to the progress and schedule review at the monthly progress meetings, as specified in Section 01310, Project Meetings.
- B. The schedule update shall reflect progress to date. The schedule update shall incorporate all revisions to logic and duration, as described below.
- C. The updated Construction Schedule shall be submitted by the CONTRACTOR as specified herein and under Subparagraph 1.3.D.2 in this Section.
  - 1. Logic changes to the schedule shall be approved by the Engineer prior to incorporating them into the schedule.
  - 2. The schedule update submittal shall be provided to the Engineer three working days prior to the monthly progress meeting.
  - 3. If at the progress meeting the Engineer determines that the updated schedule does not accurately reflect the progress of the work to date or project the anticipated progress to date or is otherwise unacceptable to the OWNER, the CONTRACTOR shall revise the schedule within 5 working days thereafter.
  - 4. If the CONTRACTOR fails to submit to the Engineer the updated Construction Schedule, in accordance with the findings at the progress meeting, as described above, or if it is submitted and found unacceptable by the Engineer, no monthly progress payment will be made.
- D. Updates shall be performed on the most recent accepted version of the Construction Schedule.

#### 1.6 REVISIONS TO CONSTRUCTION SCHEDULE

- A. The cost of revision to the Construction Schedule not resulting from contract change orders shall be borne by the CONTRACTOR.
- B. Except as specified in the preceding Subparagraph A, the cost of revisions to the Construction Schedule resulting from contract change orders in the work shall be included in the cost for the contract change orders.
- C. Corrections resulting from the Engineer's review and comments shall be carried out as specified for Construction Schedule update.
- D. Revisions shall be made on the most recent accepted version of the Construction Schedule.

#### 1.7 ADJUSTMENT OF THE CONTRACT TIME AND CHANGE ORDERS

- A. Adjustments of the contract time due to delays, additional work, or any other cause will only be issued through a contract change order in accordance with the General Conditions.

1. In the event the CONTRACTOR requests an adjustment of the contract time, the CONTRACTOR shall furnish such justification, Construction Schedule data, and supporting evidence as the Engineer may deem necessary, for a determination as to whether or not the CONTRACTOR is entitled to an adjustment of time under the provisions of the Contract.
    - a. The CONTRACTOR shall submit proof based on revised activity logic, durations, and costs with each request.
  2. The Construction Schedule shall clearly indicate that the CONTRACTOR has used, in full, all the float time available for the work involved in the request.
  3. Total and free float is not for the exclusive use or benefit of either the OWNER or the CONTRACTOR, but is a resource available to both parties for the benefit of the project on a first needed basis.
  4. The CONTRACTOR shall not be entitled to additional compensation due to schedule impacts for change order work that extends the contract beyond the scheduled completion date, but not beyond the contract completion date.
  5. The Engineer's determination as to the adjustment of the contract time will be based upon the latest version of the Construction Schedule accepted at the time of the alleged delay, and all other relevant information.
  6. Actual delays in activities which, according to the Construction Schedule, do not affect the critical path work, will not be the basis of for an adjustment to the contract time.
  7. If the Construction Schedule shows that the project is behind schedule (i.e., has negative float) then no time extensions will be allowed for contract change orders unless they create a critical path delay in excess of that already occurring. In that case, the time extension allowed will only be that amount which exceeds the already occurring delay.
- B. Change Order Requests:
1. The CONTRACTOR shall include, as part of each change order request for which the Contractor is requesting an adjustment in the contract duration, a subnetwork showing logic revisions, duration changes, and cost changes, for the work in question and its relationship to other activities on the Construction Schedule.
  2. The CONTRACTOR shall incorporate each Change Order into the Project Schedule.
- C. The Engineer will, within 15 working days after receipt of such request and supporting evidence, review the facts and advise the CONTRACTOR in writing thereof.
- D. The new Construction Schedule data, if accepted by the Engineer, shall be included in the next monthly updating of the schedule.
- E. Where the Engineer has not yet made a final determination as to the adjustment of the contract time, and the parties are unable to agree as to the amount of the adjustment to be reflected in the Construction Schedule, the CONTRACTOR shall reflect that amount of time adjustment in the Construction Schedule as the Engineer may determine as appropriate for such interim purpose.
1. It is understood and agreed that any such interim determination by the Engineer shall not be binding and shall be made only for the purpose of continuing to schedule the work, until such time as final determination as to any adjustment of the contract time acceptable to the Engineer has been made.
  2. The CONTRACTOR shall revise the Construction Schedule prepared thereafter in accordance with the final decision.

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## **PART 2 - NOT USED**

## **PART 3 - EXECUTION**

### **3.1 IDENTIFICATION OF SUBMITTALS**

- A. Completely identify each Construction Schedule submittal and resubmittal by showing at least the following information:
1. Name and address of submitter, plus name and telephone number of the individual who may be contacted for further information.
  2. Name of project as it appears in this Specification and specification number.
  3. Whether this is an original or updated submittal or resubmittal.
  4. Number all submittals sequentially in accordance with Section 01330, Submittal Procedures.

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## **SECTION 01322**

### **WEB BASED DOCUMENT CONTROL**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. The project team will use and maintain a web-based database as the primary means of communication related to the Project's correspondence, submittals, requests for information (RFIs), advisory notices, and non-compliance issues. Correspondence from the Contractor shall be sent to the Construction Manager via the PROCORE System.
- B. The Construction Manager and Contractor shall utilize PROCORE's system for electronic submittal of all data and documents (unless specified otherwise by the Construction Manager) throughout the duration of the Contract. PROCORE is a web-based electronic media site that is hosted by PROCORE LLC utilizing their PROCORE web solution. PROCORE will be made available to all Contractor's project personnel. The joint use of this system is to facilitate; electronic exchange of information, automation of key processes, and overall management of the Contract. PROCORE shall be the primary means of project information submission and management. When required by the Construction Manager, paper documents will also be required. In the event of discrepancy between the electronic version and paper documents, the paper documents will govern. PROCORE is a registered trademark of PROCORE LLC.

##### **1.2 USER ACCESS LIMITATIONS**

- A. The Construction Manager will control the Contractor's access to PROCORE by allowing access and assigning user profiles to accepted Contractor personnel. User profiles will define levels of access into the system; determine assigned function-based authorizations (determines what can be seen) and user privileges (determines what they can do).

##### **1.3 AUTOMATED SYSTEM NOTIFICATION AND AUDIT LOG TRACKING**

- A. Review comments made (or lack thereof) by the Construction Manager and Design Consultant on Contractor submitted documentation shall not relieve the Contractor from compliance with requirements of the Contract Documents. The Contractor is responsible for managing, tracking, and documenting the Work to comply with the requirements of the Contract Documents. The Construction Manager's acceptance via automated system notifications or audit logs extends only to the face value of the submitted documentation and does not constitute validation of the Contractor's submitted information.

##### **1.4 CONTRACTOR RESPONSIBILITY**

- A. The Contractor shall be responsible for the validity of their information placed in PROCORE and for the abilities of their personnel. Accepted users shall be knowledgeable in the use of computers, including Internet Browsers, email programs, CAD drawing applications, and Adobe Portable Document Format (PDF) document distribution

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program. Adobe PDF documents will be created through electronic conversion rather than optically scanned whenever possible. The Contractor is responsible for the training of their personnel in the use of PROCORE (outside what is provided by the Construction Manager) and the other programs indicated above as needed.

#### 1.5 USER ACCESS ADMINISTRATION

- A. Provide a list of Contractor's key PROCORE personnel for the Construction Manager's acceptance. The Construction Manager is responsible for adding and removing users from the system. The Construction Manager reserves the right to perform a security check on all potential users.

#### 1.6 CONNECTIVITY PROBLEMS

- A. PROCORE is a web-based environment and therefore subject to the inherent speed and connectivity problems of the Internet. The Contractor is responsible for its own connectivity to the Internet. PROCORE response time is dependent on the Contractor's equipment, including processor speed, Internet access speed, etc. and current traffic on the Internet. The Owner and Construction Manager will not be liable for any delays associated from the usage of PROCORE including, but not limited to: slow response time, down time periods, connectivity problems, or loss of information. The Contractor will ensure that its connectivity to the PROCORE system (whether at the home office or job site) is accomplished through some form of high-speed communications with 128 kb/s as the minimum bandwidth requirements for using the system. It is recommended a faster connection be used when uploading pictures and files into the system. Under no circumstances shall the usage of PROCORE be grounds for a time extension or cost adjustment to the Contract. If there are problems that persist with the PROCORE site for more than 24 consecutive hours that prevent the electronic submission of data by the Contractor, the Contractor may submit documents in paper form to the Construction Manager until such time that the Construction Manager notifies the Contractor that the PROCORE site is operable and available for use. Construction Manager shall likewise send documents to Contractor in paper form during such disruption of the Procure system.

#### 1.7 TRAINING

- A. The Construction Manager has arranged for the following training to be provided to the Contractor. The Construction Manager will provide a one-hour training class to the Contractor within ten (10) days of NTP at a time mutually agreeable to Contractor and Construction Manager. Thereafter the Construction Manager will provide up to one hour of additional training via telephone during the project per month of the project life.

### **PART 2 - PRODUCTS**

#### 2.1 GENERAL

- A. In order to process correspondence, submittals, and RFIs, the Contractor must provide and have in place for its own use the required basic components outlined below.
  - 1. Hardware

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- a. A computer with internet access and sufficient capabilities to perform all project duties; a scanner at least large enough to scan 11" x 17" sheets with sufficient resolution to maintain clarity and legibility of the document at its native size; and a color printer of sufficient size and capacity to accept incoming correspondence as described in this section.
2. Software
  - a. Adobe Acrobat 9 or higher; Microsoft's Internet Explorer v7 or higher; Microsoft Office 2010 or higher, including but not limited to Microsoft Word and Microsoft Excel.
  - b. PROCORE currently supports Mozilla's Firefox v3.5 and newer, Apple's Safari v4 and newer, Google Chrome, and Microsoft's Internet Explorer v7 and v8 web browsers for accessing the application. Certain functions may not be available when using any program other than the newest version of Microsoft's Internet Explorer.
3. Facilities
  - a. The Contractor shall make its own arrangements to provide high-speed (minimum speed: download 1Mbps/upload 256Kbps) internet connection for its own use as soon as practicable.

### **PART 3 - EXECUTION**

#### **3.1 SUMMARY**

- A. Items to be uploaded to PROCORE by the Construction Manager include but are not limited to: RFI responses, Submittal comments, Clarification letters, Design Clarifications, Field Orders, et al. These items will be emailed via PROCORE as attachments in PDF file format via PROCORE. These attachments may include files that need to be viewed and/or printed in color. Formal letters, stop notices, Field Orders, Progress Payment Requests, and Contract Change Orders will always include a wet-signed hard copy.
- B. Items to be uploaded to PROCORE by the Constructor include but are not limited to: RFI, Submittals, Request for Clarification letters, Request for Design Clarification letters, et al. These items will be emailed via PROCORE as attachments in PDF file format via PROCORE. These attachments may include files that need to be viewed and/or printed in color. Contractor shall provide wet-signed hard copies of documents required by Contract Documents, as well as any documents requested by the Construction Manager, including but not limited to: Formal letters, Progress Payment Requests, and Contract Change Orders, et al.

#### **3.2 PROCURE UTILIZATION**

- A. All project related correspondence (RFIs, submittals, etc.) originated by the Contractor or Subcontractor, Supplier, et al. shall be directed to the Construction Manager, unless otherwise indicated in the Specifications.

### 3.3 SUBMITTALS

- A. The use of the electronic communication does not waive the requirement for the provision of hard copies of all formal correspondence and submittals. The hard copies of all documents must match the electronic copies of all correspondence and submittals.
- B. Submittals shall be in accordance with Section 01300. The provisions of Section 01300 shall apply both to electronic copies and hard copies of submittals.
- C. In addition to above, PROCORE shall be utilized in connection with submittal preparation and information management required by but not limited to Sections:
  - 1. Section 01320, **PROGRESS SCHEDULES**.
  - 2. Section 01300, **SUBMITTALS**.
- D. PROCORE will be utilized by all other Sections not listed above and as required by the Construction Manager.
- E. If a submittal package has multiple items that are not directly related, each item shall be considered a separate submittal and shall be sent separately. For example, "Concrete Mix Design," and "Concrete Curing Compound" shall be submitted as separate items to the Construction Manager.

### 3.4 TERMINATION IN USE

- A. The Owner may request a termination of the use of PROCORE for the electronic submission of data, and alternatively the use of paper documents submitted in accordance with the Contract Documents by providing notification in writing with ten (10) days' notice that it intends to discontinue use of PROCORE.

### 3.5 ADOBE PDF

- A. All information, comments, questions, and statements shall be scanned and/or converted to the PDF file format and attached to the email via PROCORE. Items to be sent via email via PROCORE include but are not limited to large-format plan sheets (22" x 34" or larger), small-format plan sheets, pages within tabbed binders, RFIs, transmittal sheets, et al. The PDF attachments supplied to the Construction Manager shall be in a sufficient resolution to be fully legible at its native size.
- B. All separate files within a given piece of correspondence shall be combined into a single PDF document (e.g. An RFI that contains a text file and two photo files shall be combined into a single PDF document prior to delivery to the Construction Manager.)

### 3.6 LABELING FORMAT

- A. The subject line of each email via PROCORE, and the file name of any attached files, shall be in accordance with Section 01330-1.3.A.2 for submittals and as directed by Construction Manager other correspondence (RFIs, Letters, Transmittals, Proposed Change Orders, et al.)
- B. Label shall include the type of correspondence (i.e. RFI, etc.), a unique number, sequentially assigned for the given piece of correspondence. The Contractor will

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indicate the subject at the end of the numbering scheme with a description (key words) of the item. Each piece of correspondence shall be sent in a separate email via PROCORE.

### 3.7 ORIGINAL DOCUMENTS

- A. Where possible, the Contractor will obtain the electronic document from its original source to maintain the integrity, legibility, and searchability of the document.

### 3.8 ORGANIZATION

- A. The information included in the attachments shall be organized in a logical and thoughtful manner. Where the information originated in a tabbed format (a binder, for example), the scanned and/or converted PDF file shall be electronically bookmarked accordingly using the "bookmark" function of Adobe Acrobat 9 Std.

### 3.9 PRINTING

- A. Except where otherwise indicated, the Contractor will receive no hard copies of the above outlined correspondence. The Contractor will be required to print for its use, in color if necessary, any record copies, field copies, sub-Contractor copies, etc., if such copies are desired.

### 3.10 PROJECT FORMS

- A. The Contractor may use its own correspondence forms to be attached to correspondence emails via PROCORE as long as the Contractor's forms comply with this and all submittal sections.

**\*\*\* END OF SECTION \*\*\***

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## SECTION 01330

### SUBMITTAL PROCEDURES

#### **PART 1 - GENERAL**

##### **1.1 GENERAL**

###### A. General:

1. This Section outlines in general the items that the CONTRACTOR must prepare or assemble for submittal during the progress of the work.
2. There is no attempt herein to state in detail all of the procedures and requirements for each submittal.
3. The CONTRACTOR's attention is directed to the individual Specification Sections in these Contract Documents, which may contain additional and special submittal requirements.
4. The OWNER reserves the right to direct and modify the procedures and requirements for submittals as necessary to accomplish the specific purpose of each submittal.
5. The CONTRACTOR shall anticipate resubmitting submittals for major pieces of equipment and for control systems.
6. Should the CONTRACTOR be in doubt as to the procedure, purpose, or extent of any submittal, inquiries shall be directed to the ENGINEER.

###### B. Schedule of Submittals:

1. Within 15 working days of the Notice to Proceed, the CONTRACTOR shall submit a complete list of anticipated submittals with specification/drawing references and proposed times for submitting, reviewing and processing of submittals.
2. This list shall be updated with "late start" submittal dates within 15 working days of submittal of the CONTRACTOR's Construction Schedule.
3. The submittal dates shall be updated upon approval of the Construction Schedule and periodically thereafter.
4. Any additional submittals shall also be included in updates.
5. Additional submittals and resubmittals shall be provided in a timely manner without delaying the project.
6. Within 30 working days after the Notice to Proceed, CONTRACTOR shall submit all submittals to start construction including, but not limited to, any priority submittals identified during the Design-Assist process.

##### **1.2 ADMINISTRATIVE SUBMITTALS**

- A. The CONTRACTOR is reminded of their obligation as required by law to make required submittals promptly to the applicable federal, state, or local agency. Failure to comply with this requirement may result in the withholding of progress payments and make the CONTRACTOR liable for other prescribed action and sanctions.
- B. The CONTRACTOR shall submit to the ENGINEER a copy of all letters relative to the Contract, transmitting notifications, reports, certifications, certified payrolls, and the like, that the CONTRACTOR submits directly to a federal, state, or other governing agency.
- C. During the performance of the Contract, the CONTRACTOR shall maintain on a daily basis, and submit to the ENGINEER as requested, full and correct information as to the number of persons employed in connection with each subdivision of the work, the

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classification, rate of pay, citizenship status, and address of each person, and the cost, source, and amount of each class of materials delivered, equipment received, and major construction equipment used in each subdivision of the work.

D. Certified Payroll:

1. No later than the 25th day of each month, the CONTRACTOR shall submit to the ENGINEER a copy of the CONTRACTOR's certified payroll for the previous month, and if requested, copies of certified payrolls for Subcontractors.
2. The payrolls shall include for each employee the full name, address and social security number; the correct classification and rate of pay (including rates of contributions for, or costs assumed to provide various fringe benefits); daily and weekly hours worked; itemized deductions and actual wages paid.
3. The certified payrolls shall be on State of California forms.

### 1.3 TECHNICAL SUBMITTALS

A. General:

1. Requirements in this Section are in addition to any specific requirements for submittals specified in other divisions and Sections of these Contract Documents.
2. Submittal Contents and Numbering:
  - a. Each submittal shall have the specification Section and applicable paragraph number clearly identified on the front of the submittal transmittal form for each item submitted. The number shown on the transmittal form for each item shall be labeled in the content of the submittal. For example, if Item 1 is a ball Valve and Item 2 is a gate valve then the cut sheets for each respective valve shall be labeled Item 1 and Item 2.
  - b. Each submittal shall be sequentially numbered starting with the first one delivered for each spec section. For example, the first submittal for Section 02300 should be 02300-1-0.
  - c. Resubmittals shall include the number of the original submittal plus the suffix "-1" for the first resubmittal, "-2" for the second resubmittal. For example, a second resubmittal would be shown as 02300-1-1. Each resubmittal shall be the whole version of the corrected submittal, and shall not reference past versions. Each resubmittal shall include all items including items previously marked as NET.
  - d. Submittals not conforming to these requirements will be rejected.
  - e. If several items (i.e. different types of valves) are combined into the same submittal, none of the items will be approved for installation until the entire submittal is accepted.
3. Submitted data shall be fully sufficient in detail for determination of compliance with the provisions and intent of the Contract Documents.
4. Coordination Responsibilities:
  - a. Shop drawing submittal and coordination are the responsibility of the CONTRACTOR; this responsibility shall not be delegated in whole or in part to Subcontractors or suppliers.
  - b. Designation of work "by others," if shown on shop drawings, shall mean that the work will be the responsibility of the CONTRACTOR rather than the Subcontractor or supplier who has prepared the shop drawings.
5. No equipment or material for which listings, drawings, or descriptive material is required shall be fabricated, purchased, or installed until the ENGINEER has reviewed and accepted such lists, final shop drawings, or other descriptive material. Installation of such equipment or material without accepted submittals will be considered defective work.
6. Submittal Review Time:

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- a. Submittals will be acted upon by the ENGINEER as promptly as possible and returned to the CONTRACTOR not later than the time allowed for review in Paragraph B.4 below.
  - b. The CONTRACTOR shall provide in their Construction Schedule the time for OWNER review of each submittal (and resubmittal for major equipment and control systems) in accordance with the allowable time specified herein and in Section 01320, Progress Schedule.
  - c. This required time for OWNER review shall not be a cause for delay in contract completion nor shall it be a reason for an extension of contract time.
  - d. If the CONTRACTOR is required by the OWNER to resubmit data, then neither the time required for the CONTRACTOR to prepare and resubmit such data, nor the required time for OWNER review, shall be a cause for delay in contract completion or for an extension of contract time.
  - e. Responsibility for time required for preparing and submitting required data shall be assigned solely to the CONTRACTOR.
7. Excessive Submittal Review:
  - a. It is considered reasonable that the CONTRACTOR shall make a complete and acceptable submittal to the ENGINEER by the second submission of a submittal item.
  - b. Additional costs of the ENGINEER's review beyond the second submission shall be the responsibility of the CONTRACTOR and may be deducted from the monthly progress payments.
  - c. This applies to all submittals including shop drawings.
8. Changes After Review:
  - a. After a submittal has been reviewed and accepted, no changes or substitutions in that submittal will be allowed without the ENGINEER's approval.
  - b. If allowed, the CONTRACTOR will be responsible for the additional costs for engineering, administrative, clerical or other work required for additional review.
9. Intent of Review:
  - a. Shop drawings will be reviewed for general conformance with the drawings and specifications.
  - b. The intent of the review is to determine if the CONTRACTOR is submitting materials and equipment which are in general conformance with the Contract Documents.
  - c. Detailed review of dimensions, sizes, space requirements, coordination with other equipment, and other construction details is not performed.
  - d. Additional work and costs, resulting from errors in the shop drawings shall be the CONTRACTOR's responsibility and liability.
  - e. Accuracy, coordination, and completeness of shop drawings shall be the sole responsibility of the CONTRACTOR, including responsibility to backcheck comments, corrections, and modifications from the ENGINEER's review before fabrication.
10. The CONTRACTOR shall indicate on the submittal transmittal form if and how the submittal deviates from the contract requirements. In addition, CONTRACTOR shall include a copy of the relevant specification section in its entirety marked with ACCEPT/DEVIATE next to each paragraph. Failure to include this documentation is grounds for ENGINEER to reject and return the Submittal to the CONTRACTOR for resubmission.
11. Rebar Shop Drawings:
  - a. The CONTRACTOR shall supply the ENGINEER with a copy of all reinforcing steel detail drawings.
  - b. Changes to the Contract Documents made by the CONTRACTOR in reinforcing steel shop drawings shall be called out in the letter of submittal.

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- c. Such changes will not be acceptable unless the ENGINEER has expressed consent to such changes in writing.
- 12. Submittals of shop drawings, layout diagrams, catalog cuts and data, test reports, and information in sufficient detail to show complete compliance with all specified requirements shall be furnished to the ENGINEER, covering but not limited to the following items (as applicable):
  - Aggregate Base Course
  - Air compressors
  - Asphalt mixes
  - Block masonry
  - Building specialties
  - Cabinets
  - Caulking and sealing compounds
  - Chemical systems
  - Concrete mixes
  - Control panels
  - Demolition plan
  - Detection systems
  - Doors and frames
  - Electrical conduit, wire and specials
  - Electrical fixtures and appliances
  - Electrical load centers
  - Electrical substations
  - Electrical conduit, wire and specials
  - Engineered fill
  - Engines and appurtenances
  - Equipment provided by the CONTRACTOR
  - Fences, barricades and gates
  - Gas monitoring systems
  - Generators and appurtenances
  - Glazing
  - Grating
  - Gravel bedding
  - Grout
  - Hardware
  - Heating, ventilating and air conditioning equipment
  - Imported fill
  - Indicators
  - Instrumentation
  - Irrigation system plan
  - Landscaping
  - Lights and lighting fixtures
  - Louvers
  - Meters
  - Miscellaneous fabricated metals
  - Miscellaneous furnishings
  - Mixers
  - Motor control centers
  - Motors, starters and controls
  - Office equipment and furnishings provided by CONTRACTOR
  - Paints, coatings and finishes
  - Piles
  - Pipe, fittings and specials

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Pipe supports and anchors  
Planting plan  
Plumbing fixtures  
Precast concrete elements  
Pressure gauges  
Primary elements  
Programmable logic controllers  
Pumps  
Recorders  
Reinforcing steel and layout drawings  
Roofing and waterproofing  
Sheet pile, shoring and bracing  
Shelving  
Signs  
Structural steel  
Tanks  
Temporary bypasses  
Temporary dewatering systems and equipment  
Valve and gate operators and controllers  
Valves and gates  
Variable frequency drives  
Water heaters  
Windows  
Workstations

**B. Submittal Procedure:**

1. Unless otherwise required in this specification section, the CONTRACTOR shall submit to the ENGINEER for review one electronic copy in PDF format of each submittal (shop drawings, electrical diagrams, and catalog cuts for fabricated items and manufactured items furnished under this Contract, etc.) All electronic submittals from the Contractor shall be sent to the Construction Manager via the project Web Based Document Control (PROCORE LLC) per Section 01322.
2. Electronic PDF copies shall include electronic bookmarks for each section of the submittal to aid in navigation.
3. Hard copies of submittals shall only be provided where it is not feasible to provide submittals in electronic format.
4. Submittals shall be submitted in sufficient time to allow the ENGINEER not less than twenty (20) working days for examination and response, except for:
  - a. Designs for turnkey items for which thirty (30) working days will be allowed, and
  - b. Substitutions for which (40) working days will be allowed.
5. Shop drawings shall be accurate, distinct, and complete, and shall contain all required information, including satisfactory identification of items, units, and assemblies in relation to the Contract Drawings and Specifications.
6. CONTRACTOR Certification:
  - a. Shop drawings shall be submitted only by the CONTRACTOR, who shall indicate by a signed stamp on the shop drawings, or other approved means, that the CONTRACTOR has checked and approved the shop drawings, and that the work shown is in accordance with Contract requirements and has been checked for dimensions and relationship with work of all other trades involved.
  - b. Submitting incomplete or unchecked shop drawings for the ENGINEER to correct or finish will not be acceptable, and shop drawings that, in the opinion of the ENGINEER, indicate that they have not been checked by the CONTRACTOR will be rejected and returned to the CONTRACTOR for resubmission in the proper form.

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7. Return of Reviewed Submittals:
    - a. When the shop drawings have been reviewed by the ENGINEER, the appropriate number of submittals will be returned to the CONTRACTOR appropriately stamped.
    - b. If major changes or corrections are necessary, the shop drawing will be rejected and returned to the CONTRACTOR with the need for such changes or corrections indicated.
    - c. The CONTRACTOR shall correct and resubmit rejected shop drawings in the same manner and quantity as specified for the original submittal.
    - d. If changes are made by the CONTRACTOR (in addition to those requested by the ENGINEER) on the resubmitted shop drawings, such changes shall be clearly explained in a transmittal letter accompanying the resubmitted shop drawings.
  8. The review of such shop drawings and catalog cuts by the ENGINEER shall not relieve the CONTRACTOR from responsibility for correctness of dimensions, fabrication details, coordination with other work, and space requirements, or for deviations from the Contract Drawings or Specifications, unless the CONTRACTOR has called attention to such deviations in writing by a letter accompanying the shop drawings and the ENGINEER approves the change or deviation in writing at the time of submission; nor shall review by the ENGINEER relieve the CONTRACTOR from the responsibility for errors in the shop drawings.
  9. The CONTRACTOR agrees that shop drawing submittals processed by the ENGINEER do not become Contract Documents and are not Change Orders; that the purpose of the shop drawing review is to establish a reporting procedure and to permit the ENGINEER to monitor the CONTRACTOR's progress and understanding of the design.
- C. Shop Drawing Requirements: Shop drawings referred to herein shall include shop drawings, catalog cuts and information schematic diagrams, and other submittals for both shop and field-fabricated items. The CONTRACTOR shall submit, as applicable, the following for all prefabricated or manufactured structural items, material, and equipment:
1. General:
    - a. For structures, submit all shop, setting, equipment, miscellaneous iron and reinforcement drawings and schedules necessary for construction. The foregoing shall include detailed "pour drawings" which shall show the sequence of concrete placement, and the type, quantity and location of all embedment items (sleeves, anchor bolts, door frames, etc.)
    - b. For pipelines, submit a detailed layout of the pipeline with details of clearances for crossings, bends, closure pieces and fabricated specials and furnish any other details necessary.
    - c. For trench excavation, submit detailed plan showing the design of shoring, bracing, sloping or other provisions necessary for safety.
    - d. For boring and jacking, submit a detailed description of the process to be used.
    - e. For equipment which requires electrical service, submit detailed information to show power supply requirements, MCC and control panel, elevations, wiring diagrams, control and protection schematics, shop test data, operation and maintenance procedures, outline drawings, and manufacturer's recommendation of the interface/interlock among the equipment.
    - f. For mechanical equipment submit all data pertinent to the installation and maintenance of the equipment including shop drawings, anchorage requirements, manufacturer's recommended installation procedure, detailed installation drawings, test data and curves, operation and maintenance manuals, and other details necessary.

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- g. For architectural fabrication submit all data pertinent to the installation of the fabrications, including shop drawings, manufacturer's recommended installation procedure, detailed installation drawings, and other details necessary.
  - h. For shop drawings or equipment drawings, including dimensions, size and location of connections to other work, and weight of equipment.
  - i. Installation or placing drawings for equipment, drives, and bases.
  - j. Supporting calculations for equipment and associated supports, or hangers required or specified to be designed by equipment manufacturers, including seismic restraint information and details.
  - k. Complete coating manufacturer's specifications, including materials description and paint system.
  - l. Performance data and head vs. flow curves for compressor and pumps.
  - m. Suggested spare parts list with current price information.
  - n. List of special tools required for checking, testing, parts replacement, and maintenance. (Special tools are those which have been specially designed or adapted for use on parts of the equipment, and which are not customarily and routinely carried by maintenance mechanics.)
  - o. List of special tools furnished with the equipment.
  - p. List of materials and supplies required for the equipment prior to and during startup.
  - q. Installation instructions.
  - r. List of materials and supplies furnished with the equipment.
  - s. Samples of finish colors for selection.
  - t. Special handling instructions.
  - u. Requirements for storage and protection prior to installation.
  - v. Requirements for routine maintenance required prior to plant startup.
  - w. Startup and operating instructions.
  - x. Seismic design calculations and restraint details for equipment and piping supports. Calculations shall be stamped by a Civil or Structural Engineer registered in the State of California.
- 2. Electrical:
    - a. Wiring and control diagrams of systems and equipment. Local control panel details.
    - b. List of special motor features being provided (e.g., space heaters, altitude corrections, thermal protectors, mounting arrangement, etc.).
    - c. Complete motor rating for all motors, including motor no-load, starting, and full-load current at rated voltage; full-load speed and full-load current at 110 percent voltage; motor service factor; motor efficiency and power factor at 1/2, 3/4, and full-load at rated voltage; recommended maximum kVAR of power factor correction capacitors when capacitors are switched with motor.
    - d. See Division 16, ELECTRICAL, for additional specific submittal requirements.
  - 3. Instrumentation and Control:
    - a. See Technical Sections for additional specific submittal requirements.
    - b. The submittals shall include satisfactory identification of items, units, and assemblies in relation to the Specification Section number, and the system or equipment identification or tag number shown on the Drawings, the Process and Instrumentation Diagram (P&ID), or as provided in applicable Specification Section.
- D. Submittals required for foreign-manufactured items:
- 1. In addition to the submittal requirements stated above, suppliers of foreign-manufactured items shall submit the names and addresses of companies within the United States that maintain technical service representatives and a

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complete inventory of spare parts and accessories for each foreign-made item proposed for incorporation into the work. Failure to provide the foregoing capabilities shall be just cause for rejection of the foreign-manufactured items.

- E. Final shop drawings to be submitted to OWNER:
  - 1. Complete sets of reproducible (full size mylar or vellum base) final shop drawings shall be submitted to the OWNER before, or at the time of, delivery of equipment onto the site.
- F. Seismic loading design provisions:
  - 1. All equipment supports that are not specifically detailed on the Drawings or specified herein shall be the responsibility of the equipment manufacturers and shall be designed by a Civil or Structural Engineer registered in the State of California.
  - 2. The design shall be in accordance with the seismic provisions of the latest edition of the 2016 edition of the California Building Code (CBC) and of the seismic design requirements listed in Section 01610, General Equipment Requirements, in addition to all other loading conditions.
- G. Submittal of interface information (connection and correlation with other work):
  - 1. Where called for in the Specifications, and as determined necessary by the ENGINEER to provide proper correlation with other equipment, complete interface information shall be submitted.
  - 2. This interface information shall be accurate and contain all information necessary to allow the completion of detailed design and construction of the interfacing or connecting work.
  - 3. The CONTRACTOR shall include in their negotiation for subcontract work, such agreements as may be necessary to ensure the accuracy of Subcontractor's interface submittal information.
  - 4. In the event additional costs are incurred due to subsequent changes to information given in said interface information, such additional costs shall be borne by the CONTRACTOR.
- H. Contract As-Built Drawings:
  - 1. The CONTRACTOR shall deliver to the OWNER one complete set of final Contract As-Built Drawings for OWNER records before the contract will be accepted by the OWNER. The Contract As-Built Drawings will consist of a set of reproducible drawings of all CONTRACTOR supplied equipment (including control systems) and a marked-up set of Contract As-Built Drawings.
  - 2. As-Built Drawings of CONTRACTOR-Supplied Equipment
    - a. The drawings shall be silver imaged, positive, reverse-reading duplicates (image reversed when viewed from emulsion side), and at the same dimensional scale as the originals. They shall be on a polyester translucent base material with a matte surface on the side opposite the emulsion side. The image emulsion side shall be without a matte surface. The matte surface shall have a sufficient tooth to take a solid opaque line from a 4H pencil and be compatible to the use of ink. Minimum sheet thickness shall be (.08 mm) .003 inch.
    - b. The legibility and contrast of each drawing submitted to the OWNER shall be such that every line, number, letter, and character is clearly readable in a full size blow back from a 35 mm microfilm negative of the drawing.
    - c. The overall dimensions of each drawing submitted to the ENGINEER shall be equal to one of the OWNER's standard sheet sizes. The title block area in the lower right hand corner of each drawing shall be clear of all linework, dimensions, details, and notes, except for the CONTRACTOR's title block. The dimensions of

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the title block area are minimum and are measured from the edges of the drawing sheet.

<b>DRAWING FORMAT</b>	
Sheet Sizes Height x Width	Title Block Area Height x Width
11" x 8-1/2"	2-1/2" x 3-3/4"
11" x 17"	3" x 4"
22" x 34"	3-1/2" x 8"

3. Contract As-Built Drawings

- a. The CONTRACTOR shall keep an up-to-date set of marked-up Contract Drawings on an OWNER-supplied set of Drawings.
- b. The OWNER-supplied set of Drawings will consist of one set of full-size sepia reproductions of the Contract Drawings, supplied to the CONTRACTOR at the start of the work.
- c. During the progress of the work, the CONTRACTOR shall record on the Contract As-Built Drawings any changes from or additions to the work described in the Plans and Specifications.
- d. All information recorded on the Contract As-Built Drawings shall be clearly legible.
- e. Information to be recorded on the Contract As-Built Drawings shall include, but not be limited to, the following:
  - 1) Actual routing of electrical conduits, whose routing is only indicated in general on the Drawings.
  - 2) Actual location of manhole structures.
  - 3) Actual alignment of all installed pipe.
  - 4) Specific details of pipe connections, and manhole structures.
  - 5) Specific details on the installation and connection of mechanical and electrical equipment.
  - 6) Field dimensions where they differ from those shown on the Drawings.
  - 7) Additions to and/or deletions from the work, including all contract change orders.
  - 8) Other details showing as-built conditions, which are shown differently or only in general on the Drawings.
  - 9) Addenda.
  - 10) Location of buried features located during construction except utility service connections.
- f. It is the CONTRACTOR's responsibility to ensure that any changes, deletions, specific construction details, etc., performed by a Subcontractor are recorded on the Contract As-Built Drawings.
- g. Location Survey:
  - 1) The CONTRACTOR shall professionally survey the lateral and vertical position of anything buried underground as part of this Contract to within one inch accuracy of the benchmark and baseline provided by the OWNER.
  - 2) The survey information shall be included on the record drawings and the CONTRACTOR shall not be allowed to cover the buried materials until after the

OWNER's inspector has verified the information as accurate and complete, and is shown on the Contract As-Built Drawings.

- h. Once every month, starting from the completion of mobilization as defined in Section 01505, Mobilization, the CONTRACTOR shall provide the OWNER with a copy of the then up-to-date set of marked-up Contract As-Built Drawings in accordance with the provisions under and Section 01320, Project Schedule.
        - i. At the end of the work, prior to Project Closeout, the CONTRACTOR shall provide the OWNER with the Contract As-Built Drawings, showing all "as-built" conditions.
        - j. See also Section 01800, Operational Completion and Project Closeout.
- I. Operation and Maintenance (O&M) Manuals:
  - 1. The CONTRACTOR shall furnish three (3) hard-copies and one (1) electronic copy (PDF format) of a complete instruction manual for installation, operation, maintenance, and lubrication requirements for each component of mechanical and electrical equipment or system.
  - 2. All equipment manufacturers shall be made aware of these requirements and all associated costs shall be included in the costs for furnishing the equipment or system.
  - 3. O&M Submittal Review Checklist:
    - a. The CONTRACTOR shall include a completed O&M Manual Submittal Review Checklist (copy included at the end of this Section) with each O&M manual submittal.
    - b. The checklist shall indicate that the O&M manual as submitted complies in all respects to the contract requirements.
    - c. Any O&M manual submitted without a completed checklist will be rejected.
  - 4. The manuals shall be furnished to the ENGINEER upon the delivery of the respective equipment.
  - 5. No payment will be made for equipment or materials or equipment installation before the respective O&M manuals have been approved by the ENGINEER.
  - 6. Each O&M manual shall be complete in all respects for all equipment, controls, accessories, and associated appurtenances.
    - a. All information on pre-printed documents (text, drawings, figures, tables, etc.) that does not apply to the deliverables on this project shall be crossed out. This must be done in a clear, unambiguous manner, so that persons using this material can easily distinguish between applicable and non-applicable information.
  - 7. Each O&M manual shall include, but not be limited to, the following:
    - a. Equipment Summary Form
      - 1) OWNER requires that a Maintenance Summary Form, shown in O&M Manual Submittal Review Checklist, be filled out for each type of equipment on a project and that they be included in every O&M manual. OWNER requires that this specific form be used, and that it be placed at the front of each equipment item's O&M manual or immediately behind the item's binder tab, when multiple items are included in a binder. O&M manuals submitted without this form, or not filled out as specified may be rejected. Manufacturer's standard forms, or any other forms, will be considered on a case-by-case basis provided the form includes all of the same information that is included on Maintenance Summary Form. Contractor shall obtain approval for an alternate format prior to submission of their submittal. An electronic version of this form, in Microsoft Word format, is available from OWNER to allow required fields to be expanded or compressed as needed to accurately record the information.
    - b. Diagrams and illustrations, including pump curves indicating operating points.

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- c. Detailed description of the function of each principal component of the system.
- d. Performance and nameplate data.
- e. Installation instructions.
- f. Starting procedure
- g. Proper adjustment procedure.
- h. Test procedures.
- i. Operating procedure.
- j. Shutdown instructions.
- k. Emergency operating instructions and troubleshooting guide.
- l. Safety instructions.
- m. Maintenance and overhaul instructions which shall include detailed assembly drawings with part numbers, parts list, instructions for ordering spare parts, and complete preventive maintenance instructions required to ensure satisfactory performance and longevity of the equipment.
- n. Lubrication instructions which shall list points to be greased or oiled, shall recommend type, grade, and temperature range of lubricants, and shall recommend frequency of lubrication.
- o. List of electrical relay settings and control and alarm contact settings.
- p. Electrical interconnection wiring diagram for equipment furnished, including all control and lighting systems.
- q. Recommendations for spare parts and special tools.
- 8. Hard-Copy O&M Manuals:
  - a. Each copy of the manual shall be assembled in one or more hard-back type three-ring binders, each with title page, typed table of contents, and heavy section dividers with numbered plastic index tabs.
  - b. Cover label and title page shall be clearly labeled to designate the project title, project number, Specification Section where the item is specified, system or equipment for which it is intended with reference to the facility, equipment number, and equipment manufacturer name.
  - c. Typed table of contents for the entire set, identified by volume number, shall appear in each binder.
  - d. Each manual shall be divided into sections paralleling the equipment specifications.
  - e. All data shall be hole-punched for binding and composition and printing shall be arranged so that punching does not obliterate any data.
  - f. Pages larger than 8-1/2" x 11" shall be folded, showing title block or optionally included in binder pockets.
  - g. Where more than one binder is required, they shall be labeled "Vol. 1", "Vol. 2", and so on.
  - h. Submit manual organization and format to the ENGINEER for approval prior to manual preparation.
- 9. Electronic O&M Manuals:
  - a. In addition to the designated number of hard-copies for each required Manufacturer's O&M manual, provide an electronic copy, each on its own separate USB flash drive.
  - b. The USB flash drive shall contain one full version of the O&M manual in Adobe's Portable Document File (PDF) format.
    - 1) Text of O&M manual shall be provided in searchable PDF format, making proper use of PDF for headings and heading levels, paragraphs, tables, and lists. The submitted O&M manual shall be a collected, organized, and indexed with a set of bookmarked PDF documents comprising each O&M document that corresponds to a hardcopy binder.

- c. In addition, the USB flash drive shall contain the separate text and drawing files used to create the PDF O&M manual.
  - d. An index shall be provided on the USB flash drive as a separate text file with the name "index" and shall include the file name and detailed description of each individual file included on the USB flash drive.
  - e. The USB flash drive exterior shall be labeled with the submittal number.
  - f. In addition to being included in PDF O&M manuals, Drawings shall also be provided separately in AutoCAD format.
    - 1) All O&M manual drawings of final approved equipment, including electrical, instrumentation and control system drawings, shall be provided in latest version of AutoCAD.
10. Manuals shall be transmitted to the ENGINEER upon delivery of the equipment and all equipment shall be serviced in accordance with the manufacturer's recommendations prior to operation. A service record shall be maintained on each item of equipment and shall be delivered to the ENGINEER prior to final acceptance of the project.
- J. Manufacturers' certificates and proper installation:
- 1. The CONTRACTOR shall submit manufacturers' certificates of proper installation for items of equipment as specified under Section 01750, Testing, Training and Startup.
- K. Samples and test specimens:
- 1. Where required in the Specifications, and as determined necessary by the ENGINEER, test specimens or samples of materials, appliances, and fittings to be used or offered for use in connection with the work shall be submitted to the ENGINEER at the CONTRACTOR's expense, with information as to their sources, with all cartage charges prepaid, and in such quantities and sizes as may be required for proper examination and tests to establish the quality or equality thereof, as applicable.
  - 2. All samples and test specimens shall be submitted in ample time to enable the ENGINEER to make any tests or examinations necessary, without delay to the work. The CONTRACTOR will be held responsible for any loss of time due to their neglect or failure to deliver the required samples to the ENGINEER, as specified.
  - 3. The CONTRACTOR shall submit additional samples as required by the ENGINEER to ensure equality with the original approved sample and/or for determination of Specification compliance.
  - 4. Laboratory tests and examinations that the OWNER elects to make in its own laboratory will be made at no cost to the CONTRACTOR, except that, if a sample of any material or equipment proposed for use by the CONTRACTOR fails to meet the Specifications, the cost of testing subsequent samples shall be borne by the CONTRACTOR.
  - 5. All tests required by the Specifications to be performed by an independent laboratory shall be made by a laboratory approved by the ENGINEER. Certified test results of all specified tests shall be submitted in duplicate to the ENGINEER. The samples furnished and the cost for the laboratory services shall be at the expense of the CONTRACTOR and included in the prices bid for the associated work.
  - 6. Approved sample items (fixtures, hardware, etc.) may be incorporated into the work upon approval, and when no longer needed by the ENGINEER for reference.
- L. Material and equipment colors:
- 1. The ENGINEER will provide a schedule of selected colors within 30 working days after approval of materials and equipment, and after receiving samples of the manufacturers' standard colors for those items requiring OWNER's selection.
- M. Certificates of Compliance:

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1. A Certificate of Compliance shall be furnished for materials specified to a recognized standard or code prior to the use of any such materials in the work.
2. The ENGINEER may permit the use of certain materials or assemblies prior to sampling and testing if accompanied by a Certificate of Compliance.
3. The certificate shall be signed by the manufacturer of the material or the manufacturer of assembled materials and shall state that the materials involved comply in all respects with the requirements of the Specifications.
4. A Certificate of Compliance shall be furnished with each lot of material delivered to the work and the lot so certified shall be clearly identified in the certificate.

N. Quality Assurance

1. Source limitations: To the greatest extent possible for each unit of work, the CONTRACTOR shall provide products, materials, or equipment of a singular generic kind from a single source.
2. Compatibility of options:
  - a. Where more than one choice is available as options for CONTRACTOR's selection of a product, material, or equipment, the CONTRACTOR shall select an option which is compatible with other products, materials, or equipment already selected.
  - b. Compatibility is a basic general requirement of product/material selections.

O. Review by ENGINEER

1. After review by the ENGINEER of each of the CONTRACTOR's submissions, the material will be returned to the CONTRACTOR with actions defined as follows:
  - a. NO EXCEPTIONS TAKEN: Accepted subject to its compatibility with further submittals and additional partial submittals for portions of the work not covered in this submittal. Does not constitute approval or deletion of specified or required items not shown in the partial submittal.
  - b. MAKE CORRECTIONS NOTED: Same as 1.a., except that minor corrections as noted shall be made by the CONTRACTOR.
  - c. REVISE AND RESUBMIT: Rejected because of major inconsistencies or errors which shall be resolved or corrected by the CONTRACTOR prior to subsequent review by the ENGINEER.
  - d. REJECTED - RESUBMIT: Submitted material does not conform to Plans and Specifications in major respect, e.g., wrong item, wrong size, model, capacity, or material.
2. Items 1 and 2 above (no resubmittal required) are considered "Favorable Review." Items 3 and 4 above (correction and resubmittal required) are considered "unfavorable review."
  - a. ENGINEER's "Favorable Review" of submittals shall be obtained prior to the fabrication, delivery and construction of items requiring submittal review.
  - b. "Favorable Review" of submittals does not constitute a Change Order to the Contract requirements.
  - c. "Favorable Review" of all submittals by ENGINEER shall apply in general design only and shall in no way relieve the Contractor from responsibility for errors or omissions contained therein.
  - d. "Favorable Review" by the ENGINEER shall not relieve the Contractor of its obligation to meet safety requirements and all other requirements of laws, nor constitute a Contract Change Order.
  - e. "Favorable Review" will not constitute acceptance of any responsibility for the accuracy, coordination, and completeness of the submittals or the items of equipment represented on the submittals.

P. Requests for Information

1. Requests for Information about the Contract Documents shall be directed by the CONTRACTOR to the ENGINEER using a Request for Information (RFI) form as agreed to by the OWNER and the ENGINEER. Such requests shall not be transmitted directly to the ENGINEER from a Subcontractor or Supplier.
2. A separate form shall be used for each specific item for which information is required. Requests for Information for more than one item using a single RFI form will be permitted only when the items are so functionally related that expediency indicates review of the group of items as a whole.
3. The ENGINEER will reply to the CONTRACTOR's Request for Information as soon thereafter as practicable.

Q. Construction Photographs

1. Provide photographs showing the preconstruction site, construction progress, and the post-construction site.
2. Format: Photographs shall be digital format
  - a. Digital Format:
    - 1) Digital photos shall be taken with a minimum 8 mega pixel density and provided in JPG format.
  - b. Photos should be properly labeled with the following (at a minimum):
    - 1) Time and date stamped
    - 2) Photograph orientation and location
    - 3) Brief description of photo subject
3. Preconstruction and Post-Construction Photographs
  - a. Take a minimum of 72 photos of the preconstruction site and the property adjacent to the perimeter of the construction site. Particular emphasis shall be directed to utilities and structures both inside and outside the site, or as directed by OWNER.
  - b. Take a minimum of 72 photos of the post-construction site and the property adjacent to the perimeter of the site. Particular emphasis shall be directed to structures both inside and outside the plant boundary, or as indicated by OWNER.
  - c. Preconstruction and post-construction digital photo files shall be submitted on a USB flash drive accompanied by a text file that lists the file name, date photo was taken, and brief description of the photograph and location where the photograph was taken.
  - d. Preconstruction and post-construction digital photo files will be uploaded by Contractor to the project Web Based Document Control Software (PROCORE LLC).
4. Construction Progress Photographs
  - a. Take daily photos, a minimum of 30 per week, showing the process of the construction.
    - 1) Photos should be of enough quality and quantity such that the OWNER can interpret the progress of work and utilize the photographs to physically locate work items depicted.
    - 2) Photos should encompass all areas and scopes of work performed in that week.
    - 3) Daily construction progress digital photo files will be uploaded by Contractor to the project Web Based Document Control Software (PROCORE LLC) on a minimum once weekly basis within five (5) days of the Friday of the week they were taken.
  - b. Submit a minimum of 48 of the construction progress photos monthly showing the progress of construction. Locations shall be selected by the contractor to best depict the progress of the work, or as indicated by OWNER.

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- 1) Monthly digital photo files shall be submitted on a USB flash drive accompanied by a text file that lists the file name, date photo was taken, and brief description of the photograph and location where the photograph was taken.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION (NOT USED)**

+ + END OF SECTION + +

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## O&M MANUAL REVIEW CHECKLIST

<b>SUBMITTAL NO.</b> _____ <b>SPEC. SECTION.</b> _____ <b>SUBJECT</b> _____ <b>EQUIP. ITEM</b> _____ _____	<b>DATED</b> _____ <b>REVIEW DATE</b> _____ <b>REVIEWER</b> _____ <b>SUPPLIER</b> _____ <b>MANUFACTURER</b> _____
--	---

<b>ACCEPTABLE</b> _____ <b>UNACCEPTABLE</b> _____	<b>PROJECT TITLE:</b> _____ <b>PROJECT NO.</b> 17-083
--	--

DISPOSITION	ACCEPTABLE?			COMMENTS
	YES	NO	NA	
HARD-COPY O&M MANUALS				
▪ Minimum three (3) copies .....	_____	_____	_____	_____
▪ Three-ring binder with hard-back cover.....	_____	_____	_____	_____
▪ Cover Label and Title Page (Cover/Title Page):				
Project title and Project number .....	_____	_____	_____	_____
Specification section .....	_____	_____	_____	_____
System/Equipment names.....	_____	_____	_____	_____
Facility .....	_____	_____	_____	_____
Equipment number .....	_____	_____	_____	_____
▪ Typed table of contents.....	_____	_____	_____	_____
▪ Heavy section dividers w/numbered plastic index tabs .	_____	_____	_____	_____
▪ Sections parallel equipment specifications .....	_____	_____	_____	_____
▪ Pages punched for 3 ring binder (punching does not obliterate data) .....	_____	_____	_____	_____
▪ Info larger than 8-1/2"x11" folded showing title block, or included in binder pockets .....	_____	_____	_____	_____
▪ Multiple volumes labeled "Vol. 1", "Vol. 2", etc.....	_____	_____	_____	_____
▪ Table of contents for entire set in each binder.....	_____	_____	_____	_____
ELECTRONIC O&M MANUALS				
▪ Minimum one (1) copy on USB Flash Drive .....	_____	_____	_____	_____
▪ Full version of O&M manual in PDF format .....	_____	_____	_____	_____
▪ PDF "Bookmarks" to label each section of manual .....	_____	_____	_____	_____
▪ Separate text and drawing files used to create PDF O&M manual.....	_____	_____	_____	_____

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DISPOSITION	ACCEPTABLE?			COMMENTS
	YES	NO	NA	
▪ Index on flash drive as separate file titled "index" .....	_____	_____	_____	_____
▪ Flash drive labeled with submittal number .....	_____	_____	_____	_____
<b>TECHNICAL CONTENT</b>				
▪ Equipment Summary Form (See example of required format, Figure 2-1, 2 pages, end of this Section)	_____	_____	_____	_____
▪ Diagrams and illustrations, including pump curves .....	_____	_____	_____	_____
▪ Detailed description of function of principal components.....	_____	_____	_____	_____
▪ Performance and nameplate data .....	_____	_____	_____	_____
▪ Installation instructions.....	_____	_____	_____	_____
▪ Starting procedure .....	_____	_____	_____	_____
▪ Proper adjustment procedure.....	_____	_____	_____	_____
▪ Test procedures .....	_____	_____	_____	_____
▪ Operating procedure (Normal operation and all other operating modes).....	_____	_____	_____	_____
▪ Shutdown instructions, including emergency shutdown	_____	_____	_____	_____
▪ Emergency operating instructions & troubleshooting....	_____	_____	_____	_____
▪ Safety instructions and precautions .....	_____	_____	_____	_____
▪ Maintenance procedures and instructions, preventative, reactive and overhaul.....	_____	_____	_____	_____
▪ Troubleshooting and corrective maintenance procedures	_____	_____	_____	_____
▪ Lubrication instructions and information .....	_____	_____	_____	_____
▪ List of electrical relay settings and control and alarm contact settings .....	_____	_____	_____	_____
▪ Electrical interconnection wiring diagrams, including control and lighting systems, panel wiring, control (ladder) diagrams, logic diagrams, loop diagrams, and interconnection diagrams .....	_____	_____	_____	_____
▪ Panel layout and assembly drawings	_____	_____	_____	_____
▪ Mechanical drawings	_____	_____	_____	_____
▪ Printout of all software programs and configuration files	_____	_____	_____	_____
▪ Parts list (with exploded view and associated cross-references)	_____	_____	_____	_____
▪ Recommended spare parts and special tools .....	_____	_____	_____	_____
▪ Factory and field test procedures and results	_____	_____	_____	_____
▪ Project specific warranty statement	_____	_____	_____	_____

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MAINTENANCE SUMMARY FORM

PROJECT: \_\_\_\_\_

EQUIPMENT LOCATION: \_\_\_\_\_

1. EQUIPMENT ITEM \_\_\_\_\_

2. MANUFACTURER \_\_\_\_\_

3. EQUIPMENT/TAG NUMBER(S) \_\_\_\_\_

4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS) \_\_\_\_\_

5. NAMEPLATE DATA (hp, voltage, speed, etc.) \_\_\_\_\_

6. MANUFACTURER'S LOCAL REPRESENTATIVE \_\_\_\_\_

a. Name \_\_\_\_\_ Telephone No. \_\_\_\_\_

b. Address \_\_\_\_\_

7. MAINTENANCE REQUIREMENTS

Maintenance Operation Comments	Frequency	Lubricant (If Applicable)
List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.)	List required frequency of each maintenance operation.	Refer by symbol to lubricant required.

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FIGURE 2-1

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**8. LUBRICANT LIST**

Reference Symbol	Shell	Exxon Mobile	Chevron Texaco	BP Amoco	Or Equal
List symbols used in No. 7 above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				

**9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY.**

Part No.	Description	Unit	Quantity	Unit Cost

Note: Identify parts provided by this Contract with two asterisks.

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FIGURE 2-1

## **SECTION 01400**

### **QUALITY CONTROL**

#### **PART 1 - GENERAL**

##### **1.1 OBSERVATION AND SUPERVISION**

- A. The ENGINEER or ENGINEER's appointed representative will review the Work and the CONTRACTOR shall provide facilities and access to the Work at all times as required to facilitate this review.
- B. Responsibility:
  - 1. The CONTRACTOR shall be solely responsible to supervise and direct the entire Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to complete the Work in accordance with the Contract Documents.
  - 2. The CONTRACTOR shall be solely responsible for the means, methods, techniques, sequences, quality control, and procedures of construction and safety precautions and programs incidental thereto.
  - 3. The foregoing includes work performed by the CONTRACTOR's Subcontractors.
  - 4. The CONTRACTOR shall be responsible to see that the finished Work complies accurately with the Contract Documents.
  - 5. CONTRACTOR shall be responsible for maintaining a complete hardcopy set of all project documents at the site at all times. Project documents shall include but are not limited to all drawings, specifications, submittals, requests for information (RFI), requests for change (RFC), change orders, and up to date project record drawings.
  - 6. Project documents as described above shall be onsite and available for OWNER or ENGINEER review at all times. Failure to maintain or make project documents available will result in the stoppage of work. Schedule and cost changes resulting from stoppage of work are the responsibility of the CONTRACTOR.
- C. Superintendent:
  - 1. The CONTRACTOR shall designate in writing and submit for ENGINEER's approval a technically qualified, English-speaking superintendent, who shall be onsite and responsible for the work, and who shall not be replaced without written acceptance of the ENGINEER.
  - 2. The superintendent shall be the CONTRACTOR's representative at the job site and shall have authority to act on behalf of the CONTRACTOR.
  - 3. All communications given to the superintendent shall be as binding as if given to the CONTRACTOR.
  - 4. The CONTRACTOR's superintendent shall be present at the site of the Work at all times while work is in progress. Failure to observe this requirement shall be considered as suspension of the Work by the CONTRACTOR until such time as such superintendent is again present at the site.
  - 5. CONTRACTOR's superintendent shall be responsible for maintaining a complete hardcopy set of all project documents.

## 1.2 RESPONSIBILITY

- A. The CONTRACTOR is responsible for conducting all testing and inspection specifically required by the Specifications and otherwise necessary to ensure compliance with the Contract Documents.
  - 1. Approval of Testing Laboratories and Geotechnical Consultants:
    - a. All laboratory work under this contract shall be performed by a laboratory approved by the ENGINEER, whether the laboratory is employed by the CONTRACTOR, or is owned and operated by the CONTRACTOR.
    - b. The basis of approval includes the following:
      - 1) Testing laboratories performing work in connection with concrete, steel, and bituminous materials shall comply with ASTM E 329 and ASTM D 3666, respectively.
      - 2) Testing laboratories performing work not in connection with concrete, steel, bituminous materials, soils and non-destructive testing shall comply with ASTM E 548.
- B. The ENGINEER may conduct periodic independent testing and inspection to verify compliance with the Contract Documents.
- C. Retesting:
  - 1. The OWNER reserves the right to back-charge the CONTRACTOR for retesting of deficient or defective work or products upon written notification.
  - 2. Compensation for retesting on behalf of the OWNER will be made through deductions from the Progress Payments.
- D. The CONTRACTOR is responsible for correcting all defective work discovered prior to final acceptance of the Contract, despite the failure of the Inspector(s) to discover it.
- E. The OWNER shall employ a special inspector during construction on the types of work indicated in the Statement of Special Inspections in the drawings.
  - 1. OWNER's REPRESENTATIVE shall provide special inspection as identified with "BY OWNER" in the Statement of Special Inspections.
  - 2. CONTRACTOR shall provide special inspection as identified with "BY CONTRACTOR" in the Statement of Special Inspections.

## 1.3 TESTS AND INSPECTIONS

- A. The CONTRACTOR shall be responsible for scheduling all inspections and tests required.
  - 1. The ENGINEER shall be given a minimum 48 business hours notice prior to any inspections or tests.
- B. With the exception of the special inspections noted above to be paid for by the OWNER; the CONTRACTOR shall pay for all tests, inspections and special inspections including, but not limited to:
  - 1. Standard inspections and tests necessary to comply with laws, ordinances, rules, regulations and orders of public authorities pursuant to General Conditions.
  - 2. Concrete and CLSM compressive strength tests for trial batch mix designs.
  - 3. Tests of materials, inspections, and certifications required by the Specifications.
  - 4. Testing, adjusting, and balancing of equipment and systems required by the Specifications.
  - 5. One tension and elongation test for each 5 tons of steel or fractional part thereof for each size will be required, unless the steel can be identified by heat or melt numbers

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- and is accompanied by mill analysis and test reports. Commercial stock may be used, subject to approval of the ENGINEER.
6. Any testing performed by the CONTRACTOR for their own quality control.
  7. All compaction testing, moisture testing, field testing of CLSM for backfill placement, geotechnical observations, and all certifications necessary to comply with the specifications.
  8. Retests or re-inspections by the OWNER, if required, and tests or inspections required due to CONTRACTOR error or lack of required identifications of material.
  9. Any and all water used by the CONTRACTOR in any testing.
  10. Special Inspections as identified with "BY CONTRACTOR" in the Statement of Special Inspections in the drawings.
- C. The CONTRACTOR shall be responsible for scheduling all tests and inspections pertaining to soils which includes all items covered by 02300 EARTHWORK. CONTRACTOR shall hire a third party accredited laboratory and geotechnical consultant for approval by OWNER a minimum of 30 days in advance of using the laboratory or geotechnical consultant.
- D. Two copies of the agency or laboratory report of each test or inspection shall be provided to the ENGINEER. All tests of materials shall be made in accordance with the commonly recognized standards of national technical organizations, and such other special methods and tests as are prescribed in the Contract Documents. Hardcopies of soils testing daily reports shall be provided to the ENGINEER before close of business the day tests are completed.
- E. Along with the monthly progress pay application submittal, the CONTRACTOR shall provide to the ENGINEER a typed summary of all tests performed for the current month including test location by station or location, elevation, depth below finished grade, material tested, wet density, moisture content, dry density, maximum density curve used, and percent relative compaction. Lab test results shall also be included in the monthly report with clear description of material tested, intended use on the Project, and a statement of compliance or noncompliance with the Project requirements.
- F. Purchase Orders:
1. One copy of each of the CONTRACTOR's purchase orders for materials forming a portion of the work shall be furnished to the ENGINEER, if requested.
  2. Each such purchase order shall contain a statement that the materials included in the order are subject to inspection by the OWNER.
  3. Materials purchased locally will be inspected at the point of manufacture or supply, and materials supplied from points more than 50 miles from the job site will be inspected upon arrival at the job, except when other inspection requirements are provided for specific materials in other Sections of this Specification.
- G. Samples:
1. The CONTRACTOR shall furnish samples of materials as are required by the ENGINEER, without charge.
  2. No material shall be used until the ENGINEER has had the opportunity to test or examine such materials.
  3. Samples will be secured and tested whenever necessary to determine the quality of the material.
  4. Samples and test specimens prepared at the job site, such as concrete test cylinders, shall be taken or prepared by the ENGINEER in the presence and with the assistance of the CONTRACTOR.

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#### 1.4 AUTHORITY AND DUTIES OF INSPECTOR

- A. Inspectors employed by the OWNER shall be authorized to inspect all work done and materials and equipment furnished to complement the CONTRACTOR furnished independent inspector.
  - 1. Such inspection may extend to all or any part of the work, and to the preparation, fabrication, or manufacture of the materials and equipment to be used.
  - 2. The Inspector will not alter or waive the provisions of the Contract Documents.
  - 3. The Inspector will keep the ENGINEER informed as to the progress of the work and the manner in which it is being done.
  - 4. The Inspector will call the CONTRACTOR's attention to nonconformance with the Contract Documents that the Inspector may have observed.
  - 5. The Inspector will not be responsible for the adequacy or correctness of the CONTRACTOR's means, methods, techniques, sequences, or procedures for construction.
  - 6. The Inspector will not approve or accept any portion of the work, issue instructions contrary to the Contract Documents, or act as foreman for the CONTRACTOR.
  - 7. The Inspector may reject defective materials, equipment, or work when it is not in compliance with the Contract Documents.
  - 8. The Inspector will not be responsible for:
    - a. The CONTRACTOR's quality control program.
    - b. The CONTRACTOR's safety program.
    - c. Coordinating the work or activities of the CONTRACTOR or their Subcontractor.

#### **PART 2 - PRODUCTS (NOT USED)**

#### **PART 3 - EXECUTION (NOT USED)**

+ + END OF SECTION + +

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## SECTION 01420

### REFERENCE STANDARDS AND ABBREVIATIONS

#### **PART 1 - GENERAL**

##### **1.1 REFERENCE STANDARDS**

- A. The standards referred to, except as modified, shall have full force and effect as though printed in this Specification, and shall be the latest edition or revision thereof in effect on the bid opening date, unless a particular edition or issue is indicated. Copies of these standards are not available from the OWNER.
- B. The ENGINEER will furnish, upon request, information as to how copies may be obtained.
- C. Abbreviations and terms, or pronouns in place of them, shall be interpreted as follows:

AAMA:	Architectural Aluminum Manufacturer's Association
AAN:	American Association of Nurserymen
AAR:	Association of American Railroads
AASHTO:	American Association of State Highway and Transportation Officials, Standard Specifications
AATCC:	American Association of Textile Chemists and Colorists
ACI:	American Concrete Institute, Standards
AFBMA:	Anti-Friction Bearing Manufacturer's Association, Inc.
AGA:	American Gas Association
AGC:	Associated General Contractors
AGMA:	American Gear Manufacturer's Association
AHAM:	Association of Home Appliance Manufacturer's
AI:	The Asphalt Institute
AIA:	American Institute of Architects
AISC:	American Institute of Steel Construction, Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings, and the AISC Code of Standard Practice
AISI:	American Iron and Steel Institute
AITC:	American Institute of Timber Construction
AMCA:	Air Moving and Conditioning Association, Standards
ANS:	American Nuclear Society
ANSI:	American National Standards Institute
APA:	American Plywood Association
API:	American Petroleum Institute
APWA:	American Public Works Association, Standard Specifications for Public Works Construction
ASA:	Acoustical Society of America
ASAE:	American Society of Agriculture Engineers
ASCE:	American Society of Civil Engineers
ASHRAE:	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASLE:	American Society of Lubricating Engineers
ASME:	American Society of Mechanical Engineers

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ASQC:	American Society of Quality Control
ASSE:	American Society of Sanitary Engineers
ASTM:	American Society for Testing and Materials, Standards
AWG:	American Wire Gauge
AWPA:	American Wood-Preservers' Association, Standards
AWPI:	American Wood Preservers Institute
AWS:	American Welding Society
AWWA:	American Water Works Association, Standards
BBC:	Basic Building Code, Building Officials and Code Administrators International
BHMA:	Builders Hardware Manufacturer's Association
CAL/OSHA:	California/Occupational Safety and Health Administration, Standards
CBM:	Certified Ballast Manufacturer's
CCR:	California Code of Regulations
CEMA:	Conveyors Equipment Manufacturer's Association
CGA:	Compressed Gas Association
CISPI:	Cast Iron Soil Pipe Institute, Standards
CLPCA:	California Lathing and Plastering Contractors Association
CLFMI:	Chain Link Fence Manufacturer's Institute
CMAA:	Crane Manufacturers' Association of America
CMA:	Concrete Masonry Association
CORDCS:	City of Roseville Design & Construction Standards
CORPCS:	City of Roseville Process Control Standards
CRSI:	Concrete Reinforcing Steel Institute, Standards
CSS:	CalTrans Standard Specifications, State of California, Department of Transportation
DCDMA:	Diamond Core Drill Manufacturer's Association
DOSH:	Division of Occupational Safety and Health, State of California, Department of Industrial Relations
EIA:	Electronic Industries Association
ETL:	Electrical Test Laboratories
FED/OSHA:	Federal Occupational Safety and Health Administration, Standards
FM:	Factory Mutual
ICBO:	International Conference of Building Officials
ICEA:	Insulated Cable Engineers Association
IEEE:	Institute of Electrical and Electronic Engineers
IES:	Illuminating Engineering Society
IME:	Institute of Makers of Explosives
IP:	Institute of Petroleum (London)
IPC:	Institute of Printed Circuits
IPCEA:	Insulated Power Cable Engineers Association
ISA:	Instrument Society of America
ISO:	International Organization of Standardization
ITE:	Institute of Traffic Engineers
MBMA:	Metal Building Manufacturer's Association
MPTA:	Mechanical Power Transmission of Association
MTI:	Marine Testing Institute
MSS:	Manufacturers Standardization Society
NAAM:	National Association of Architectural Metal Manufacturers

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NACE:	National Association of Corrosion Engineers, Standards
NBS:	National Bureau of Standards
NCCLS:	National Committee for Clinical Laboratory Standards
NEC:	National Electric Code
NEMA:	National Electrical Manufacturers' Association, Standards
NFPA:	National Fire Protection Association
NFPA:	National Forest Products Association
NGLI:	National Lubricating Grease Institute
NMA:	National Microfilm Association
NWMA:	National Woodwork Manufacturers Association
OSHA:	Occupational Safety and Health Administration
PCA:	Portland Cement Association
PCI:	Prestressed Concrete Institute
RIS:	Redwood Inspection Service, Standard Specifications
RVIA:	Recreational Vehicle Industry Association
RWMA:	Resistance Welder Manufacturer's Association
SAE:	Society of Automotive Engineers
SAMA:	Scientific Apparatus Makers Association
SDI:	Steel Door Institute
SIS:	Swedish Standards Association
SMA:	Screen Manufacturer's Association
SMACNA:	Sheet Metal and Air Conditioning Contractors National Association
SPR:	Simplified Practice Recommendation
SSBC:	Southern Standard Building Code, Southern Building Code Congress
SSPC:	Steel Structures Painting Council, Specifications
SSPWC:	Standard Specifications for Public Works Construction
TAPPI:	Technical Association of the Pulp and Paper Industry
TFI:	The Fertilizer Institute
UBC:	Uniform Building Code of the International Conference of Building Officials
UPC:	Uniform Plumbing Code
UL:	Underwriters Laboratories
WCLA:	West Coast Lumbermen's Association, Standard Grading and Dressing Rules
WCLIB:	West Coast Lumber Inspection Bureau
WCRSI:	Western Concrete Reinforcing Steel Institute
WIC:	Woodwork Institute of California
WRI:	Wire Reinforcement Institute, Inc.
WWPA:	Western Wood Products Association

## 1.2 OTHER ABBREVIATIONS

- A. Other common abbreviations that may be found in the Specifications are, but may not be limited to:

acrylonitrile butadiene styrene	ABS	ampere average	A, amp avg
alternating current	a-c, AC	biochemical oxygen demand	BOD
American wire gauge	AWG	brake horsepower	bhp
ante meridiem	am		

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British thermal unit	Btu	inch	in
Centigrade	C	inch-pound	in-lb
chlorinated polyvinyl chloride	CPVC	input/output	I/O
company	Co	inside diameter	ID
cubic inch	cu in, in <sup>3</sup>	instrumentation and control	I&C
cubic foot	cu ft, CF, ft <sup>3</sup>		
cubic yard	cu yd, CY, yd <sup>3</sup>	kilovolt	kV
cubic feet per minute	cfm, ft <sup>3</sup> /min	kilovolt-ampere	kVA
cubic feet per second	cfs, ft <sup>3</sup> /s	kilowatt	kW
		kilowatt-hour	kWhr
decibel	dB		
decibels, A-weighted	dBA	length	L
degree Centigrade (Celsius)	°C, C	length to least radius of gyration	L/r
degree Fahrenheit	°F, F	light emitting diode	LED
diameter	diam, Ø	linear	lin
direct current	d-c, DC	linear foot	lin ft
dollars	\$	liter	l
ductile iron	DI		
each	ea, @	manhole	MH
efficiency	eff	maximum	max
elevation	El., Elev	mean sea level	MSL
ethylene propylene rubber	EPDM	mercury	Hg
exhaust fan	EF	miles per hour	mph
		milli-amp	mA
Fahrenheit	F	milliampere DC	mAdc
feet	ft	milligram	mg
feet per hour	fph, ft/h	milligrams per liter	mg/l
feet per minute	fpm, ft/min	milliliter	ml
feet per second	fps, ft/s	millimeter	mm
fiberglass reinforced plastic	FRP	million gallon	mil
figure	Fig.	million gallons per day	mgd
flange	flg	minimum	min
foot-pound	ft-lb	motor control center	MCC
gallon	gal	net positive suction head available	NPSHA
gallons per hour	gph, gal/hr	net positive suction head required	NPSHR
gallons per minute	gpm, gal/min	number	No., #
gallons per second	gps, gal/s	National Pipe Thread	NPT
gram	g		
ground fault current interrupter	GFCI	Operation and Maintenance	O&M
		ounce	oz
hand/off/automatic heating, ventilating, and air conditioning	HOA HVAC	outside diameter	OD
Hertz	Hz		
hour	hr	parts per million	ppm
horsepower	hp	post meridiem	pm
		plus or minus	+/-, ±
		polytetrafluorethylene	PTFE

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polyvinyl chloride	PVC	stainless steel	SS
pound	lb	standard	std
pounds per square foot	psf, lb/ft <sup>2</sup>	standard cubic feet	
pounds per square inch	psi, lb/in <sup>2</sup>	per minute	scfm
pounds per square inch absolute	psia	symmetrical	sym.
pounds per square inch gage	psig	total dynamic head	tdh
Process and Instrumentation Diagrams	P&ID	totally-enclosed, fan- cooled	TEFC
random access memory	RAM	totally-enclosed, non- ventilated	TENV
reinforced concrete pipe	RCP	twisted shielded	TWSH
reinforced concrete cylinder pipe	RCCP	ultraviolet	UV
relative humidity	RH	United States	US, USA
revolutions per minute	rpm	variable frequency drive	VFD, AFD
second	sec, s	volt	V
specific gravity	sp gr	volts alternating current	VAC
square foot	sq ft, SF, ft <sup>2</sup>	volts direct current	VDC
square inch	sq in, in <sup>2</sup>	water to cement	W/C, wc
square yard	sq yd, SY, yd <sup>2</sup>	water column	W.C.

## **PART 2 - PRODUCTS (NOT USED)**

## **PART 3 - EXECUTION (NOT USED)**

+ + END OF SECTION + +

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## SECTION 01500

### TEMPORARY CONSTRUCTION FACILITIES AND UTILITIES

#### **PART 1 - GENERAL**

##### **1.1 CONTRACTOR'S STAGING AREA AND WORK ACCESS PLAN**

- A. The CONTRACTOR shall limit the location of the storage of equipment and materials to the staging area(s) designated on the Drawings and as directed by the ENGINEER.
- B. The CONTRACTOR shall make their own arrangements for additional space that may be required and shall bear all associated costs.
- C. Work Access Plan: The CONTRACTOR shall submit a work access plan showing the planned access route for deliveries of supplies and mobilization of work force for ENGINEER's approval prior to mobilization.
- D. On-Site Project Office:
  - 1. The CONTRACTOR shall provide and maintain an on-site contractor construction office for CONTRACTOR's management staff. Hardcopies of all the Contract Documents, project progress records, submittal(s), RFI(S), RFC(s) record drawings, project schedule, shop drawings, SWPPP documentation, and all other relevant documents shall be stored, organized, and maintained in Contractor's management staff onsite project office. CONTRACTOR's project office and project documents shall be accessible to the OWNER and ENGINEER during normal working hours.
  - 2. The CONTRACTOR shall make their own arrangements for any additional space that may be required to maintain on-site project offices and bear all associated costs.
  - 3. Contractor shall provide an ENGINEER's Field Office as described herein and bear all associated costs.
  - 4. The CONTRACTOR shall make available for use On-Site Project Offices prior to the start of any work at Site, relocate these facilities as necessary to accommodate project phasing, and maintain these in good working order on-site for a minimum of 7 days after final acceptance of the work.
- E. Temporary Facilities Plan:
  - 1. The CONTRACTOR shall submit to the ENGINEER for approval, as part of the mobilization effort, the proposed plan and layout for all temporary offices, sanitary facilities, temporary construction roads, storage buildings, storage yards, temporary water service and distribution, temporary telephone and temporary power service and distribution.
  - 2. The plan shall show all temporary fencing and gates and all proposed access to the work areas.
  - 3. Prior to the removal of existing fence, the CONTRACTOR shall provide temporary security fencing at least equal to the existing chain link and barbed wire fencing to protect the existing facilities and structures.
- F. Access Roads:
  - 1. The CONTRACTOR shall "winterize" and maintain all access roads at all times to provide a driving surface satisfactory for 2-wheel drive low clearance vehicular traffic.
  - 2. The roads shall be gravel surfaced, smooth, and free from humps and depressions.
  - 3. Contractor shall perform dust control on all access roads.

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4. All costs of complying with this requirement shall be included in the GMP.

## 1.2 STORAGE - GENERAL

- A. The CONTRACTOR shall provide any temporary storage required for the protection of equipment and materials as recommended by manufacturers of such materials.

## 1.3 STORAGE BUILDINGS

- A. The CONTRACTOR shall erect or provide temporary storage buildings of the various sizes as required for the protection of mechanical and electrical equipment and materials as recommended by manufacturers of such equipment and materials.
- B. The buildings shall be provided with such environmental control systems that meet recommendations of manufacturers of all equipment and materials stored in the buildings.
- C. The buildings shall be of sufficient size and so arranged or partitioned to provide security for their contents and provide ready access for inspection and inventory.
- D. At or near the completion of the work, and as directed by the ENGINEER, the temporary storage buildings shall be dismantled, removed from the site, and remain the property of the CONTRACTOR.
- E. Combustible materials (paints, solvents, fuels, etc.) shall be safely stored and separated in accordance with the manufacturer's requirements and in compliance with hazardous material storage requirements. CONTRACTOR shall be responsible for providing proper storage buildings for combustible materials.

## 1.4 STORAGE YARDS

- A. The CONTRACTOR shall provide temporary storage yards as required for the storage of materials that are not subject to damage by weather conditions.
- B. Materials such as pipe, reinforcing and structural steel, shall be stored on pallets or racks, off the ground, and stored in a manner to allow ready access for inspection and inventory.
- C. Temporary gravel surfacing of the storage yards shall meet with the approval of the ENGINEER.

## 1.5 PARKING AREAS

- A. Control vehicular parking to preclude interference with public traffic or parking, access by emergency vehicles, OWNER's operations, or construction operations.

## 1.6 VEHICULAR TRAFFIC

- A. Comply with Laws and Regulations regarding closing or restricting use of public streets or highways. No public or private road shall be closed, except by written permission of proper authority. Assure the least possible obstruction to traffic and normal commercial pursuits.

- B. Conduct the Work to interfere as little as possible with public travel, whether vehicular or pedestrian.
- C. Whenever it is necessary to cross, close, or obstruct roads, driveways, and walks, whether public or private, provide and maintain suitable and safe bridges, detours, or other temporary expedients for accommodation of public and private travel.

#### 1.7 DELIVERY-STORAGE-HANDLING

##### A. General:

- 1. The CONTRACTOR shall deliver, handle, and store materials and equipment in accordance with supplier's written recommendations and by methods and means which will prevent damage, deterioration, and loss including theft.
- 2. Delivery schedules shall be controlled to minimize long-term storage at the site and overcrowding of construction spaces.
- 3. In particular, the CONTRACTOR shall provide delivery/ installation coordination to ensure minimum holding or storage for material or equipment recognized to be flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other sources of loss.

##### B. Transportation and Handling:

- 1. Materials and equipment shall be transported by methods to avoid damage and shall be delivered in dry, undamaged condition in supplier's unopened containers or packaging.
- 2. The CONTRACTOR shall provide equipment and personnel to handle the materials, and equipment by methods that will prevent soiling and damage.
- 3. The CONTRACTOR shall provide additional protection during handling to prevent marring and otherwise damaging packaging, and surrounding surfaces.

##### C. Storage and Protection:

- 1. Materials and equipment shall be stored in accordance with supplier's written instructions, with seals and labels intact and legible. Exposed metal surfaces of valves, fittings and similar materials shall be coated with grease in accordance with manufacturer's recommendations to prevent corrosion. Sensitive materials and equipment shall be stored in weather-tight enclosures and temperature and humidity ranges shall be maintained within tolerances required by supplier's written instructions.
- 2. For exterior storage of fabricated materials, they shall be placed on sloped support above ground. Materials or equipment subject to deterioration shall be covered with impervious sheet covering; ventilation shall be provided to avoid condensation.
- 3. Loose granular materials shall be stored on solid surfaces in a well-drained area and shall be prevented from mixing with foreign matter.
- 4. Inspection:
  - a. Storage shall be arranged to provide access for inspection.
  - b. The CONTRACTOR shall periodically inspect to assure materials and equipment are undamaged and are maintained under required conditions.
- 5. Storage shall be arranged in a manner to provide access for maintenance of stored items.

#### 1.8 PROJECT SECURITY

- A. The CONTRACTOR shall make adequate provision for the protection of the work area against fire, theft and vandalism, and for the protection of the public and OWNER personnel against exposure to injury, and for the security of any off-site storage areas.
- B. All costs for this protection shall be included within the CONTRACTOR's bid.

#### 1.9 TEMPORARY UTILITIES

- A. The CONTRACTOR shall provide and pay for all necessary temporary telephones, fuel, power, potable water, sanitary, and proper toilet accommodations. CONTRACTOR shall not use OWNER-owned utilities except for potable water. OWNER will work with CONTRACTOR to provide potable water free of charge. The CONTRACTOR, however, shall be required to furnish and lay such pipe and/or provide such other means as may be necessary and/or incidental to the delivery of water at such point or points of use and at such pressure as may be necessary. No additional compensation will be made therefore. Contractor shall not use quick acting valves which might create surges.
- B. The temporary facilities to be provided by the CONTRACTOR as described above shall conform to all requirements in regard to operation, safety, and fire hazards of State and local authorities and of Underwriters.
- C. CONTRACTOR shall return the site and facilities to their original "pre-construction" condition, unless otherwise specified in the Contract Documents, at the completion of the project.

#### 1.10 SOUND CONTROL

- A. The CONTRACTOR shall comply with all local sound control and noise level rules, regulations and ordinances which apply to any work performed pursuant to the contract.
- B. Each internal combustion engine, used for any purpose on the job or related to the job, shall be equipped with a muffler of a type recommended by the manufacturer, so as to produce a maximum noise level of 85 dBA at 5 feet.
- C. No internal combustion engine shall be operated on the project without said muffler.
- D. Special Precautions for Inhabited Areas:
  - 1. In inhabited areas, particularly residential, operations shall be performed in a manner to minimize unnecessary noise generation.
  - 2. In residential areas, special measures shall be taken to suppress noise generated by repair and service activities during the night hours.

#### 1.11 DUST/AIR POLLUTION CONTROL

- A. The CONTRACTOR shall comply with all Federal, State and local regulatory requirements with respect to air pollution prevention.
- B. The CONTRACTOR shall take whatever steps, procedures, or means as are required to prevent dust conditions being caused by operations in connection with the execution of

the Work; and on any road which the CONTRACTOR or any of their Subcontractors are using, excavation or fill areas, demolition operations, or other activities.

- C. Control shall be by sprinkling, use of dust palliatives, modification of operations, or any other means acceptable to agencies having jurisdiction.
- D. Damage to personal property, etc., resulting from the CONTRACTOR's construction operations shall be borne by the CONTRACTOR at no cost to the OWNER.
- E. The CONTRACTOR shall keep the streets and work area clean at all times by means of mechanical sweepers or hand sweeping. Water will be used for dust control only, and not for cleaning streets.
- F. Burning of waste, rubbish, or other debris will not be permitted on or adjacent to site.

#### 1.12 WASTE DISPOSAL

- A. The CONTRACTOR shall dispose of surplus materials, waste products, and debris and shall make necessary arrangements for such disposal. The CONTRACTOR shall obtain written permission from property owner prior to disposing surplus materials, waste products, or debris on private property.
- B. All waste disposal shall be done in accordance with applicable laws and regulations.
- C. Landfill Disposal:
  - 1. If the CONTRACTOR proposes to dispose of construction debris, trench spoils, excavation spoils, etc., at a landfill, the CONTRACTOR shall be responsible to provide and pay for all permits and analyses required by the landfill.
  - 2. If the analyses determine that the material is hazardous, then an equitable adjustment of the Contract for the cost of hazardous waste disposal will be made in accordance with the General Conditions, and the following:
    - a. Time extension or contract costs will not be granted for delays that could have been avoided by the CONTRACTOR redirecting their forces and equipment to perform other work on the contract.
- D. Ditches, washes, or drainageways shall not be filled.
- E. Disposal operations shall not create unsightly or unsanitary nuisances.
- F. The CONTRACTOR shall maintain the disposal site in a condition of good appearance and safety during the construction period.
- G. Prior to final acceptance of the work, the CONTRACTOR shall have completed the leveling and cleanup of the disposal site.

#### 1.13 CLEAN UP

- A. Throughout the period of construction, the CONTRACTOR shall keep the work site free and clean of all rubbish and debris, and shall promptly remove from the site, or from property adjacent to the site of the work, all unused and rejected materials, surplus earth, concrete, plaster, and debris.

- B. Upon completion of the work, and prior to final acceptance, the CONTRACTOR shall remove from the vicinity of the work all plant, surplus material, and equipment belonging to the CONTRACTOR or used under their direction during construction.

#### 1.14 TEMPORARY ENCLOSURES

- A. When sandblasting, spray painting, spraying of insulation, or other activities inconveniencing or dangerous to property or the health of employees, the public or construction workers, are in progress, the area of activity shall be enclosed adequately to contain the dust, over spray, or other hazard.
- B. In the event there are no permanent enclosures of the area, or such enclosures are incomplete or inadequate, the CONTRACTOR shall provide suitable temporary enclosures as required by the ENGINEER to meet field conditions in accordance with the recommendations of the owner-furnished equipment supplier (if applicable) and the CONTRACTOR's equipment supplier requirements.
- C. Said temporary or permanent enclosures shall be adequately ventilated to ensure the safety of the workers.

#### 1.15 DRAINAGE

- A. The CONTRACTOR shall take all necessary actions as required to meet discharge requirements of the State of California and other pertinent local ordinances and regulations pertaining to dewatering and/or site drainage discharged into storm drains and creeks. This may include, but may not be limited to, the use of retention basins and silt basins to settle most of the solids prior to discharge.
- B. In excavation, fill, and grading operations, care shall be taken to disturb the pre-existing drainage pattern as little as possible.
- C. Particular care shall be taken not to direct drainage water onto private property or into streets or drainageways inadequate for the increased flow.
- D. Drainage means shall be provided to protect the work.

#### 1.16 TEMPORARY LIGHTING

- A. The CONTRACTOR shall provide temporary lighting in all work areas sufficient to maintain a lighting level during working hours not less than the lighting level required by OSHA standards.

#### 1.17 CONSTRUCTION FACILITIES

- A. Construction hoists, elevators, scaffolds, stages, shoring, and similar temporary facilities shall be of ample size and capacity to adequately support and move the loads to which they will be subjected. Railings, enclosures, safety devices, and controls required by law or for adequate protection of life and property shall be provided.
- B. Temporary supports shall be designed with an adequate safety factor to assure adequate load bearing capability. Whenever required by safety regulations, the CONTRACTOR shall submit design calculations for staging and shoring prior to application of loads.

## 1.18 REMOVAL OF TEMPORARY FACILITIES AND UTILITIES

- A. At such time or times as any temporary construction facilities and utilities are no longer required for the work, the CONTRACTOR shall notify the ENGINEER of their intent and schedule for removal of the temporary facilities and utilities, and obtain the ENGINEER's approval before removing the same.
  - 1. Unless otherwise approved by OWNER, CONTRACTOR'S office and ENGINEER'S field offices shall remain on the project site a minimum of 7 days after OWNER's final acceptance of the work.
- B. As approved, the CONTRACTOR shall remove the temporary facilities and utilities from the site as CONTRACTOR's property and leave the site in such condition as specified, as directed by the ENGINEER, and/or as shown on the Drawings.
- C. In unfinished areas, such as planted medians, the condition of the site shall be left in a condition that will restore original drainage, evenly graded, seeded or planted as necessary, and left with an appearance equal to, or better than original.

## **PART 2 - PRODUCTS (NOT USED)**

### 2.1 ENGINEER'S FIELD OFFICES

- A. Furnish and maintain equipment specified for exclusive use of OWNER and its representatives.
- B. Ownership of equipment furnished under this article will remain, unless otherwise specified, that of CONTRACTOR.
- C. Equipment furnished shall be new or like new in appearance and function.
- D. Minimum Features:
  - 1. Integrated sanitary facilities including toilet and wash basin with hot and cold running water.
  - 2. 110-volt lighting and wall plugs.
  - 3. Fluorescent ceiling lights.
  - 4. Electric heating and self-contained air conditioning unit properly sized for Project locale and conditions. Provide ample electric power to operate installed systems.
  - 5. Railed stairways and landings at entrances.
  - 6. Sign on entrance door reading "Water Works Engineers", letter height 4 inches minimum.
  - 7. Exterior Door(s):
    - a. Number: Two.
    - b. Type: Solid core.
    - c. Lock(s): Cylindrical; keyed alike.
  - 8. Number of Windows: Four.
  - 9. Minimum Interior Height: 8 feet
- E. Floor Space: Minimum 425 square feet.
- F. Rooms:
  - 1. Two, with minimum private office floor space of 80 square feet.
  - 2. One restroom.

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- 3. Remainder of space configured for open meeting or storage space.
- G. Security guard screens on all windows.
- H. Provide and Maintain the Following in The Quantity Shown:

Office Equipment-General:

- 1. Bottled Water Service: One.
- 2. Paper Cup Dispenser with Cups: One .
- 3. Paper Towel Dispenser with Towels: One.
- 4. Desk: Two , steel, 30 inches by 60 inches.
- 5. Swivel desk Chair: Two .
- 6. Folding Table: Two, 36 inches by 72 inches.
- 7. Steel Folding Chairs: Eight.
- 8. Four Drawer Steel File with Lock and Key: Two , legal width.
- 9. Drawing Rack with Drawing Hangers: Two.
- 10. Bookcase: Two , 36 inches wide by 48 inches high.
- 11. Wastepaper Basket: Two .
- 12. Clothes Rack: One.
- 13. First-Aid Kit: One.
- 14. Carbon Dioxide (10-Pound) Fire Extinguisher: One.

## 2.2 PROJECT SIGN

- A. Provide and maintain two, 8-foot wide by 4-foot high signs constructed of ¾-inch exterior high density overlaid plywood. Sign shall bear name of Project, OWNER, CONTRACTOR, ENGINEER, and other participating agencies. Lettering shall be blue applied on a white background by an experienced sign painter. Paint shall be exterior type enamel. Information to be included will be provided by OWNER. Signs to be located as directed by OWNER. Once sign information is provided by OWNER, CONTRACTOR shall submit proposed sign layout, color, materials, etc. for ENGINEER'S approval prior to mobilization. Signs shall be installed on the project site as directed by OWNER within 7 days of CONTRACTOR starting mobilization.

## **PART 3 - EXECUTION (NOT USED)**

### 3.1 ENGINEER'S FIELD OFFICE

- A. Make available for ENGINEER'S use prior to the start of any work at Site. ENGINEER'S field office shall remain on the site for a minimum of 7 days after final acceptance of the work.
- B. Locate on common site with CONTRACTOR'S construction offices; level, block, tie down, skirt, provide stairways, and relocate when necessary and approved. Construct on proper foundations, provide proper surface drainage and connections for utility services.
- C. Provide minimum 100 square feet of aggregate base, minimum depth of 4 inches, at each entrance.
- D. Raise grade under field office, as necessary, to an elevation adequate to avoid flooding.
- E. Provide sanitary facilities in compliance with state and local health authorities.

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- F. Provide all necessary hookups, piping, storage tanks, etc. as required to provide fully functioning restroom facilities in ENGINEER's field office.
- G. Exterior Door Keys: Furnish two sets of keys.
- H. CONTRACTOR shall maintain in good repair and appearance including weekly cleaning service and replenishment of field office supplies.

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## **SECTION 01505**

### **MOBILIZATION**

#### **PART 1 - GENERAL**

##### **1.1 GENERAL**

- A. Mobilization shall include the obtaining of all bonds, insurance, and licenses; moving onto the site of all plant and equipment; furnishing and erecting plants, temporary buildings, and other construction facilities; all as required for the proper performance and completion of the work.
- B. Mobilization shall include but not be limited to the following principal items:
  - 1. Moving on to the site of all CONTRACTOR's plant and equipment.
  - 2. Installing temporary construction power, wiring, and lighting facilities.
  - 3. Establishing fire protection system.
  - 4. Developing construction water supply.
  - 5. Furnishing the work access plan as specified in Section 01500, Temporary Construction Facilities and Utilities.
  - 6. Providing all on-site CONTRACTOR communication facilities, including telephones, and radio pagers and any radio communications facilities required for the CONTRACTOR to coordinate their forces.
  - 7. Providing on-site sanitary facilities and potable water facilities as specified in Section 01500, Temporary Construction Facilities and Utilities.
  - 8. Arranging for and erection of the CONTRACTOR's work and storage yard, including site security.
  - 9. Posting all EPA and OSHA required notices and establishment of safety programs.
  - 10. Post all required labor and EEOE notices.
  - 11. Have the CONTRACTOR's superintendent at the job site full time.
  - 12. Submittal and OWNER acceptance of the Construction Schedule.
  - 13. Establishing site security, lighting, fencing, and signing.
  - 14. Obtaining all bonds, insurance and licenses.
  - 15. Providing an organization chart of the project and for the CONTRACTOR's firm. The project chart shall include the name, title and responsibilities of each position which is involved in the work.
  - 16. Other mobilization items approved by the ENGINEER required to support the complete work (e.g., Health and Safety Plans for Hazardous Waste).

#### **PART 2 - PRODUCTS (NOT USED)**

#### **PART 3 - EXECUTION (NOT USED)**

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## SECTION 01610

### GENERAL PRODUCT REQUIREMENTS

#### PART 1 - GENERAL

##### 1.1 SCOPE

- A. All products furnished and installed under this contract shall conform to the general stipulations set forth in this Section except as otherwise specified in other Sections.

##### 1.2 COORDINATION

- A. The CONTRACTOR shall coordinate all details of the products and equipment with other related parts of the work, including verification that all structures, piping, wiring, and equipment components are compatible. The CONTRACTOR shall be responsible for all structural and other alterations in the work required to accommodate products or equipment differing in dimensions or other characteristics from that contemplated in the Contract Drawings or Specifications.

##### 1.3 DESIGN REQUIREMENTS

- A. Where CONTRACTOR design is specified, design and installation of systems, equipment, and components, including supports and anchorage, shall be in accordance with provisions of 2016 edition of the California Building Code (CBC).
  - 1. Basic Wind Speed: 115 mph, Exposure C.
  - 2. Seismic:
    - a.  $S_s$  (maximum short-term spectral response acceleration) = 0.538
    - b.  $S_1$  (maximum 1-second spectral response acceleration) = 0.260
    - c.  $S_{DS}$  (design short-term spectral response acceleration) = 0.491
    - d.  $S_{D1}$  (design 1-second spectral response acceleration) = 0.326
    - e.  $I_e$  (Seismic Importance Factor) = 1.5
    - f. Risk Category = IV
    - g. Seismic Use Group = III
  - 3. Maximum Rain Intensity: 3-inches/hour
- B. Proof of Compliance:
  - 1. Structural integrity and anchorage shall be certified by an approved calculation that demonstrates the adequacy of the anchorage system for seismic forces. This calculation may be based on principles of structural analysis and engineering mechanics, or based on similarity to approved shake-table tests.
  - 2. The CONTRACTOR shall submit for review and approval test data or calculations certified by a Civil or Structural Engineer registered in the State of California to show compliance with the above requirements.

##### 1.4 ENVIRONMENTAL REQUIREMENTS

- A. Altitude: Provide materials and equipment suitable for installation and operation under rated conditions at 100 feet above sea level.

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- B. Provide equipment and devices installed outdoors or in unheated enclosures capable of continuous operation within an ambient temperature range of 15 degrees F to 120 degrees F.

#### 1.5 WORKMANSHIP AND MATERIALS

- A. The CONTRACTOR shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.
- B. All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and gages so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.
- C. Except where otherwise specified, structural and miscellaneous fabricated steel used in equipment shall conform to AISC standards. All structural members shall be designed for shock or vibratory loads. Unless otherwise specified, all steel which will be submerged, all or in part, during normal operation of the equipment shall be at least 1/4 inch thick.
- D. Except where otherwise specified, all metal which will be exposed to weather, submerged or otherwise exposed to moisture shall be either non-ferrous or stainless steel, as the application may require.

#### 1.6 LUBRICATION

- A. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.
- B. Lubricants of the type recommended by the equipment manufacturer shall be provided in sufficient quantity to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment by OWNER. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.
- C. Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

#### 1.7 ELECTRIC MOTORS

- A. Unless otherwise specified, motors furnished with equipment shall meet the following requirements:
  - 1. Designed and applied in accordance with NEMA, ANSI, IEEE, AFBMA, and NEC for the duty service imposed by the driven equipment, such as frequent starting, intermittent overload, high inertia, mounting configuration, or service environment.
  - 2. Premium efficiency rated.
  - 3. Rated for continuous duty at 40-degrees Celsius ambient, unless the application is well recognized for intermittent duty service as a standard industry practice.
  - 4. Insulated with Class F insulation and designed for a service factor of 1.15, or greater.

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5. Three phase motors used in conjunction with variable speed drives shall have Class F insulation with a Class B temperature rise at rated nameplate horsepower, and 1.15 service factor.
6. When operating at service factor load, maximum observable temperature rise of insulation and motor parts, as determined by resistance or thermometer methods, shall not exceed the NEMA allowable limits for the type of motor, the type of enclosure, and the particular application with regard to continuous or intermittent duty.
7. To ensure long motor life, nameplate horsepower, regardless of service factor, shall be at least 115 percent of the maximum load imposed by the driven equipment.
8. Designed for full voltage starting.
9. Designed to operate from an electrical system that may have a maximum of 5 percent voltage distortion per IEEE Standard 519.
10. Derated, if required, for the altitude at which the equipment is installed.
11. Clamp-type grounding terminal shall be inside motor conduit box.
12. External conduit boxes shall be oversized at least one size larger than NEMA standard.
13. Totally enclosed motors shall have a continuous moisture drain which also excludes insects.
14. Bearings shall be either oil or grease lubricated.
15. Manufacturer's standard motor may be supplied on integrally constructed, packaged assemblies such as appliances, tools, unit heaters, and similar equipment specified by model number, in which case a redesign of the unit would be required to furnish motors of other than the manufacturer's standard design. However, in all cases, totally enclosed motors are preferred and shall be furnished if offered by the manufacturer as a standard option.
16. Totally enclosed motors shall be furnished on:
  - a. Equipment for installation below grade.
  - b. Equipment operating in wet or dust-laden locations.
17. Drip-proof motors, or totally enclosed motors at the supplier's option, shall be furnished on equipment in indoor, above-grade, clean, and dry locations.
18. Explosion-proof or submersible motors shall be furnished as required by applicable codes, as specified in other Sections, or at the supplier's option.
19. Motors shall be rated and constructed as follows:
  - a. Below 1/2 hp:
    - 1) 115 volts, 60 Hz, single phase.
    - 2) Built-in manual-reset thermal protector, or integrally mounted stainless steel enclosed manual motor starter.
  - b. 1/2 hp and above:
    - 1) 460 volts, 60 Hz, 3 phase.
    - 2) Where specified or required by the drawings, motors used on 240 volt systems shall be 230 volts, 60 Hz, 3 phase.

## 1.8 DRIVE UNITS

- A. The nominal input horsepower rating of each gear or speed reducer shall be at least equal to the nameplate horsepower of the drive motor. Drive units shall be designed for 24 hours continuous service.
- B. Unless otherwise specified, the use of gearmotors will not be acceptable.
- C. Gear reducers:

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1. Each gear reducer shall be a totally enclosed unit with oil or grease lubricated antifriction, rolling element bearings throughout.
  2. Helical, spiral bevel, combination bevel-helical, and worm gear reducers shall have a service factor of at least 1.50 based on the nameplate horsepower of the drive motor. Shaft-mounted and flange-mounted gear reducers shall be rated AGMA Class II. Helical gear reducers shall have a gear strength rating to catalog rating of 1.5. Each gear reducer shall bear an AGMA nameplate.
  3. The thermal horsepower rating of each unit shall equal or exceed the nameplate horsepower of the drive motor. During continuous operation, the maximum sump oil temperature shall not rise more than 100°F above the ambient air temperature in the vicinity of the unit and shall not exceed 200°F.
  4. Bearings:
    - a. Each grease lubricated bearing shall be installed in a bearing housing designed to facilitate periodic regreasing of the bearing by means of a manually operated grease gun.
    - b. Each bearing housing shall be designed to evenly distribute new grease, to properly dispose of old grease, and to prevent overgreasing of the bearing.
    - c. The use of permanently sealed, grease lubricated bearings will not be acceptable.
    - d. An internal or external oil pump and appurtenances shall be provided if required to properly lubricate oil lubricated bearings.
    - e. A dipstick or sight glass arranged to permit visual inspection of lubricant level shall be provided on each unit.
  5. Gear reducers that require the removal of parts or periodic disassembly of the unit for cleaning and manual regreasing of bearings will not be acceptable.
  6. Certification shall be furnished by the gear reducer manufacturer indicating that the intended application of each unit has been reviewed in detail by the manufacturer and that the unit provided is fully compatible with the conditions of installation and service.
- D. V-belt drives:
1. Each V-belt drive shall include a sliding base or other suitable tension adjustment. V-belt drives shall have a service factor of at least 1.6 at maximum speed based on the nameplate horsepower of the drive motor.

#### 1.9 SAFETY GUARDS

- A. All belt or chain drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard.
- B. Safety guards shall be fabricated from 16 USS gauge or heavier galvanized or aluminum-clad sheet steel or 1/2 inch mesh galvanized expanded metal.
- C. Each guard shall be designed for easy installation and removal.
- D. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized.
- E. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

#### 1.10 ANCHOR BOLTS

- A. Equipment suppliers shall furnish suitable anchor bolts for each item of equipment.

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- B. Anchor bolts, together with templates or setting drawings, shall be delivered sufficiently early to permit setting the anchor bolts when the structural concrete is placed.
- C. Anchor bolts shall comply with Section 05051, Anchors, Inserts and Epoxy Dowels and, unless otherwise specified, shall have a minimum diameter of 1/2-inch.
- D. Unless otherwise indicated or specified, anchor bolts for items of equipment mounted on baseplates shall be long enough to permit 1-1/2 inches of grout beneath the baseplate and to provide adequate anchorage into structural concrete.

#### 1.11 EQUIPMENT BASES

- A. Unless otherwise indicated or specified, all equipment shall be installed on concrete bases at least 6 inches high.
- B. Cast iron or welded steel baseplates shall be provided for pumps, compressors, and other equipment.
- C. Each unit and its drive assembly shall be supported on a single baseplate of neat design.
- D. Baseplates shall have pads for anchoring all components and adequate grout holes.
- E. Baseplates for pumps shall have a means for collecting leakage and a threaded drain connection.
- F. Baseplates shall be anchored to the concrete base with suitable anchor bolts and the space beneath filled with grout as specified in Section 03600, Grout.

#### 1.12 SPECIAL TOOLS AND ACCESSORIES

- A. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

#### 1.13 SHOP PAINTING

- A. Surface Protection:
  - 1. All steel and iron surfaces shall be protected by suitable paint or coatings applied in the shop.
  - 2. Surfaces that will be inaccessible after assembly shall be protected for the life of the equipment.
  - 3. Exposed surfaces shall be finished smooth, thoroughly cleaned, and filled as necessary to provide a smooth uniform base for painting.
  - 4. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with a high-grade oil-resistant enamel suitable for coating in the field with an alkyd enamel.
  - 5. Coatings shall be suitable for the environment where the equipment is installed.
- B. Shop Primer:
  - 1. Surfaces to be painted after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer.

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2. Unless otherwise specified, the shop primer for steel and iron surfaces shall be:
  - a. Cook "391-N-167 Barrier Coat",
  - b. Koppers "No. 10 Inhibitive Primer",
  - c. Tnemec "37H Chem-Prime HS",
  - d. Valspar "13-R-28 Chromox Primer",
  - e. Or equal.
- C. Machined, polished, and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound, Houghton "Rust Veto 344", Rust-Oleum "R-9", or equal.

#### 1.14 PREPARATION FOR SHIPMENT

- A. All equipment shall be suitably packaged to facilitate handling and protect against damage during transit and storage. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements and shall be kept thoroughly dry at all times.
- B. Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. All painted surfaces which are damaged prior to acceptance of equipment shall be repainted to the satisfaction of ENGINEER.
- C. Grease and lubricating oil shall be applied to all bearings and similar items.
- D. Each item of equipment shall be tagged or marked as identified in the delivery schedule or on the Shop Drawings. Complete packing lists and bills of material shall be included with each shipment.

#### 1.15 STORAGE

- A. Upon delivery, all equipment and material shall immediately be stored and protected until installed in the work.
- B. Pumps, motors, electrical equipment, and all equipment with antifriction or sleeve bearings shall be stored in weathertight structures maintained at a temperature above 60°F. Equipment, controls, and insulation shall be protected against moisture and water damage. All space heaters furnished in equipment shall be connected and operated continuously.
- C. Equipment and materials shall not show any pitting, rust, decay, or other deleterious effects of storage when installed in the work.

#### 1.16 INSTALLATION AND OPERATION

- A. Equipment shall not be installed or operated except by, or with the guidance of, qualified personnel having the knowledge and experience necessary for proper results. When so specified, or when employees of the CONTRACTOR or their subcontractors are not qualified, such personnel shall be field representatives of the manufacturer of the equipment or materials being installed.
- B. Qualified field representatives shall be provided by the equipment manufacturers as required by Section 01750, Testing, Training and Startup.

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- C. All equipment installed under this Contract, including that furnished by OWNER shall be placed into successful operation according to the written instructions of the manufacturer or the instructions of the manufacturer's field representative. All required adjustments, tests, operation checks, and other startup activity shall be provided.
- D. Acceptance of work in connection with the installation of equipment furnished by others will be subject to approval of the field representative. The CONTRACTOR shall be responsible for planning, supervising, and executing the installation of work, and the approval or acceptance of ENGINEER or the field representative will not relieve the CONTRACTOR of responsibility for defective work.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION (NOT USED)**

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## SECTION 01700

### INITIAL SUPPLY OF TREATMENT CHEMICALS

#### **PART 1 - GENERAL**

##### 1.1 DESCRIPTION

- A. Scope: Provide treatment chemicals as indicated herein.

##### 1.2 QUALITY ASSURANCE

- A. Chemicals shall meet standards specified in this Section.

##### 1.3 SUBMITTALS

- A. Product Data:
1. Material Safety Data Sheet (MSDS).
  2. Manufacturer's delivery and unloading information including available volumes for delivery and packaging information.
  3. Chemical supplier's certification that the chemical meets applicable standards.

##### 1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Chemicals shall be delivered, stored, and handled in accordance with the Manufacturer's supplied MSDS and applicable sections of the 2003 International Fire Code.
- B. Chemicals shall be delivered to the site by manufacturer's representative with proper identification and manufacturer's name clearly visible.
- C. Chemicals shall be stored indoors, protected from damage, extreme temperature variation, and contamination.

#### **PART 2 - PRODUCTS**

##### 2.1 TREATMENT CHEMICALS

- A. Provide the following:

<b>Chemical Name and Formula</b>	<b>Form</b>	<b>Strength</b>	<b>Chemical Volume</b>	<b>Location</b>	<b>Standard</b>
Sodium Hypochlorite	Liquid	12.5%	500 gal	Booster Pump Station	AWWA B300

#### **PART 3 - EXECUTION (NOT USED)**

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## SECTION 01750

### TESTING, TRAINING AND STARTUP

#### **PART 1 - GENERAL**

##### **1.1 GENERAL**

- A. Scope:
  - 1. This Section covers general equipment and system testing and startup requirements, services of the manufacturer's representatives and special coordinating services required of the CONTRACTOR that shall apply during construction and training of the OWNER's personnel for facilities operation.
  - 2. Specific testing and tracking procedures and requirements found in the Technical Specifications shall also apply.
- B. The CONTRACTOR shall inform all Subcontractors and manufacturers of the requirements herein and include the required services in their costs for the work specified in these Contract Documents. Where a minimum amount of time is stated in the Technical Specifications for manufacturers' services, any additional time required to perform the specified services shall be provided at no additional cost to the OWNER.
- C. Scheduling:
  - 1. Equipment testing and plant startup are requisite to satisfactory completion of the Contract and, therefore, shall be completed within the contract time.
  - 2. All equipment testing and plant startup activities shall be realistically allowed for and shown on the CONTRACTOR's Construction Schedule, in accordance with Section 01320, Progress Schedule.
  - 3. All equipment testing and plant startup activities shall be scheduled in conformance with the restrictions specified in Section 01130, Special Project Constraints.
- D. Equipment testing shall be satisfactorily completed prior to commencing plant startup associated with the particular equipment item or equipment package. The equipment shall not be considered ready for testing until the following conditions are satisfied:
  - 1. Manufacturer's certification of equipment installation has been accepted by the ENGINEER.
  - 2. Electrical and/or instrumentation Subcontractor certification of motor control logic has been accepted by the ENGINEER.
  - 3. Related Technical Submittals, O&M Manual and Final Shop Drawings have been accepted by the ENGINEER.
  - 4. Operator training services have been furnished by the CONTRACTOR (operational testing only).
  - 5. Testing procedures have been submitted in writing and accepted by the ENGINEER in accordance with Section 01330, Submittal Procedures. All testing procedures and results shall be submitted in writing.
- E. The requirements of plant startup specified herein shall also apply to the startup of individual treatment plant processes and facilities.
- F. Startup Plan:

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1. Not less than 3 months prior to initial equipment or system startup, the CONTRACTOR shall submit to the ENGINEER for review, a detailed Facilities Startup Plan for the associated items of equipment and/or systems.
2. The Startup Plan shall include:
  - a. A detailed sub-network of the CONTRACTOR's Construction Progress Schedule including the following activities:
    - 1) Manufacturer's Services;
    - 2) Installation Certifications;
    - 3) Operator Training;
    - 4) O&M Manual;
    - 5) Functional Testing;
    - 6) Performance Testing;
    - 7) Operational Testing;
    - 8) All other activities necessary to affect a coordinated and successful Testing, Training and Startup.
  - b. Written testing plan with proposed data logs for each item of equipment to be tested.
  - c. A discussion of any coordination required with the Owners staff and/or any system or equipment outage requirements.
  - d. The Plan shall be updated and/or revised as necessary prior to subsequent Construction Progress Meetings.
  - e. Testing shall not be scheduled earlier than 30 days after approval of the Plan.

## 1.2 SERVICES DURING CONSTRUCTION

### A. General:

#### 1. Manufacturer's Representative:

- a. The CONTRACTOR shall provide the services of competent and experienced technical representatives of the manufacturers of all equipment and systems furnished under the contract, for as many days as may be necessary for assembly, installation, testing assistance and operator training.
- b. Manufacturer's field representatives shall observe, instruct, guide, and direct CONTRACTOR's erection or installation procedures, or perform an installation check, as required.
- c. In each case, the CONTRACTOR shall arrange to have the manufacturer's representative revisit the job site as often as necessary until operator training is complete and testing and startup problems have been resolved to the satisfaction of the ENGINEER.
- d. This requirement applies to manufacturers of all equipment furnished (excluding manually operated valves smaller than 24 inches in size, and any other items of equipment specifically exempted by the ENGINEER in writing), whether or not specifically set forth in the Technical Specifications.
- e. The CONTRACTOR shall maintain a service record on each item of equipment and shall deliver these service records to the ENGINEER prior to acceptance of operational testing.

### B. Fulfillment of Specified Minimum Services:

1. The CONTRACTOR shall obtain prior written approval from the ENGINEER for providing manufacturers' services.
2. All requests to the ENGINEER for prior approval shall (1) be in writing, (2) be submitted not less than 10 calendar days prior to the providing of the subject services, (3) state the service to be provided, and (4) state the reason(s) why the timing of the service is appropriate.

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3. Request made to the ENGINEER less than 10 calendar days prior to the manufacturers' services may not receive consideration and response prior to the times the services are provided.
  4. Visits of manufacturers and their representatives to the jobsite or training classroom without prior approval as provided herein may not act to fulfill the specified minimum man-day requirements.
- C. Certificate of Proper Installation:
1. Equipment requiring factory tests shall not be delivered to the jobsite until the CONTRACTOR submits acceptable certified test results to the ENGINEER.
  2. Equipment shall not be considered ready for functional testing until after the following certifications have been submitted and accepted by the ENGINEER.
    - a. Manufacturer Representatives:
      - 1) The CONTRACTOR shall require that each manufacturer's representative furnish to the ENGINEER a written and signed report addressed to the OWNER certifying that the equipment has been properly installed, adjusted, lubricated, is in accurate alignment, is free from any undue stress imposed by connecting piping or anchor bolts, has been operated satisfactorily under full-load conditions and is ready for full-time operation.
      - 2) For pumps, compressors, blowers, engines, motors, and other rotating or reciprocating equipment, the report shall certify that the equipment operates within the manufacturer's allowable limits for vibration.
      - 3) The report shall also certify that all controls, protective devices, instrumentation, and control panels furnished as part of the manufacturer's equipment package are properly installed and calibrated; and that the control logic for equipment startup, shutdown, sequencing, interlocks, and emergency shutdown has been tested and is properly operating.
      - 4) The CONTRACTOR shall also sign said certification.
      - 5) The CONTRACTOR shall submit "Manufacturer's Certification of Proper Installation" on the OWNER form.
    - b. Electrical and Instrumentation Subcontractor:
      - 1) The CONTRACTOR shall require that the electrical and/or instrumentation Subcontractor shall furnish a written and signed report to the ENGINEER certifying that the motor control logic for the equipment item that resides in motor control centers, control panels, control boards, microprocessors, distributed processing units, computers, and the like furnished by the electrical and/or instrumentation Subcontractor has been properly tested and calibrated.
      - 2) The report shall certify that the control logic for equipment startup, shutdown, sequencing, interlocks, and emergency shutdown has been tested and is properly operating.
      - 3) The CONTRACTOR shall also sign said certification.

### 1.3 STARTUP AND TESTING

- A. General:
1. The CONTRACTOR shall provide the effective coordination of all parties necessary for the successful project startup.
  2. The ENGINEER shall not be responsible to instruct the CONTRACTOR in the startup of the project, however, the ENGINEER will be available prior to and during startup to provide operational and technical support to the CONTRACTOR.

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3. The CONTRACTOR shall furnish all labor, consumables (power, water, chemicals, air, etc.) tools, equipment, instruments, and services required and incidental to completing all functional, performance and operational testing of installed equipment.
  4. The CONTRACTOR shall submit for favorable review the proposed test procedures to the ENGINEER for review at least 30 days prior to testing.
  5. After favorable review of the test procedures, the CONTRACTOR shall give the ENGINEER written notice confirming the date of testing at least five working days before the time the equipment is scheduled to be tested.
  6. All testing shall be witnessed by the ENGINEER to be considered valid.
  7. Test Reports:
    - a. CONTRACTOR shall submit written detailed results of all functional, performance and operational testing.
    - b. Upon successful completion of Operational testing all equipment installation, testing and maintenance records shall be submitted to the ENGINEER.
    - c. Said records shall be bound separately for each piece of equipment or system and shall be collected by type of record.
  8. For factory tests, written test results shall be submitted to the ENGINEER at least 10 days prior to shipment.
- B. Functional testing:
1. All items of mechanical and electrical equipment shall be functionally tested by the CONTRACTOR after installation for proper operation.
  2. A minimum of ten (10) days prior to the start of functional testing, the CONTRACTOR shall submit interconnection diagrams for the equipment and for the alarms, controls and instruments associated with the equipment. This requirement shall not relieve the CONTRACTOR of meeting any requirements in the technical specifications for earlier submittal of the interconnection diagrams.
  3. Minimum Test Requirements
    - a. The functional test of each piece of mechanical equipment shall continue for not less than eight (8) continuous hours without interruption.
    - b. The functional test shall include checking for proper rotation, alignment, speed, flows, pressure, vibration, sound level, etc. Initial equipment and system adjustment and calibrations shall be performed in the presence of and with the assistance of the manufacturer's representative.
    - c. The functional test shall include a demonstration of the proper performance of all alarms, local and remote controls, instrumentation, equipment functions, and all other electrical, mechanical and piping systems.
    - d. All parts shall operate satisfactorily in all respects, under continuous full load, and in accordance with the specified requirements, for the full duration of the eight-hour test period.
    - e. If any part of a unit shows evidence of unsatisfactory or improper operation during the eight-hour test period, correction or repairs shall be made and the full eight-hour test operation, as specified herein, shall be repeated after all parts operate satisfactorily.
- C. Performance testing:
1. Where performance testing is required by the Technical Specifications, the testing shall be supervised by the manufacturer's representative. These services shall continue until such times as the applicable equipment or system has been successfully tested for performance and has been accepted by the ENGINEER for operational testing.
  2. Performance testing shall take place after functional testing is successfully completed in accordance with Article 1.3 B.

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3. Performance testing shall demonstrate that the equipment meets all performance requirements specified.
- D. Startup/operational testing:
1. Upon successful completion of operator training and the functional, performance and leakage testing, the CONTRACTOR shall startup the plant facilities and test the equipment operation and performance by conducting a seven (7) day, continuous operational test of the completed facilities as an operational process unit to demonstrate to the ENGINEER's satisfaction that all equipment and systems required by these specifications will operate in the manner in which they are intended to perform.
  2. The OWNER will provide CONTRACTOR-trained operating personnel for the duration of the operational test. Said operation shall be conducted and under the supervision and direction of the CONTRACTOR and/or manufacturer's representative.
  3. Operational Defects:
    - a. All defects in materials or workmanship which appear during the operational test shall be immediately corrected by the CONTRACTOR.
    - b. In the event of a malfunction or deficiency that results in shutdown or partial operation of a system or process unit or results in performance that is less than that specified, the startup duration shall be repeated for that corresponding system or process unit and any other affected equipment so its proper operation and performance as required by the Contract Documents is demonstrated for a minimum of seven (7) continuous and trouble free days.
  4. If the operational test is interrupted through no fault of the CONTRACTOR, the test may resume at the earliest mutually agreeable time.
  5. No unit process or part thereof shall be placed in service until it has successfully completed operational testing.
  6. During plant startup, the CONTRACTOR shall provide the appropriate construction trades and the services of authorized Manufacturer's representatives for operational testing and as necessary, to correct faulty equipment operation.
  7. After completion of all startup/operational testing, the CONTRACTOR shall repaint, hose, scrub, clean up and otherwise return the work to a "like new" condition, prior to OWNER acceptance.

#### 1.4 TRAINING OF OWNER PERSONNEL

- A. General:
1. Operation and maintenance training of OWNER's personnel shall be provided for mechanical, electrical, instrumentation and control equipment as listed in this Section or elsewhere in the Specifications.
  2. For the purposes of this requirement, operations training is considered to be separate from maintenance training. Instructions are to be tailored to the needs of each group.
  3. These training services shall be conducted by the manufacturer's representative and shall ensure measurable and observable means that OWNER personnel are qualified to perform equipment task requirements, including essential knowledge, skills and abilities.
  4. Training shall be conducted by competent representatives who are certified by the manufacturer to be thoroughly familiar with the subject matter as well as instructional methods.
  5. Training materials shall be submitted to the OWNER (see Paragraph 1.4 C below) for review. Acceptance of training materials is required prior to start of training.
  6. All training shall be completed prior to beginning operational testing.

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7. The OWNER shall have the right to videotape any or all training sessions, or may designate separate sessions or portions thereof for the sole purpose of videotaping.
- B. Training coordinator:
1. The CONTRACTOR shall designate and provide one or more persons to be responsible for coordinating and expediting training duties.
  2. The person or persons so designated shall be present at all training coordination meetings with the OWNER.
- C. Training schedule:
1. The CONTRACTOR's coordinator shall coordinate the training periods with OWNER's personnel and manufacturer's representatives, and shall submit a training schedule and the training materials for each piece of equipment or system for which training is to be provided.
  2. The training schedule shall be submitted not less than 21 calendar days prior to the time that the associated training is to be provided and shall be based on the then current Plan of Operation.
  3. Equipment and/or systems shall be deemed suitable for use in training upon satisfactory completion of functional testing.
  4. All training with regards to a unit process or part thereof shall be completed prior to the start of operational testing.
  5. As a minimum, training shall be provided on the following equipment and systems:
    - a. Booster Pumps
    - b. Electronic Control Valve (Altitude Valve)
    - c. Chemical Feed System
    - d. HVAC Systems
    - e. Electrical Systems
    - f. Instrumentation and Controls
    - g. Automatic Gate Operator
    - h. Irrigation System
    - i. Other systems not identified but where training would be beneficial to OWNER's staff.
  6. The CONTRACTOR shall provide distinct and separate training sessions for both operations and maintenance personnel, meeting the following criteria:
    - a. Maintenance Training:
      - 1) Maintenance training shall be provided for all items in 1.4.C.5 above.
      - 2) Maintenance training shall be scheduled on at least one day shift, Monday through Thursday.
      - 3) Training shall emphasize theory of operations, troubleshooting, and preventative maintenance and repair procedures.
      - 4) The discussion shall encompass issues relating to instrumentation, electrical, and mechanical systems.
    - b. Operations training:
      - 1) Operations training shall be provided for each piece of equipment listed in Paragraph 1.4.C.5 above.
      - 2) Operations and/or Maintenance training shall be scheduled on three consecutive day shifts, Tuesday through Thursday.
    - c. Training session schedules shall be approved by the ENGINEER.
    - d. Training shall emphasize theory of operations, startup instructions, emergency and normal shutdown instructions, lockout procedures, troubleshooting, preventative maintenance, and alarm and control logic.
  7. The CONTRACTOR shall confirm each training period a minimum of three working days prior to the schedule time.

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8. If a manufacturer's representative fails to conduct a scheduled training class, the CONTRACTOR hereby agrees to compensate the OWNER for labor costs, including overhead, for all OWNER personnel in attendance for the entire scheduled training period.
9. If the CONTRACTOR or the manufacturer's representative fails to provide training that qualifies the OWNER personnel to perform equipment task requirements, the CONTRACTOR hereby agrees to provide remedial training to ensure OWNER personnel proficiency at no additional cost to the OWNER.

## **PART 2 - PRODUCTS (NOT USED)**

## **PART 3 - EXECUTION**

### **3.1 RECORD KEEPING**

- A. The CONTRACTOR shall maintain as a minimum, the following records:
  1. Equipment manufacturer's shop drawings.
  2. Daily logs indicating all equipment testing and startup activities.
  3. Log and time sheets of all manufacturer's representatives performing services on the jobsite.
  4. Updated equipment testing and startup schedules.
  5. Records of system cleaning.
  6. Hydrostatic and pressure test records.
  7. Equipment alignment and vibration measurements and corrective actions.
  8. Equipment lubrication records.
  9. Insulation resistance measurements.
  10. Electrical phase, voltage and amperage measurements.
  11. Electrical breaker inspection, test, and adjustment records.
  12. Logs of abnormal circuits and lifted wires.
  13. Testing and validation of all central and alarm functions.
  14. Data sheets of all testing and calibration of instrumentation devices and control loops including documentation of set points.
  15. Equipment and system release logs (from construction to startup).
  16. Daily work reports.

### **3.2 GENERAL PROCEDURES**

- A. The general work procedures listed below outline the work to be performed by the CONTRACTOR. Additional procedures applicable to specific equipment items are specified elsewhere.
- B. Technical assistance and support:
  1. Obtain the assistance of the appropriate construction trades and the manufacturer or vendor, as required for technical assistance during equipment installation, testing, and startup by the CONTRACTOR and for training of the OWNER's Operation and Maintenance personnel.
  2. Furnish names and telephone numbers of manufacturer's and vendor's current technical service representatives for use by the ENGINEER.
- C. Instructions:

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1. Maintain an adequate manufacturer's instruction file so that the information will be readily available during equipment testing and startup.
  2. Prior to equipment testing, finalize, and transmit to the ENGINEER the applicable technical manuals as required under Section 01330, Submittal Procedures of the Contract Specifications.
- D. Removal of rust preventives:
1. Prior to equipment testing, remove all rust preventives and oils used to protect the equipment during the construction period whenever these protective materials will be detrimental to operation or equipment maintenance.
- E. Lubricants:
1. At least 60 days prior to startup, provide a list of the manufacturer's recommended lubricants for use in the plant. All equipment lubrication shall be listed with the lubricant types and quantities recommended and approved by the equipment manufacturers.
  2. Provide the necessary lubricants for startup and the initial 60 days of operation.
  3. Flush systems and install the initial charge of all lubricants. Dispose of flushing oil in accordance with applicable regulations.
  4. The CONTRACTOR shall lubricate the equipment in accordance with the manufacturer's recommendations until the equipment is accepted by the OWNER.
  5. Maintain a lubrication record for each item of equipment. The CONTRACTOR shall submit the lubrication records to the ENGINEER prior to equipment testing.
- F. Packing and seals:
1. Install, adjust, and replace packing, mechanical seals, and accessories, as necessary, during the equipment testing and startup period.
  2. Adjust seal water and flushing water flow rates in accordance with the equipment manufacturer's recommendations.
- G. Removal of temporary bracing:
1. Prior to equipment testing, remove all temporary supports, bracing, or other foreign objects that were installed in vessels, transformers, rotating machinery, or other equipment to prevent damage during shipping, storage, and erection, and repair any damage sustained.
- H. Rotation, alignment, and vibration:
1. Prior to equipment testing, check rotating machinery for correct direction of rotation and for freedom of moving parts before connecting the driver.
  2. Prior to equipment testing, perform the cold alignment and hot alignment to the manufacturer's tolerances.
  3. Prior to equipment testing, test equipment vibration and correct any vibration in excess of the manufacturer's recommendation.
- I. Tie-ins at the contract limits:
1. Provide proper notification, preparation, and coordination for safe tie-ins and minimal interference with the plant operation.
  2. Obtain approval and make the necessary tie-ins at the unit limits as required by the Contract Documents and as approved by the ENGINEER.
  3. Prior to startup, remove the temporary blind flanges, plugs, bulkheads, seals, etc.
- J. Leak and pressure tests:

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1. Provide the ENGINEER with 3-day advance notification in writing of the schedule for non-operating field leak tests or field pressure tests on piping and field fabricated equipment, unless otherwise directed by the ENGINEER.
  2. Provide the water, air and any special media required for the test purposes.
  3. Prior to startup, conduct all leak and pressure tests in accordance with applicable codes, regulations, and the Contract Documents, and as approved by the ENGINEER. The CONTRACTOR is advised that the tests shall be witnessed by the ENGINEER, to be considered valid.
  4. Maintain a record of the leak and pressure test data and work completed.
  5. Dispose of the test media in a manner that is acceptable to and approved by the OWNER and applicable regulatory agencies.
  6. Isolate in-line equipment as necessary for protection against test pressure.
- K. Pressure/vacuum safety relief devices:
1. Prior to equipment testing, test and adjust all safety devices as recommended by the equipment manufacturer.
  2. Prior to plant startup, provide the ENGINEER with a list of all field or factory equipment settings.
- L. Flushing and chemical/mechanical cleaning:
1. Prior to equipment operation, conduct all flushing, blowing, and chemical/mechanical cleaning operations without using the permanently installed equipment.
  2. Provide any special media needed for flushing and/or cleaning purposes.
  3. Dispose of all media in a manner that is acceptable to and approved by the OWNER and the applicable regulatory agencies.
  4. All systems shall be free of trash and construction debris before initiating startup.
  5. Maintain a record of the work completed.
- M. Screens, strainers, and blind flanges:
1. Provide and install temporary strainers, screens, and blind flanges as necessary to protect the equipment and to test the equipment and pipelines.
  2. Prior to startup, remove all of the temporary blinds and temporary appurtenances.
  3. Clean the screens and strainers as required during startup.
  4. At the end of startup, clean all of the permanently installed screens and strainers.
- N. Purging/inerting:
1. Prior to startup, purge and/or passivate the facilities as specified.
  2. Install purge/inerting connections in accordance with the manufacturer's recommendations.
  3. Provide purge or inerting materials and conduct the necessary operations as recommended by the equipment manufacturer.
- O. Drying out:
1. Prior to startup, dry out the facilities as specified or recommended by the equipment manufacturer to prevent contamination of catalysts, operating materials, and/or product.
  2. Dry out systems, protective coatings, refractories, and linings as specified or recommended by the equipment manufacturers.

### 3.3 SPECIFIC PROCEDURES

- A. In addition to the work responsibilities described in Subsection 3.2, the procedures outlined below further define the work responsibilities of the CONTRACTOR for specific systems and items of equipment.
- B. Mechanical equipment:
1. Level baseplates and soleplates and grout under all load bearing surfaces.
  2. Install suitable supports and flexible connections to alleviate any piping stresses that may be imposed on pumps, compressors, and drivers.
  3. In accordance with the manufacturer's recommendations, chemically clean lube oil, seal oil, and cooling systems. Dispose of waste and cleaning media in a manner that is acceptable to and approved by the OWNER and applicable regulatory agencies.
  4. In accordance with the manufacturer's recommendations, charge the lube oil, seal oil, and cooling systems with flushing media and circulate for cleaning purposes. Dispose of any flushing media in a manner that is acceptable to and approved by the OWNER and applicable regulatory agencies.
  5. Charge the lube oil systems, seal oil systems, and cooling systems with the amount and type of operating oil or coolant recommended by the manufacturer.
  6. Operate the equipment and check for excessive vibration, abnormal operating noises, overheating and lubricant leakage, etc., and test any safety shutdown/alarm devices for proper operation, and make any operating tests required by the ENGINEER. The adjustments required for proper operation shall be made prior to operational testing.
  7. Utilize manufacturer's representative for technical assistance during installation and startup.
  8. Prior to startup, all sidewalks, gratings, handrails, safety chains, safety shields, etc., shall be installed.
  9. Prior to startup, demonstrate to the ENGINEER's satisfaction that all chemical solution pipelines are connected to the intended tank(s), feeder(s), pump(s), and application points, and that the pipes, appurtenances contained therein and diffusers will operate at the intended flow rates.
  10. Prior to startup, the applicable safety equipment, emergency shower and eyewash units, fire extinguishers, fire suppression equipment, self-contained breathing apparatus, toxic and/or combustible gas detectors (including the respective personnel warning system), protective clothing, emergency repair kits, etc., shall be installed in an acceptable manner-subject to the ENGINEER's approval, and be fully ready for operation.
  11. All safety hazards, e.g., exposed drive shafts or rotating equipment members, exposed electrical circuitry, open electrical junction boxes and panels, improperly supported piping and conduits, missing safety devices, etc., shall be corrected prior to supplier training of the OWNER's personnel.
  12. The CONTRACTOR shall perform a comprehensive safety inspection and correct any safety deficiencies found before implementing plant startup.
  13. Roadways that are required for ambulance service, fire fighting access, delivery of treatment chemicals and supplies, and disposal of the treatment byproducts shall be completed prior to startup.
  14. Prior to startup, install all warning and safety signs, labels, and devices.
- C. Tanks:
1. Test all tanks and internals, as required to demonstrate conformance to the Contract Documents. Dispose of test media in a manner that is acceptable to and approved by the OWNER and the applicable regulatory agencies.



2. Prior to startup, conduct chemical cleaning or flushing operations as specified. Dispose of wastes and cleaning media in a manner that is acceptable to and approved by the OWNER and the applicable regulatory agencies.
  3. Prior to startup, install all chemical identification, warning, and safety signs and labels.
- D. Electrical power and lighting systems:
1. Provide the ENGINEER with 3-day advance notification in writing of the test schedule. The CONTRACTOR is advised that the tests shall be witnessed by the ENGINEER.
  2. Perform insulation resistance tests on all wiring 120 volt and larger. Do not meggar instruments or solid-state devices.
  3. Perform insulation resistance tests on all motor and transformer windings from phase to phase and phase to ground.
  4. Perform grounding system tests to determine the continuity of connections and the value of resistance to ground.
  5. Fill electrical gear with oil and/or other media as recommended by the equipment manufacturer.
  6. Prior to energizing electrical equipment, startup, test and set switchgear and circuit breaker relays for proper coordination and operation.
  7. The CONTRACTOR shall obtain the services of a qualified "independent testing service", member of the National Electric Testing Association, to perform a thermographic survey on all switchgear buses, insulators and power connections when energized and under at least 20 percent load. Significant hot spots shall be further checked by infrared pyrometer for exact temperature rise. The CONTRACTOR shall troubleshoot and correct the thermographic hot spots. Correction shall be verified by repeating the thermographic survey at no additional cost to the OWNER.
  8. The CONTRACTOR shall obtain the services of a qualified "independent testing service", member of the National Electric Testing Association, to inspect and test the protective relays and the 800-ampere and larger drawout breakers for proper installation, adjustment, and operation in accordance with the manufacturer recommendations.
  9. The CONTRACTOR shall obtain the services of a qualified "independent testing service", member of the National Electrical Testing Association, to perform DC high potential tests on all cables that will operate at more than 2,000 volts to ground.
  10. Obtain local electrical inspector's approval where required.
  11. Energize all substations, with approval of the Utility Company and the ENGINEER after completion of all electrical testing.
  12. Prior to startup, perform tests and adjustments on all switchgear and motor control equipment to demonstrate proper operation and conformance to the Contract Documents and manufacturer's recommended settings.
  13. Prior to startup, test installation of emergency power and lighting systems for proper operation, including light intensity.
  14. Prior to startup, provide the ENGINEER with a record of all test data and the work completed.
  15. Vacuum clean all electrical equipment prior to startup and acceptance.
- E. Piping systems:
1. Provide the ENGINEER with 3-day advance notification in writing of test schedule.
  2. Hydrostatically or pneumatically test all piping as required by the codes and contract documents.
  3. After successful testing of the piping, slowly drain the system and then flush the system. Orifice plates shall be installed after testing. If installed with the piping,

they will be removed and replaced with spacers or pipe spools of equal length prior to the pressure test.

4. Dewater the system, remove blind flanges, and perform tightness tests, as required by the ENGINEER.
5. Insulate or paint piping, flanges, threaded joints, or field welds after the specified testing of each item has been completed unless instructed otherwise by the ENGINEER.
6. Leave exposed all welded joints (longitudinal, girth, and nozzle) in underground piping that have not been shop tested until the specified testing has been completed. After final testing of these joints, cover the system.
7. Prior to substantial completion and startup, check pipe hangers, supports, guides, and pipe specialties for the removal of all shipping and erection stops and for the correctness of the cold and hot settings for the design service, make adjustments as necessary to obtain proper installation. Provide the ENGINEER with instructions for the hot settings.
8. As necessary during equipment testing and at the end of substantial completion and startup, clean or replace the screens and filter elements as appropriate for the filter type and service.
9. Prior to startup, verify, to the extent required by the ENGINEER, that specified valve packing has been provided on valves installed in the plant.
10. Prior to startup, install all of the valve and piping system identification labels.
11. Prior to startup, check and record the position of all process system valves.
12. Prior to startup, correct support, vibration, and thermal expansion problems detected during the preliminary equipment testing.
13. Prior to the startup, retorque all hot and cold service bolting as required to ensure a permanent and proper installation.
14. Prior to startup, demonstrate to the ENGINEER's satisfaction that each piping system (e.g., chemical, sample, utility, irrigation process, etc.) functions as designed and required by the Contract Documents.

+ + END OF SECTION + +

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## **SECTION 01800**

### **PROJECT CLOSEOUT**

#### **PART 1 - GENERAL**

##### **1.1 GENERAL**

- A. Closeout is hereby defined to include general requirements near the end of the Contract Time, in preparation for Final Completion, Final Payment, normal termination of Contract, occupancy by OWNER and similar actions evidencing completion of the Work.
- B. Specific requirements for individual units of Work are specified in Sections of Divisions 2 through 16.
- C. Where a conflict exists between this section and the Contract Documents, the conditions in the Contract Documents take precedence.

##### **1.2 CERTIFICATION OF SUBSTANTIAL COMPLETION**

- A. Prior to requesting the ENGINEER's inspection for certification of each phase as Substantially Complete, the CONTRACTOR shall certify in writing that each phase of the Work is Substantially Complete and shall submit a list of known items still to be completed or corrected (Contractor's punchlist) prior to Contract Completion.
- B. The following items shall be completed:
  - 1. OWNER has been advised of any pending insurance changeover requirements.
  - 2. Specific warranties, maintenance agreements, final certifications and similar documents have been submitted.
  - 3. All tools, spare parts, extra stocks of materials, and similar physical items have been delivered to OWNER.
  - 4. Instruction of OWNER's operation/maintenance personnel and start up testing has been completed.
  - 5. Submittal and acceptance of all O&M manuals.
  - 6. Changeover of locks to OWNER's cores/keys.
- C. Punchlist:
  - 1. When the CONTRACTOR considers that the Work, or a portion or phase thereof which the OWNER agrees to accept separately, is Substantially Complete, the CONTRACTOR shall certify in writing that the work is Substantially Complete and shall prepare and submit to the ENGINEER a comprehensive list of items to be completed or corrected prior to Contract Completion (punchlist).
  - 2. The ENGINEER may add additional work items to the punchlist.
  - 3. Failure to include an item on the punchlist does not alter the responsibility of the CONTRACTOR to complete all Work in accordance with the Contract Documents.
  - 4. Upon receipt of the CONTRACTOR's punchlist, the ENGINEER will make an inspection to determine whether the Work or designated portion thereof is Substantially Complete.
  - 5. If the ENGINEER's inspection discloses any item, whether or not included on the CONTRACTOR's list, that is not in accordance with the requirements of the Contract Documents, the CONTRACTOR shall, upon notification by the ENGINEER and before

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- an issuance of the Certificate of Operational Completion is provided, complete or correct such item.
6. The CONTRACTOR shall then submit a request for another inspection by the ENGINEER.
  7. When the Work or designated portion thereof is accepted by the ENGINEER to be Substantially Complete, the ENGINEER will prepare a Certificate of Operational Completion.
  8. The date of Operational Completion shall be the date of the ENGINEER's inspection and acceptance.

### 1.3 FINAL CLEANUP

- A. At completion, leave project clean and ready for use.
  1. Legally dispose of waste materials, debris and rubbish off the site.
  2. Remove grease, dust, dirt, stains, labels, fingerprints and other foreign materials from exposed and enclosed surfaces.
  3. Repair, patch and touch up all affected curbs, gutters, and sidewalks to match adjacent surfaces.
  4. Broom clean paved surfaces, rake clean other surfaces of grounds. Vacuum clean all interior surfaces, rake clean other surfaces of grounds.

### 1.4 CONTRACT AS-BUILT DRAWINGS

- A. The CONTRACTOR shall prepare and submit Contract As-Built Drawings for the OWNER.
  1. The CONTRACTOR shall make a record of changes during construction on prints of the Drawings provided by the OWNER for this purpose (Contract As-Built Drawings) as described in Section 01330, Submittal Procedures.
  2. ENGINEER will verify on a monthly basis and provide written verification that the Contract As-Built Drawings are being developed and kept updated prior to submitting CONTRACTOR'S progress payment to the OWNER.
  3. The reproducible drawings on which changed conditions are recorded shall be returned to the ENGINEER prior to Final Completion.

### 1.5 WARRANTIES

- A. The Contract Documents cover the CONTRACTOR's responsibility to remedy defects due to faulty workmanship and materials.
- B. Special warranties are required by various Sections of these Specifications. Assemble written warranties, label and submit to the ENGINEER.
  1. Equipment warranties shall be written in the manufacturer's standard form and shall be countersigned by the Subcontractor or supplier and the CONTRACTOR.
  2. All other warranties shall be written on the Subcontractor's or supplier's letterhead and shall be countersigned by the CONTRACTOR.

### 1.6 SPARE PARTS AND MAINTENANCE MATERIALS

- A. Spare parts and maintenance materials are required by various Sections of the Specifications.
  1. Parts and materials shall be packaged so as to preclude damage in normal handling and storage.
  2. Packages shall be labeled with full description of contents and project name and clearly identified as to which item of equipment they belong to. CONTRACTOR shall

- maintain a spare parts inventory list which shall be provided to the OWNER prior to Final Completion.
3. Submit packaged parts and materials to ENGINEER.
  4. Submit the value of all spare parts.

#### **1.7 FINAL INSPECTION**

- A. Prior to requesting ENGINEER's final inspection for certification of Final Completion and Final Payment, complete the following and list known exceptions (if any):
  1. Submit Final Payment request with final releases and supporting documentation not previously submitted and accepted.
  2. Submit copy of final punchlist of itemized work to be completed or corrected, stating that each item has been completed or otherwise resolved for acceptance, endorsed and dated by ENGINEER.
  3. Submit Consent of Surety.
  4. Revise and submit evidence of final, continuing insurance coverage complying with insurance requirements.
- B. Certify in writing that the work has been completed in accordance with the Contract Documents, and request ENGINEER's final inspection.
- C. Reinspection:
  1. Within seven (7) days after receipt of the CONTRACTOR's notice that the work has been completed, including punchlist items resulting from earlier inspections, and excepting incomplete items delayed because of acceptable circumstance, the ENGINEER will reinspect the work.
  2. Upon completion of reinspection, ENGINEER will either prepare a certificate of Final Completion or advise the CONTRACTOR of work not complete or obligations not fulfilled as required for Final Completion.
  3. If necessary, inspection procedure will be repeated.

#### **PART 2 - PRODUCTS (NOT USED)**

#### **PART 3 - EXECUTION (NOT USED)**

+ + END OF SECTION + +

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## **SECTION 01810**

### **CLEANING**

#### **PART 1 - GENERAL**

##### **1.1 WORK INCLUDED**

- A. This Section covers the work necessary for cleaning during construction and final cleaning on completion of the Work.

##### **1.2 GENERAL**

- A. At all times maintain areas covered by the Contract and public properties free from accumulations of waste, debris, and rubbish caused by construction operations.
- B. Pollution Control:
  - 1. Conduct cleaning and disposal operations to comply with local ordinances and anti-pollution laws.
  - 2. Do not burn or bury rubbish and waste materials on project site.
  - 3. Volatile wastes shall be properly stored in covered metal containers and removed daily.
  - 4. Do not dispose of volatile wastes such as mineral spirits, oil, or paint thinner in storm or sanitary drains.
  - 5. Do not dispose of wastes into streams or waterways.
- C. Construction materials such as concrete forms and scaffolding shall be neatly stacked by the CONTRACTOR when not in use. The CONTRACTOR shall promptly remove splattered concrete, asphalt, oil, paint, corrosive liquids, and cleaning solutions from surfaces to prevent marring or other damage.
- D. Use only cleaning materials recommended by manufacturer of surface to be cleaned.
- E. Use cleaning materials only on surfaces recommended by cleaning material manufacturers.

#### **PART 2 - PRODUCTS (NOT USED)**

#### **PART 3 - EXECUTION**

##### **3.1 CLEANING DURING CONSTRUCTION**

- A. During execution of Work, clean site and public properties and dispose of waste materials, debris, and rubbish to assure that buildings, grounds, and public properties are maintained free from accumulations of waste materials and rubbish.
- B. Wet down dry materials and rubbish to lay dust and prevent blowing dust.
- C. Provide approved containers for collection and disposal of waste materials, debris, and rubbish. Empty containers within one day after they are full.

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- D. Remove grease, dust, dirt, stains, labels, fingerprints, and other foreign materials from exposed and semi-exposed surfaces.
- E. Repair, patch, and touch up marred surfaces to specified finish to match adjacent surfaces.
- F. Vacuum clean all interior spaces, including inside cabinets. Broom clean paved surfaces, rake clean other surfaces of grounds.
- G. Handle materials in a controlled manner with as few handlings as possible; do not drop or throw materials from heights.
- H. Schedule cleaning operations so that dust and other contaminants resulting from cleaning process will not fall on wet, newly painted surfaces.
- I. Vacuum clean interior building areas when ready to receive finish painting and continue vacuum cleaning on an as-needed basis until building is ready for substantial completion or occupancy.

### 3.2 FINAL CLEANING

- A. Refer to the requirements of the Contract Documents in addition to the requirements of this Section.
- B. See Section 01800, Project Closeout, for additional requirements.
- C. At the completion of Work on all Contracts and immediately prior to final inspection, cleaning of the entire Project will be accomplished according to the following provisions:
  - 1. The CONTRACTOR shall thoroughly clean, sweep, wash, and polish all work and equipment, including finishes. The cleaning shall leave the structures and site in a complete and finished condition to the satisfaction of the ENGINEER.
  - 2. Should the CONTRACTOR not remove rubbish or debris or not clean the building and site as specified above, the OWNER reserves the right to have the cleaning done at the expense of the CONTRACTOR.
  - 3. Employ professional cleaners for final cleaning.
  - 4. In preparation for substantial completion of occupancy, conduct final inspection of sight-exposed interior and exterior surfaces, and of concealed spaces.
  - 5. Remove grease, dust, dirt, stains, labels, fingerprints, and other foreign materials from sight-exposed interior and exterior finished surfaces; polish surfaces so designated to shine finish.
  - 6. Repair, patch, and touch up marred surfaces to specified finish, to match adjacent surfaces.
  - 7. Broom clean paved surfaces; rake clean other surfaces of grounds.
  - 8. Replace air-handling filters if units were operated during construction.
  - 9. Clean ducts, blowers, and coils, if air-handling units were operated without filters during construction.
  - 10. Clean luminaires in accordance with manufacturer's recommendations. Clean all light fixtures.
  - 11. Remove from the OWNER's property all temporary structures and all materials, equipment, and appurtenances not required as a part of, or appurtenant to, the completed work. See Section 01500 - Temporary Construction Facilities and Utilities.

+ + END OF SECTION + +

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## **SECTION 02140**

### **DEWATERING**

#### **PART 1 – GENERAL**

##### 1.1 DESCRIPTION

- A. Furnish all labor, materials, equipment and incidentals required and remove and dispose of all surface water and groundwater encountered.
- B. Groundwater was identified in the geotechnical report; the level of groundwater will vary over time and groundwater may be present during construction. The Contractor shall assume dewatering to meet the requirements of these contract documents is required and included in lump sum bid at no additional cost to Owner.

##### 1.2 SUBMITTALS

- A. Submit a detailed dewatering plan showing all details of proposed dewatering system including proposed areas for drainage disposal and treatment processes if necessary. Dewatering plan shall be submitted within 7 days of mobilization and shall be approved prior to any grading activities. Dewatering plans shall be developed for each phase of the work.

#### **PART 2 – PRODUCTS**

##### 2.1 MATERIALS

- A. Piping, pumping equipment and all other materials required to provide dewatering of excavations shall be suitable for the intended purpose. Standby pumping units shall be maintained at the site to be used in case of failure of the normal pumping units.

#### **PART 3 – EXECUTION**

##### 3.1 DEWATERING AND DRAINAGE SYSTEM

- A. General:
  - 1. Continuously control all water during the course of construction, including surface water and groundwater, to prevent any damage to any excavation, fill or to any other construction activities occurring within the site.
  - 2. Maintain all dewatering systems full time (24-hours/day) during the entire time the excavation is open. Do not shut down dewatering systems at night, on weekends or on holidays, or any other time the excavation is open.
  - 3. Provide and maintain proper equipment and facilities to remove all water entering each excavation to be kept dry during subgrade and pipe bedding preparation and continually thereafter until the structure to be built, or the pipe to be installed therein is inspected by the ENGINEER and backfill operations have been completed.
  - 4. Provide adequate alarm, monitoring and back-up systems for all dewatering systems to maintain control of all water during all times any excavation is open.

5. Temporary dewatering and drainage systems shall be in place and operational prior to beginning any demolition or earthwork activities.
6. Collect water entering the excavation from surface runoff in shallow ditches around the perimeter of the excavation, drain to sumps and pump from the excavation to maintain a bottom free from standing water and groundwater level a minimum of 2 feet below lowest point of excavation or subgrade.
7. Take all additional precautions to prevent uplift of any structure during construction. All such arrangements shall be subject to the approval of the ENGINEER.
8. Dispose of drainage so that flow or seepage back into the excavated area will be prevented. Disposal area shall be approved by the ENGINEER.
9. Prevent flotation by maintaining a positive and continuous operation of the dewatering system. If for any reason the dewatering system is found to be inadequate, make additions, changes and replacements, as necessary, to provide a satisfactory system at no additional cost to the OWNER. All damage resulting from failure to properly dewater excavations shall be repaired to the satisfaction of the Engineer at no additional cost to the OWNER.
10. CONTRACTOR shall continuously control all water during the course of construction to ensure that any earthwork materials on the site that could be used later in the project are completely protected until needed. If suitable materials are left unprotected and it results in materials being deemed unsuitable due to moisture, contamination, etc., CONTRACTOR shall remove materials from the site and replace at no additional cost to OWNER.

B. Surface Water:

1. Provide and maintain adequate drainage and dewatering system to prevent surface water from entering excavations and to remove and dispose of all rainwater entering excavations, trenches, or other parts of the Work.
2. Keep the different working areas on the site free of surface water at all times. Special care will be taken to eliminate depressions that could serve as mosquito pools.
3. The diversion and removal of surface water will be performed in a manner that will prevent the accumulation of water behind temporary structures or at any other locations within the construction area where it may be detrimental.

C. Groundwater:

1. Provide, operate and maintain dewatering system to permit excavation and subsequent construction activities in a dry, safe environment.
2. System shall be of sufficient size and capacity to maintain groundwater level a minimum of 2 feet below the lowest point of excavation.
3. CONTRACTOR shall make an assessment of the potential for dewatering induced settlement of surrounding soils and structures. CONTRACTOR shall provide all necessary equipment and facilities, including re-injection wells, cutoff walls, infiltration trenches, etc., to prevent damage to adjacent structures.

D. Disposal of water:

1. Disposal of collected water including but not limited to groundwater, surface water, and storm water shall conform to any and all applicable permit requirements.
2. Contractor shall monitor, test, record, and make any and all necessary adjustments to project BMP's to ensure compliance with project SWPPP and other permit requirements. This includes all monitoring, testing, recording, and reporting water quality information for all discharges from the site; including but not limited to discharges caused by run-on whether naturally occurring or storm

water related, storm water, non-stormwater; groundwater; and any project generated discharges.

+ + END OF SECTION + +

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**SECTION 02200**  
**SITE PREPARATION**

**PART 1 - GENERAL**

**1.1 DEFINITIONS**

- A. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.
- B. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface.
- C. Grubbing: Removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 0.5 inch caliper to a depth of 6 inches below subgrade.
- D. Stripping: Removal of topsoil remaining after applicable scalping is completed.
- E. Project Limits: Areas, as shown or specified, within which Work is to be performed.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION**

**3.1 GENERAL**

- A. Clear, grub, and strip areas actually needed for waste disposal, borrow, or site improvements within limits shown or specified.
- B. Do not injure or deface vegetation that is not designated for removal.

**3.2 LIMITS**

- A. As follows, but not to extend beyond Project limits.
  - 1. Excavation 5 feet beyond top of cut slopes.
  - 2. Trench Excavation: 4 feet from trench centerline, regardless of actual trench width.
  - 3. Waste Disposal:
    - a. Clearing: 5 feet beyond perimeter.
    - b. Scalping and Stripping: Not required.
    - c. Grubbing: Around perimeter as necessary for neat finished appearance.
  - 4. Structures: 5 feet outside of new structures.
  - 5. Roadways: Clearing , grubbing and stripping 50 feet from centerline.
  - 6. Overhead Utilities:
    - a. Clearing and Grubbing: Entire width of easements and rights-of-way.
    - b. Scalping and Stripping: Wherever grading is required.
  - 7. Other Areas: As shown.
- B. Remove rubbish, trash, and junk from entire area within Project limits.

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### 3.3 CLEARING

- A. Clear areas within limits shown or specified.
- B. Fell trees so that they fall away from facilities and vegetation not designated for removal.
- C. Cut stumps not designated for grubbing flush with ground surface.
- D. Cut off shrubs, brush, weeds, and grasses to within 2 inches of ground surface.

### 3.4 GRUBBING

- A. Grub areas within limits shown or specified.

### 3.5 STRIPPING

- A. Do not remove topsoil until after scalping is completed.
- B. Strip areas within limits to minimum depths shown or specified. Do not remove subsoil with topsoil.

### 3.6 DISPOSAL

- A. Clearing and Grubbing Debris: Dispose of debris offsite.
- B. Strippings:
  - 1. Dispose of strippings that are unsuitable for topsoil or that exceed quantity required for topsoil offsite or approved by ENGINEER.
  - 2. Stockpile topsoil in sufficient quantity to meet Project needs. Dispose of excess strippings as specified for clearing and grubbing.

+ + END OF SECTION + +

## **SECTION 02220**

### **DEMOLITION**

#### **PART 1 - GENERAL**

##### **1.1 DEFINITIONS**

- A. "Demolish": CONTRACTOR shall remove from the site as property of CONTRACTOR. Demolition includes disconnecting, removal, loading, repairs, cleanup, transportation, unloading, disposal permits and fees, disposal, and all other items required to remove the material from the site.
- B. "Salvage": CONTRACTOR shall remove from area of Work and place in location designated by ENGINEER. Equipment is property of OWNER. Salvage includes disconnecting, removal, repairs, cleanup, loading, transportation, unloading, and all other items required to remove and relocate the material.
- C. "OWNER to Remove": OWNER will remove from area of Work prior to CONTRACTOR commencing demolition Work for this area.
- D. "Relocate": CONTRACTOR shall relocate material shown to new locations shown on Drawings or stated herein. Relocation includes disconnecting, removal, reconnecting, attaching, repairs, and all other items required to relocate material to new location.
- E. "Abandon": CONTRACTOR shall disconnect and leave in place as specified.
- F. "Materials": Any and all items and objects that are scheduled, specified, or shown to be demolished, salvaged, removed, relocated, or abandoned.

##### **1.2 SUBMITTALS**

- A. Submittals:
  - 1. Product Information: Grout, sealants, and bonding agents to be used for patching.
- B. Informational Submittals:
  - 1. Plan and schedule phased demolition, including limits of demolition, as part of and consistent with the progress schedule specified in Section 01320, PROGRESS SCHEDULE.
  - 2. Methods of demolition and equipment proposed to demolish materials.
  - 3. Copies of any authorizations and permits required to perform Work.
  - 4. Copies of Hazardous Materials Inspection Reports.
  - 5. Repair procedures for demolition of materials beyond limits shown on Drawings.

#### **PART 2 - PRODUCTS**

##### **2.1 GENERAL**

- A. CONTRACTOR shall provide all materials and equipment in suitable and adequate quantity as required to accomplish the Work shown, specified herein, and as required to complete the Project.

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## **PRODUCTS**

### **PART 3 - EXECUTION**

#### **3.1 GENERAL**

- A. Drawings are based on available information. The Work may differ slightly from what is shown. CONTRACTOR shall be responsible for determining the work required by inspecting the site.

#### **3.2 SAFETY REQUIREMENTS**

- A. All Work shall be done in conformance with all applicable rules and regulations pertaining to safety.
- B. Hazardous Materials:
  - 1. See General Conditions.
  - 2. Existing facilities, or portions thereof, to be demolished may contain hazardous materials such as asbestos cement piping, residual chemicals in existing or abandoned piping, lead-based paint, mercury seals, or other unknown hazardous materials.

#### **3.3 SEQUENCE**

- A. Be responsible for the sequence of Work.
- B. Conform to constraints as specified in Section 01130, SPECIAL PROJECT CONSTRAINTS.

#### **3.4 COORDINATION**

- A. Coordination with ENGINEER:
  - 1. Only materials specified herein, shown on the Demolition Photographs or the Drawings, or approved by ENGINEER in the field shall be demolished, salvaged, removed, relocated, or abandoned.
  - 2. Verify materials scheduled to be demolished, salvaged, removed, relocated, or abandoned with ENGINEER prior to performing Work.
  - 3. Do not remove materials without prior approval of ENGINEER.
  - 4. Provide at least 3 working days' notice to ENGINEER prior to start of Work.
  - 5. Notify ENGINEER to turn off affected services or facilities before starting Work.
  - 6. Provide temporary services during interruptions to affected services or facilities as acceptable to ENGINEER.
  - 7. ENGINEER will indicate limits of Work if not clearly shown.
- B. Coordination with Utility Owners:
  - 1. Notify utility owners to turn off affected services or facilities before starting Work.
  - 2. Provide not less than 72 hours notice to utility owners prior to shutdown, unless otherwise directed by utility owners.
  - 3. Provide temporary services during interruptions to affected services or facilities as acceptable to utility owners.



### 3.5 LIMITS

- A. Drawings define minimum portions of materials to be demolished. Unless otherwise shown, rough cuts or breaks may be made to limits of demolition shown. If rough cuts or breaks are made exceeding limits shown, CONTRACTOR shall repair the cuts or breaks back to the dimensions shown on Drawings at CONTRACTOR's expense.
- B. If limits are not clear on the Drawings or Demolition Photographs, limits shall be as directed by ENGINEER.
- C. All areas not within the limits of demolition Work shown on the Drawings, or as specified herein, shall be left undisturbed, unless necessary for demolition of materials.

### 3.6 DEMOLITION

- A. General:
  - 1. Inspect condition of materials to be demolished prior to bidding to assess potential for salvage value.
  - 2. Remove all materials associated with existing equipment that is to be demolished.
  - 3. Materials within limits of demolition will become the property of CONTRACTOR.
  - 4. All materials from the demolition process shall be removed safely from the project site as soon as possible. They shall be disposed of in accordance with applicable federal, state, and city regulations. CONTRACTOR is responsible for determining these regulations and shall bear all costs associated with disposal of the materials.
- B. Pavement and Curbs:
  - 1. Provide saw cut at all concrete and pavement surfaces and curb removal limits and where neat connection lines are required.
  - 2. Surfaces exposed by demolition activities shall be repaired and finished to provide a uniform, smooth, level transition between adjacent surfaces.
- C. Concrete, CMU, and Reinforcing:
  - 1. In areas where concrete or CMU portions are to be removed from a structure, the edge of removal shall be cut with a concrete saw to leave a perpendicular edge or by core-drilling where a circular hole is required.
  - 2. Damaged concrete shall be removed to solid concrete. Damaged concrete shall include concrete that is soft, spalled, cracked, or otherwise damaged as determined by ENGINEER.
  - 3. Depth of removal shall be as determined by ENGINEER unless otherwise shown or specified.
  - 4. Reinforcing shall be cut and removed unless otherwise shown or instructed by ENGINEER.
  - 5. Spalled edges may be required to be resawn at the discretion of the ENGINEER.
  - 6. Protect adjacent structures and equipment from damage during Work.
  - 7. Exposed surfaces following demolition activities shall be repaired and finished to provide a uniform, smooth, and level transition between adjacent surfaces.
  - 8. Remove and repair designated cracked and damaged concrete areas shown in accordance with this section and Section 03300, CAST-IN-PLACE CONCRETE.
- D. Concrete Embedded Items:
  - 1. Except for core drills, demolish anchor bolts, reinforcing steel, conduit, and other materials that are concrete embedded to a minimum of 1 inch below final finished

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surface. For core drills, coat rebar exposed by core drilling with System No. 304 in accordance with Section 09900, PAINTING.

2. Plug empty pipes and conduits with fireproof sealant to maintain fire ratings for floors or walls.
  3. Patching:
    - a. Demolish damaged concrete. Damaged concrete shall be removed to solid concrete. Damaged concrete shall include concrete that is soft, spalled, cracked, or otherwise damaged as determined by ENGINEER.
    - b. Coat with approved bonding agent.
    - c. Patch with nonshrink, nonmetallic grout.
- E. Piping:
1. Pressurized Services: Install restrained caps or plugs at the demolished ends, unless otherwise shown.
  2. Gravity Services: Install concrete plugs, 5-foot minimum length.
- F. Utilities:
1. Excavate utility lines serving structures to be demolished.
  2. Demolish electrical, sanitary, and storm drainage lines serving structures to be demolished.
  3. Support or relocate utility lines exposed by Work.
  4. For water and gas lines to be demolished or capped and terminated, provide a permanent leakproof closure. Closure type shall be as recommended by utility owner.
- G. Electrical:
1. Remove conduits and wiring from materials to be demolished back to nearest junction box.
  2. For existing circuits to remain operational, intercept existing conduit at the most convenient location, or as shown, and splice and extend conduit to new location. Install new conductors as required to accomplish intended results. New conductors shall be continuous without splices between junction boxes.
  3. For existing circuits no longer needed, demolish conductors from conduits.
  4. Demolish all surface-mounted conduit which is no longer needed.
  5. For conduit below grade or concealed within walls, cap and abandon in place.

### 3.7 SALVAGE

- A. Salvage materials for OWNER's own use where shown.
- B. Remove materials with extreme care so as not to damage.
- C. Promptly remove materials from Work area.
- D. Store materials in location designated by ENGINEER.
- E. Clean and protect materials from dust, dirt, natural elements, and store as directed.

### 3.8 RELOCATION

- A. ENGINEER will determine condition of materials prior to removal.
- B. Remove all materials associated with items to be relocated.

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- C. Existing materials shall not be damaged during removal.
- D. Properly store and maintain materials in same condition as when removed.
- E. Clean and protect materials from dust, dirt, natural elements, and store as directed.

### 3.9 ABANDONMENT

- A. Structures: Break holes into or core drill floor slabs, catch basins, and other below-grade concrete structures to be abandoned in place to allow water to freely migrate through.
- B. Piping and Conduits:
  - 1. General: Piping and conduits to be abandoned shall be capped with a watertight plug at demolished end in a manner that will prevent entrance of soil, groundwater, or moisture.
  - 2. Pressurized Services: Install restrained caps or plugs at the demolished ends, unless otherwise shown.
  - 3. Gravity Services: Install concrete plugs, 5-foot minimum length.

### 3.10 REPAIR AND REPLACEMENT

- A. Any damaged materials scheduled to be salvaged or relocated shall be repaired by the CONTRACTOR to the satisfaction of ENGINEER or replaced at the CONTRACTOR's expense.
- B. Any damage to areas not within the limits of demolition Work shown on the Demolition Photographs, Drawings, or as specified herein shall be repaired or replaced to original precontract conditions at the CONTRACTOR's sole expense.

### 3.11 DISPOSAL

- A. Dispose of materials offsite in licensed landfills and in accordance with all local, state, and federal regulations. CONTRACTOR is responsible for obtaining any and all necessary permits for disposal.

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## SECTION 02300

### EARTHWORK

#### **PART 1 - GENERAL**

##### **1.1 DESCRIPTION**

- A. Section includes: All excavation, backfill, fill, retaining walls, grading, subgrade preparation and disposing of earth materials as required. It also includes all temporary means needed to prevent discharge of sediment to watercourses from dewatering systems or erosion.

##### **1.2 REFERENCES**

- A. American Society for Testing and Materials (ASTM)
1. ASTM C33, Standard Specification for Aggregate Material.
  2. ASTM C150 Standard Specification for Portland Cement
  3. ASTM C618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
  4. ASTM D422, Method for Particle-Size Analysis of Soils.
  5. ASTM D423, Liquid Limit of Soils.
  6. ASTM D427, Shrinkage Factors of Soils.
  7. ASTM D698, Test Method for Laboratory Compaction Characteristics of Soil.
  8. ASTM D1140 Standard Test Methods for Amount of Material in Soils Finer Than the No. 200 (75-um) Sieve
  9. ASTM D1556, Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
  10. ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil
  11. ASTM D2166, Unconfined compressive strength of soils.
  12. ASTM D2922, Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
  13. ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
  14. ASTM D4832 Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders
- B. U.S. Environmental Protection Agency (U.S. EPA)
1. EPA 9090 – Compatibility Test for Wastes and Membrane Liners
- C. APWA Greenbook
1. Section 200-2.5 Processed Miscellaneous Base
- D. Occupational Safety and Health Administration (OSHA)
1. Title 29, Code of Federal Regulations, Part 1926
- E. SECTION 01400 - QUALITY CONTROL

##### **1.3 SYSTEM DESCRIPTION**

- A. Permits and Regulations:

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1. Perform excavation Work in compliance with applicable requirements of governing authorities having jurisdiction.
2. Obtain all necessary permits for Work in roads, rights-of-way, railroads, etc. Also, obtain permits as required by local, state and federal agencies for discharging water from excavations, for erosion control, and for prevention of air and water pollution.

#### 1.4 SUBMITTALS

- A. Earthwork Reports: CONTRACTOR'S approved Testing laboratory or geotechnical consultant shall submit copies of the following reports directly to ENGINEER:
  1. Tests on all materials covered by this specification section
  2. Tests on borrow material.
  3. Tests on footing and pad subgrade.
  4. Field density tests.
  5. Optimum moisture - maximum density curve for each material used for backfill.
  6. Reports of observations and statements of compliance with the project geotechnical report for all borrow material, fill, backfill, and grading including subgrades.
  7. Quality Control Plan: Names and phone numbers of independent testing companies that will be used to perform CONTRACTOR'S soil testing, asphalt concrete testing, placement observation, certifications required by the building permit (if any), statement of qualifications, and proposed procedures for performing tests and providing test results and certifications to ENGINEER.
  8. Refer to specification section 01400 Quality Control for additional requirements.
- B. Submit to the ENGINEER samples of all materials, including but not limited to select backfill, general backfill, bedding, crushed stone, lime treatment, aggregate base, sand, topsoil, and any other materials requested by ENGINEER. Submit samples of the proposed material at least seven days in advance of its anticipated use.
- C. Contractor shall submit all pot holing results to engineer a minimum of 30 days in advance of starting work on any item that requires potholing
- D. Submit PVC geomembrane liner product data sheet, installation manual, and certification from the manufacturer.
- E. Submit a Final Project Soils Testing and Observation Report.
  1. The purpose of the final report is to summarize the daily or monthly reports and indicate that all the work for the grading operation was properly performed.
  2. The final report shall be a copy of all the monthly reports and a letter tying all the monthly reports (table with reports dates) and a statement that all the work (subgrade approval, compaction tests, sampling, laboratory testing, and reporting) for the grading operation was properly performed in accordance of 01400 Quality Control.
- F. Permits:
  1. CONTRACTOR shall submit copies of all permits a minimum of 7 days in advance of starting any associated work.
- G. Quantities:
  1. CONTRACTOR shall also submit backup calculations to substantiate all payment requests for work covered by this spec section.

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- H. Excavation Support Plan:
  - 1. CONTRACTOR shall submit in advance of performing any excavation,
  - 2. CONTRACTOR shall designate on-site competent person(s) and provide copies of training records.
- I. Quality control plan for earthwork activities.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. General:
  - 1. All materials shall be tested by the CONTRACTOR'S quality control laboratory or by supplier's quality control laboratory for conformance to the project requirements. Test results shall be submitted to the ENGINEER for approval.
  - 2. No material shall be placed without the approval of the ENGINEER. Materials not approved by the ENGINEER through the standard project submittal procedures will not be allowed to be installed. If CONTRACTOR places unapproved materials, a stop notice will be issued and CONTRACTOR shall be solely responsible for all schedule and cost ramifications of placing materials without obtaining contractual required approvals.
- B. Marking Tape:
  - 1. Plastic (Non-Detectable, for metallic pipes that also have pipe locating wire or as required):
    - a. Inert polyethylene, impervious to known alkalis, acids, chemical reagents, and solvents likely to be encountered in soil.
    - b. Thickness: Minimum 4 mils.
    - c. Width: 12 inches.
    - d. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
    - e. Manufacturers and Products:
      - 1) Reef Industries; Terra Tape.
      - 2) Pro-Line; Non-Detectable Tape.
      - 3) Or equal.
  - 2. Metallic (Detectable, for nonmetallic pipes or as required):
    - a. Solid aluminum foil, visible on unprinted side, encased in a protective high visibility, inert polyethylene plastic jacket.
    - b. Foil Thickness: Minimum 5.5 mils.
    - c. Width: 12 inches.
    - d. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
    - e. Joining Clips: Tin or nickel-coated, furnished by tape manufacturer.
    - f. Manufacturers and Products:
      - 1) Reef Industries; Terra "D".
      - 2) Pro-Line; Detectable Tape.
      - 3) Or equal.
  - 3. Marking tape shall be marked with the following statements:
    - a. Influent/Effluent Pipeline: "RESTRAINED PIPE"
    - b. Sanitary Sewer Pipeline: "CAUTION – SANITARY SEWER PIPELINE BURIED BELOW."
    - c. Storm Drain Pipeline: "CAUTION – STORM DRAIN PIPELINE BURIED BELOW."

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- d. For Existing Utilities Within Trench Limits: "CAUTION – BURIED PIPELINE/CONDUIT" or as specified by utility owner.
- 4. Color:
  - a. Influent/Effluent Pipeline: Blue, as specified in ANSI Z53.1 Safety Color Code.
  - b. Sanitary Sewer Pipeline: Green, as specified in ANSI Z53.1 Safety Color Code.
  - c. Others Disturbed: Color, as specified for specific utility in ANSI Z53.1 Safety Color Code.
- C. Pipe Locating Wire (Tracer Wire):
  - 1. Pipe locating wire shall be Agave insulated AWG No. 12, soft drawn, single-strand copper wire, direct burial tracer wire 600 volts E-246360 rated with 45 mil blue colored polyethylene jacket.
  - 2. Provide at least 6-mil PVC electrical tape insulation around wire where adjacent to metal pipe, valves, and in all valve boxes.
- D. Filter Fabric
  - 1. Filter fabric shall be Mirafi, Type 140N; Dupont, Type PAR, Style 3401, or equal product by Amoco and shall conform to the following requirements:
  - 2. Minimum grab strength of 120 lbs per ASTM D1682.
  - 3. Apparent open size (AOS) to be equal to or greater than the U.S. Standard Sieve No. 100 (0.210 mm) per ASTM D4751.
  - 4. Percent open area not to exceed about 25 percent. The percent open area is defined as the ratio of the sum of 20 or more individual open areas (times 100) to the sum of the corresponding 20 or more individual total areas.
  - 5. Coefficient of permeability shall not be less than 10<sup>-2</sup> cm/sec.
- E. Fill Material:
  - 1. Common Fill (Select or Engineered Fill):
    - a. Common Fill materials shall consist of soils obtained from on-site excavations or off-site sources that are uniformly mixed, contain no organic material, and have been passed through a 3" screen or otherwise processed to achieve a maximum particle size of 3". As defined in project specific Geotechnical Report as Engineered Fill. Select fill or backfill is material selected by the ENGINEER from the excavation.
    - b. The maximum plasticity of off-site materials shall be less than 12 as determined by a Plasticity Index (PI) Test in accordance with ASTM D4318.
    - c. If on-site material is unsuitable as determined by the ENGINEER then imported fill shall be used.
    - d. If on-site material becomes unsuitable as a result of increased moisture content, it shall be the CONTRACTOR's responsibility to off haul the unsuitable material and imported fill shall be provided by CONTRACTOR at no cost to the OWNER. Contract time extensions will not be approved by OWNER for CONTRACTOR delays caused by unsuitable materials.
    - e. All imported fill shall be approved by the OWNER in advance of delivery to the site. CONTRACTOR shall provide full analytical test results for all proposed non-virgin fill materials.

Sieve Size	% Passing
3-inch	100
¾-inch	70-100
No. 200	0-30
Liquid Limit	Plasticity Index

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<30	<12
<b>Organic Content</b>	
<3%	

- F. ¾" Aggregate Base (Aggregate Base):
1. Class 2, ¾" maximum particle size conforming to Section 26 of the Caltrans Standard Specifications. Recycled aggregate base shall not be used.
- G. 1-1/2" Aggregate Base:
1. Class 2, 1-1/2" maximum particle size conforming to Section 26 of the Caltrans Standard Specifications. Recycled aggregate base shall not be used.
- H. Drain Rock (1" Rock)
1. Drain rock shall consist of a washed uniform-graded processed gravel with 100 percent passing 1 ½" and less than 3 percent passing No. 4 sieve.
- I. Crushed Stone (¾" Crushed Rock):
1. Crushed stone will be a washed crushed rock or gravel conforming to the requirements of ASTM C33, Sieve Size #57.
- J. Granular Fill (Pervious Backfill or Granular Bedding):
1. Washed chips
  2. Unfrozen, friable, and no clay balls, roots, or other organic material.
  3. Clean or gravelly sand or gravel or crushed rock, with particle sizing distribution, as determined in accordance with ASTM D422, of:
    - a. 100 percent passing
      - 1) 1/2 inch for pipe 12" or smaller
      - 2) 3/4 inch for pipe over 12"
    - b. less than 50% percent passing 3/8 inch
    - c. Less than 10% passing No. 8 sieve;
    - d. less than 3 percent passing a No. 100 sieve; and
    - e. less than 2 percent passing a No. 200 sieve.
  4. Maximum particle size and other requirements as follows, unless otherwise specified.
    - a. 1/2 inch maximum particle size for pipe 12" or smaller; and
    - b. 3/4 inch maximum particle size for pipe over 12".
- K. Sand:
1. Natural or manufactured granular material, containing no organic material.
  2. Sand, clean or clean to silty, less than 12 percent passing No. 200 sieve.
  3. Individual Particles: Free of sharp edges.
  4. Maximum Size Particle: Pass a No. 4 sieve.
  5. If more than 5 percent passes No. 200 sieve, the fraction that passes No. 40 sieve shall be non-plastic as determined in accordance with ASTM D4318.
- L. Gravel Surfacing
1. Gravel Surfacing will be crushed rock, angular, and well-graded.
  2. Maximum size of ¾", at least 50% passing the No 4. screen, between 10 and 30% passing the No. 10 screen and no more than 15% passing the No. 40 screen.
  3. Color to be selected by OWNER.
- M. Controlled Low Strength Material (CLSM):

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1. Select and proportion ingredients to obtain compressive strength between at 28-days between 100 psi and 200 psi in accordance with ASTM D4832. Sufficient cement shall be added to meet the strength and material requirements given below and as required to provide sufficient strength for compacting overlying trench backfill. Provide certified mix design and test results in accordance with submittal requirements.
2. Materials:
  - a. Cement: ASTM C150, Type I or II, two sacks minimum per cubic yard.
  - b. Aggregate: ASTM C33, maximum Size 7. The amount of material passing a No. 200 sieve shall not exceed 12 percent. The above No. 200 sieve material shall be well graded so as to avoid segregation. The minus #200 sieve fraction shall be nonplastic.
  - c. Fly Ash (if used): ASTM C618, Class F.
  - d. Water: Clean, potable, containing less than 500 ppm of chlorides.
3. Mix Design:
  - a. The CONTRACTOR and its suppliers shall determine the materials and proportions used to meet the requirements of these Specifications. Make daily checks of the aggregate gradation and adjust the mix design as required. Modify the CLSM mix as necessary to meet the flowability, pumpability, and set time requirements for each individual pour.
  - b. At least 30 days before placing CLSM, submit to the ENGINEER a mix design for each CLSM to be used. The mix design shall include trial lab and field data, with pairs of 6-inch by 12-inch cylinder breaks performed at 7, 14, and 28 days. Molds shall be plastic or waxed cardboard. The mix design shall be performed by an independent laboratory under the direction of an engineer licensed in California.
  - c. No CLSM shall be placed until the ENGINEER has approved the mix design. The ENGINEER's approval of the mix design shall be understood to indicate conditional acceptance. Final acceptance will be based on tests conducted on field samples and conformance with these Specifications.
  - d. Prior to placing backfill over CLSM, CLSM shall achieve an indentation diameter less than or equal to 75 mm (3 inches) as determined in accordance with ASTM C6024.

N. Polyvinyl chloride (PVC) geomembrane liner:

1. Certified Properties
  - 1) Thickness per ASTM 5199: 30 mils
  - b. Minimum Tensile Properties per ASTM D882
    - 1) Strength at Break: 73 lbs/in.
    - 2) Elongation at Break: 380%
    - 3) Modulus at 100% Elongation: 32 lbs/in.
  - c. Tear Strength per ASTM D1004: 8 lbs min.
  - d. Dimensional Stability per ASTM D1204: 3%
  - e. Low Temperature Impact per ASTM D1790: -20 deg F
2. Index Properties
  - a. Specific Gravity per ASTM D792: 1.2
  - b. Water Extraction (% loss max) per ASTM D1239: 0.15%
  - c. Average Plasticizer Molecular Weight per ASTM D2124: 400
  - d. Volatile Loss (Max % wt loss) per ASTM D1203: 0.7%
  - e. Resistance to Soil Burial per ASTM G160
    - 1) Breaking Factor: 5%

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- 2) Elongation at Break: 20%
- 3) Modulus Force at 100% Elongation: 20%
- f. Hydrostatic Resistance per ASTM D751: 100 psi
- 3. Seam Requirements
  - a. Shear Strength per ASTM D3083: 58.4 lbs/in.
  - b. Peel Adhesion per ASTM D413: 15 lbs/in.
- 4. Manufacturer's and Products
  - a. Watersaver Company; Colorado
  - b. Or equal.

## **2.2 STOCKPILES**

- A. Anything that is temporary fill or permanent fill shall meet compaction requirements. Stockpiles are not temporary fill and do not need compacting. The stockpile base elevation needs to be surveyed prior to any stockpile placement. After stockpile removal, the ground shall be surveyed to confirm that the entire stockpile has been removed.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Inspection:
  - 1. Provide ENGINEER with sufficient notice and with means to examine the areas and conditions under which excavation, fill, and grading are to be performed.
  - 2. ENGINEER will notify CONTRACTOR if conditions are found that may be detrimental to the proper and timely completion of the Work.
  - 3. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.
  - 4. CONTRACTOR'S third party independent quality control laboratory or geotechnical consultant shall perform any and all inspection, observation, and testing necessary to comply with special inspection requirements.
- B. "Pot-holing":
  - 1. Excavate and backfill, in advance of the construction, test pits to determine conditions or location of existing utilities and structures as required to complete the work.
  - 2. Determine the location of each existing facility involved within the area of the excavation for Work under this Contract.
  - 3. Exercise care during such location work to avoid damaging and/or disrupting the affected facility.
  - 4. CONTRACTOR is responsible for repairing, at his expense, damage to any structure, piping, or utility caused by his Work.
  - 5. Contractor shall include pot holing activities in the project schedule.
- C. Temporary Fencing:
  - 1. Furnish and install a temporary security fence surrounding excavations and work area, including stockpile and storage areas.
  - 2. Provide fence openings with gates only at vehicular, equipment and worker access points.

### 3.2 EROSION CONTROL

- A. General: Implement the construction procedures outlined herein to assure minimum damage to the environment during construction. Take all additional measures required to conform to the requirements of applicable codes and regulations.
  - 1. Whenever possible, locate and construct access and temporary roads to avoid environmental damage. Make provisions to regulate drainage, avoid erosion and minimize damage to vegetation.
  - 2. Where areas must be cleared for storage of materials or temporary structures, provisions will be made for regulating drainage and controlling erosion, subject to the ENGINEER'S approval.
  - 3. Remove only those shrubs and grasses that must be removed for construction. Protect the remainder to preserve their erosion-control value.
- B. Control Measures: Apply measures to control erosion and to minimize the siltation of the existing waterways, and natural ponding areas. Such measures include, but are not limited to, the use of berms, baled straw silt barriers, gravel or crushed stone, mulch, slope drains and other methods.
  - 1. Install erosion and sediment control practices where shown and according to applicable standards, codes and specifications. The practices will be maintained in effective working condition during construction and until the drainage area has been permanently stabilized.
  - 2. Temporary measures will be coordinated with the construction of permanent drainage facilities and other Work to the extent practicable to assure economical, effective, and continuous erosion and siltation control.
  - 3. CONTRACTOR will provide special care in areas with steep slopes. Disturbance of vegetation will be kept to a minimum to maintain stability.
  - 4. After stabilization, remove all straw bale dikes, debris, etc., from the site.
- C. Dust Control:
  - 1. Prevent blowing and movement of dust from exposed soil surfaces and access roads to reduce on- and off-site damage and health hazards.
  - 2. Control may be achieved by irrigation in which the site is sprinkled with water until the surface is moist.
  - 3. Repeat the process as needed.
- D. Failure to Comply: In the event CONTRACTOR repeatedly fails to satisfactorily control erosion and siltation, the OWNER reserves the right to employ outside assistance or to use its own forces to provide the corrective measures indicated. The cost of such work, plus engineering costs, will be deducted from monies due CONTRACTOR.

### 3.3 DEWATERING

- A. General: Conform to the requirements of Specification Section 02140 - Dewatering.
- B. Continuously control all water during the course of construction, including surface water and groundwater, to prevent any damage to any excavation, fill or to any other construction activities occurring within the site.
- C. CONTRACTOR shall continuously control all water during the course of construction to ensure that any earthwork materials on the site that could be used later in the project are completely protected until needed. If suitable materials are left unprotected and it results in materials being deemed unsuitable due to moisture,

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contamination, etc., CONTRACTOR shall remove materials from the site and replace at no additional cost to OWNER.

### 3.4 EXCAVATION SUPPORT SYSTEMS

#### A. Trench Support

1. Provide, install and maintain trench shields for all trench excavations for which trench shields are required (at a minimum, as required by OSHA).
2. Follow all OSHA guidelines and other applicable laws and ordinances.
3. Elevation of Bottom:
  - a. Excavation of earth material below the bottom of a shield will not exceed the limits established by ordinances, codes, laws and regulations.
  - b. When using a shield for pipe installation, the bottom of the shield will not extend below the mid-diameter of installed pipe at any time.
  - c. When using a shield for the installation of structures, the bottom of the shield shall not extend below the top of the bedding for the structures.
4. Moving Shield: When a shield is removed or moved ahead, extreme care will be taken to prevent the movement of pipe or structures or the disturbance of the bedding for pipe or structures. Pipe or structures that are disturbed are to be removed and reinstalled as specified.

#### B. Below Grade Structure Excavation Support

1. Provide, install and maintain excavation support systems for all structural excavations where excavation support is required (at a minimum, as required by OSHA).
2. Follow all OSHA guidelines and other applicable laws and ordinances.
3. Prepare excavation support plan addressing the following topics:
  - a. Details of shoring, bracing, sloping or other provisions for worker protection from the hazards of caving ground
  - b. Design assumptions and calculations
  - c. Methods and sequencing of installing excavation support
  - d. Proposed locations of stockpiled excavated materials
  - e. Minimum lateral distance from the crest of slopes for vehicles, equipment and materials
  - f. Location of vertical and horizontal monitoring points on structures and recommended frequency of monitoring for excavation support system stability and performance
4. Design of excavation support systems and excavation support plan shall be prepared by a civil or structural engineer registered in the state in which the system is installed.
  - a. Excavation support system shall consist of h-pile and lagging, sheet piles, or other reliable method of excavation support.
  - b. The use of below-ground tiebacks is allowed, however, Contractor is responsible for locating and avoiding potential conflicts with existing utilities in the area in which the tie-backs are installed. All tiebacks shall be further than 3 feet from any conflicting utility. Tiebacks shall not use existing structures for support. Tiebacks cannot extend beyond property boundary.

#### C. Removal of Excavation Support

1. Completely remove all excavation support unless ENGINEER specifically allows requested excavation support to remain in place after backfill.
2. Remove all excavation support in a manner that will maintain support as excavation is backfilled and will not leave voids in the backfill.

### 3.5 EXCAVATION

#### A. General:

1. Material removed: Excavations include earth, sand, clay, gravel, hardpan, boulders, rock, silt, cobbles, pavements, rubbish and all other materials within the excavation limits.
2. Excavations for structures and pipelines will be open excavations. Provide excavation protection system(s) required by ordinances, codes, law and regulations to prevent injury to workers and to prevent damage to new and existing structures or pipelines.

#### B. Structural Excavation:

1. The elevation of the bottom of footings shown is approximate only. ENGINEER may order such changes in dimensions, and elevations as may be required to secure a satisfactory footing.
2. Hand-trim all structure excavations to permit the placing of full widths and lengths of footings on horizontal beds. Rounded and undercut edges will not be permitted.
3. Excavations shall allow for aggregate base, forms, working space, installation of shoring or bracing or the safe sloping of banks.

#### C. Pipe Trench Excavation:

1. No more than 100' of trench may be opened in advance of pipe laying.
2. Minimize trench width to the greatest extent practical, but conform to the following:
  - a. Sufficient to provide room for installing, jointing and inspecting piping, but in no case wider at top of pipe than pipe barrel outside diameter plus 3'.
  - b. Enlargements at pipe joints may be made, if required, and approved by ENGINEER.
  - c. Sufficient for shoring and bracing, or shielding and dewatering.
  - d. Sufficient to allow thorough compaction of backfill adjacent to bottom half of pipe.
  - e. Depth of trench will be as shown. If required and approved by ENGINEER, depths may be revised.

#### D. Subgrades:

1. Subgrades for roadways, structures and trench bottoms shall be firm, unyielding, dense, and thoroughly compacted and consolidated; free from mud, muck, and other soft or unsuitable materials; and remain firm, unyielding and intact under all construction operations.
2. Subgrades that are otherwise solid, but which become soft or mucky on top due to construction operations, shall be reinforced with select fill.
3. The finished elevation of stabilized subgrades shall not be above subgrade elevations shown.
4. Subgrades should be proof rolled prior to use or placement of engineered fill. Proof rolling should be performed using a loaded water truck, loaded scraper, loaded 10 wheeled truck or any other equipment of sufficient size and weight that is approved by Engineer. Engineer shall observe the proof rolling and verify that the subgrade is firm and unyielding prior to further construction on the subgrade soils.
5. If the trench bottom is not firm and unyielding, then trench subgrade shall be stabilized with placement of a geotextile fabric on the trench bottom and wrap it with at least one foot of 1-inch drain rock or compacted processed miscellaneous base as per APWA Greenbook Section 200-2.5.

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6. CONTRACTOR'S dewatering operations shall maintain the groundwater level a minimum of 2 feet below the subgrade at all times.
- E. Material Storage: Stockpile satisfactory excavated materials in approved areas, until required for backfill or fill. Place, grade and shape stockpiles for proper drainage.
  1. Locate and retain soil materials away from edge of excavations.
  2. Dispose of excess soil material and waste materials as specified hereinafter.
- F. Unauthorized Excavation:
  1. All excavation outside the lines and grades shown, and which is not approved by ENGINEER, together with the removal and disposal of the associated material is at the CONTRACTOR'S expense.
  2. Unauthorized excavations shall be filled and compacted with select fill by the CONTRACTOR at CONTRACTOR's expense and will not be approved for payment under the GMP.

### 3.6 PLACEMENT OF FILL AND BACKFILL

- A. General:
  1. Backfill excavations as promptly as Work permits, but not until completion of the following:
    - a. Acceptance by the ENGINEER of construction below finish grade.
    - b. Inspection, testing, approval, and recording of locations of underground piping and ductwork.
    - c. Removal of concrete formwork.
    - d. Removal of shoring and bracing, and backfilling of voids with satisfactory materials.
    - e. Removal of trash and debris.
  2. Remove and replace with approved fill material, as specified, fill containing organic materials or other unacceptable material "and uncertified fill.
  3. Compact all fill and backfill as specified in Subsection 3.7.
- B. Structural Backfill:
  1. Select fill shall be placed as structural backfill where shown on the Drawings or indicated herein.
  2. Constraints:
    - a. Backfill water-holding basins or structures only after satisfactory leakage tests have been conducted as specified in Sections Concrete, Precast Concrete, and Prestressed Concrete Tank.
    - b. No backfill or fill material shall be placed when free water is standing on the surface of the area.
    - c. No compaction of fill will be permitted with free water on any portion of the fill to be compacted.
    - d. No fill shall be placed or compacted in a frozen condition or on top of frozen material.
    - e. Any fill containing organic materials or other unacceptable material previously described shall be removed and replaced with approved fill material prior to compaction.
  3. Levels of backfill against concrete walls are not to differ by more than 2' on either side of walls, unless walls are adequately braced or all floor framing is in place up to and including grade level slabs.
  4. Wherever a pipe passes through a structure backfill, the structure backfill shall be placed and compacted to an elevation 12" above the top of the pipe before the trench is excavated.

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C. Backfill in Pipe Trenches:

1. Pipeline trenches may be backfilled prior to pressure testing, but no structure shall be constructed over any pipeline until it has been tested.
2. Unless otherwise shown, place all pipe on a minimum 6" thick layer of Granular Fill. The bedding shall extend 12" above the top of the pipe.
3. Install bedding as follows:
  - a. Spread and compact bedding and grade to provide a uniform and continuous support beneath the pipe at all points between bell holes or pipe joints.
  - b. After each pipe section is placed, deposit and compact sufficient bedding material under and around each side of the pipe to hold the pipe in proper position and to maintain alignment during subsequent pipe jointing and bedding operations.
  - c. Bedding material shall be deposited and compacted uniformly and simultaneously on each side of the pipe to prevent lateral displacement. Then place and compact the bedding material to an elevation 12" above the top of pipe.
4. Above the level of bedding, place Select or Common Fill, as specified elsewhere in these specifications.
5. Controlled Low Strength Material (CLSM):
  - a. When CLSM pipe zone material is indicated, the pipe may be supported above the trench floor on pea gravel bags or sandbag supports. The CONTRACTOR shall demonstrate to the ENGINEER, 7 days prior to full pipeline backfill installation, placement of CLSM as described below. This demonstration shall occur on the first 300 feet of trench, The CLSM pipe zone material shall be installed as indicated.
    - 1) Bedding and Embedment: Place and consolidate CLSM pipe zone material using the following techniques:
      - a) Following placement and anchoring of the pipe, remove all loose soil and debris from trench walls and floor. Remove any unstable soil at the top of the trench which might fall into the trench during placement of the CLSM.
      - b) Deliver the CLSM to the trench in ready mix trucks or traveling pug mill and utilize pumps or chutes to place the CLSM in the trench. Direct CLSM to one side of the pipe, taking care not to displace the pipe at any time. Continue placing CLSM on one side of the pipe until CLSM has gone under the pipe and up the other side to a depth of 6 inches above the pipe bottom. Use at least two handheld vibrators to continuously liquefy and move CLSM into all voids. Adjust water in mixture to maintain fluid consistency but maintain strength requirements. Continue placing CLSM on both sides of the pipe continuously using two vibrators for every 30 feet of pipe run.
      - c) Maintain stability of pipe and conduit throughout CLSM placement and curing. CLSM will likely require placement in lifts to prevent pipe flotation. No movement of the pipe caused by flotation will be allowed. If any movement occurs, the CLSM material shall be removed and/or repaired in full conformance with these Contract Documents at no additional cost to the OWNER. Remove all sloughed material or other debris from top of previously placed CLSM.
      - d) Indentation in the CLSM of a diameter of less than or equal to 3" in accordance with ASTM C6024 is required prior to placing each lift as well as trench zone material or other fill on top of CLSM. A smaller cure period will be allowed if it can be demonstrated to the ENGINEER that it will support the individual lift or trench zone material. The CLSM shall

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be sufficiently strong to support trench backfill material and the compaction effort required to achieve the specified compaction.

D. Marking Tape:

1. Continuously install marking tape along centerline of all buried piping, on top of last lift of pipe zone material unless otherwise shown. Coordinate with piping installation drawings. Install in accordance with manufacturer's recommendations.
  - a. Metallic Marking Tape: Install with nonmetallic piping and waterlines. Join ends with clips provided by the manufacturer.
  - b. Plastic Marking Tape: Install with metallic piping.

E. Pipe-Locating Wire:

1. Pipe-locating wire shall be provided for the entire length of all water pipelines and shall be continuous around restrained joint sections.
2. Install pipe locating wire by strapping to the top of the pipe with PVC tape, polyethylene-backed tape, or tie locks. Test pipe locating wire with pipe locator equipment prior to final acceptance.
3. Stub the pipe-locating wire up inside each valve box or flush-mounted Type C corrosion monitoring stations. Sufficient excess length shall be provided at terminal connections to allow continuation of the pipe-locating wire to the terminal connection.
4. Wire splices shall be made with compression fittings or soldering; wrapped with Tac-Tape, Aqua-Seal, or equal, and wrapped with electrical tape. Prevent bare copper wire from contacting metallic appurtenances including, but not limited to, pipe, buried valves, or fittings.

F. Resume backfilling operations using the techniques described above to complete the pipe zone backfill. ENGINEER will approve the pipe zone backfill prior to initiating the trench zone backfill.

G. Embankments:

1. To the maximum extent available, use excess earth obtained from structure and trench excavations for construction of acceptable embankments. Obtain additional material from borrow pits, if such pits are shown, otherwise obtain additional material from offsite sources as necessary.
2. Strip, scarify, level, key, and roll the subgrade so that surface materials of the subgrade will be compact and well bonded with the first layer of the embankment.
3. Wherever a pipe is to pass through a fill or embankment, place and compact the fill or embankment material to an elevation 12" above the top of the pipe before the trench is excavated.

H. Crushed Stone:

1. Place where shown on the Drawings, to the limits shown.
2. Place in hand-tamped lifts, not to exceed 6".

I. Replacement of Unacceptable Excavated Materials: In cases where over-excavation for the replacement of unacceptable soil materials is required, backfill the excavation to the required subgrade with select backfill material and thoroughly compacted.

### 3.7 COMPACTION

A. General:

1. Compaction by inundation with water will not be permitted.

2. Provide equipment capable of discing, aerating, and mixing the soil to ensure reasonable uniformity of moisture content throughout the material and to reduce the moisture content by air drying, if necessary.
3. Perform compaction with equipment suitable for the type of fill material being placed. Select equipment that is capable of providing the minimum relative compaction required by these Specifications. Use hand-operated compacting equipment within a distance of 3 feet from the wall of any completed below grade structure. Between 3 feet and 12 feet adjacent to structures, compaction may be completed with lightweight compaction equipment weighing less than 15,000 pounds. Beyond 12 feet adjacent to structures, there are no equipment weight restrictions. Provide equipment that is capable of compacting in restricted areas next to structures and around piping.

B. Fill Compaction Density Requirements: The degree of compaction required for several types of materials are listed below. Moisten or aerate material as necessary to provide the moisture content specified, or if not specified, that will facilitate obtaining the specified compaction.

<b>MATERIAL</b>	<b>Required Minimum Density (ASTM D 1557)</b>	<b>Maximum Uncompacted Lift*</b>
Common Fill:	90%	8"
Select Fill and Trench Backfill:		
Within 2 feet of final grade	95%	8"
More than 2 feet below final grade	90%	8"
Aggregate Base:	95%	8"
Granular Fill	90%	6"
Sand	90%	6"
Gravel Surfacing	95%	6"

\*Where large areas of backfill allow for use of large, heavy equipment, ENGINEER may, at their option, allow uncompacted lifts up to 12".

- C. Moisture Content: All fill and backfill shall be prepared and thoroughly mixed to achieve optimum moisture content,  $\pm 3\%$ , with the following exception: On site clayey soils moisture content is limited to optimum to  $+3\%$ .
- D. Testing: Testing shall be performed as specified under Paragraph 3.11, "Field Quality Control".
- E. Subgrade compaction shall be as shown in subsection 3.8, "Grading".

### 3.8 GRADING

- A. General:
  1. Uniformly grade areas within limits of grading under this Section, including adjacent transition areas.
  2. Smooth subgrade surfaces within specified tolerances, and compact with uniform levels or slopes between points where elevations are shown or between such points and existing grades.

- B. Adjacent to Structures: Grade areas adjacent to structures to drain away from structures (including fences) and to prevent ponding.
- C. Walks: Shape surface of areas under walks to line, grade and cross-section, with finish surface not more than 1" above or below the required subgrade elevation.
- D. Pavements: Shape surface of areas under pavement to line, and grade and cross-section with finish surface not more than 1/2" above or below the required subgrade elevation.
- E. Under Building Slabs: Grade smooth and even, free of voids, compacted as specified and to required elevation. Provide final grades within a tolerance of 1/2" when tested with a 10' straightedge.
- F. Special Areas: In turfed areas or areas covered with gravel, stone, wood chips, or other special cover, grade to within not more than 1-inch above or below the required subgrade elevations.
- G. Subgrade Compaction: After excavating or grading, compact subgrade surfaces to the required minimum densities as follows for each area classification.

Area	Required Minimum Density (ASTM D 1557)
Beneath Structures, Tanks, and Buildings	95%
Beneath Asphalt Concrete Pavement	95%
Landscaped Areas	85%
Other areas not specifically described above	90%

### 3.9 PAVEMENT BASE COURSE

- A. Shoulders:
  - 1. Place shoulders along edges of base course to prevent lateral movement.
  - 2. Construct shoulders of acceptable soil materials, placed in such quantity to compact to thickness of each base course layer.
  - 3. Compact and roll at least a 12" width of shoulder simultaneously with compacting and rolling of each layer of base course.
- B. Placing:
  - 1. Place base course material on prepared subgrade in layers of uniform thickness conforming to indicated cross-section and thickness.
  - 2. Maintain to +/- 3% of optimum moisture content for compacting base material during placement operations.

### 3.10 MEMBRANE LINER INSTALLATION

- A. Prior to placing the top 1-foot of coarse aggregate, the subgrade base shall be compacted and then the leak detection trench shall be lined with 30-mil thick geomembrane liner as specified in this Section using waterproof joints.
- B. Laps shall be sealed by glue at all joints in accordance with the manufacturer's instructions.

- C. Placement of the 30 mil sheeting shall start at the outside circumference of the tank and be carried to the center of the tank.
- D. The Contractor shall not drive stakes through the membrane unless a method of membrane repair has been submitted and approved by the ENGINEER.
- E. The liner shall be cut/fitted to provide a uniform layer of liner material against the start and termination surfaces with a maximum fold thickness and layers at any point as shown on plans
- F. Liner shall be held tight to tank by tensioned bull tape with minimum wraps and spacing as shown on plans.

### 3.11 FIELD QUALITY CONTROL:

- A. General: Testing by a testing laboratory of materials, testing for moisture content during placement and compaction of fill materials, subgrade certification, fill placement observation, and of compaction requirements for compliance with technical requirements of the Specifications, geotechnical report, and building permit requirements shall be the CONTRACTOR's responsibility.
- B. The CONTRACTOR shall retain one or more independent testing agencies to perform all quality control testing, placement observation, and certification required for all materials except portland cement concrete. The required testing includes but is not limited to all soil, aggregates, imported gravel, aggregate base, asphalt concrete, and CLSM. Each independent testing agency shall perform the testing under the supervision of an engineer registered in California. Technicians performing the testing shall be certified to operate the equipment, employed by the testing agency, and have at least 1 full year of experience in the type of tests being performed.
- C. A Quality Control Plan shall be submitted by the CONTRACTOR to the ENGINEER at least 30 days before earthwork operations begin. It shall include the names, addresses, and phone number of the companies, the major personnel that will be involved, and resumes of the individuals that will be supervising, performing testing and observing CONTRACTOR'S earthwork operations. Copies of certificates held by the companies and the testing personnel shall be included.
- D. CONTRACTOR's independent testing agency shall perform all field and laboratory testing as described in these Specifications. Tests shall include specific gravity, sand equivalent, durability, abrasion resistance, soundness, gradation, Plasticity Index, compaction curves, lab and field moisture contents, compressive strength, and field density. Other tests shall be performed by the CONTRACTOR's independent testing agency as may be required to meet the Specifications. Mix design testing for portland cement concrete, CLSM, and asphalt concrete shall also be performed by the CONTRACTOR. Field sampling and testing for portland cement concrete will be performed by the ENGINEER.
- E. CONTRACTOR shall schedule all lab testing so that materials arriving at the site have been previously approved by the ENGINEER for use on the Project.
- F. All lab tests shall be performed on Samples obtained from the source of actual material that will be used on the Project. No test results more than 90 days old shall be submitted for review.

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- G. The location of field density tests shall be determined by the ENGINEER.
- H. Frequency of tests: Frequency will be not less than as follows:
1. For trenches:
    - a. In open fields: Minimum of 2 locations every 500 linear feet or less, for each lift
    - b. Along dirt, gravel, or paved roads or off traveled right-of-way: Minimum of 2 locations every 250 linear feet or less, for each lift
    - c. Crossing roads: Minimum of 2 locations along each crossing, for each lift
  2. For structural backfill: Minimum of 1 every 50 cubic yards.
  3. In embankment or fill: Minimum of 1 every 200 cubic yards.\
  4. Base material: Minimum of 1 every 50 cubic yards
  5. Footing Subgrade: 1 every 50 linear feet, for each lift.
  6. Paved Areas, Structure Subgrades: 1 every 500 square feet, but in no case less than 3 tests, for each lift.
- I. The ENGINEER may modify the frequency or spacing of tests to provide for testing at specific structures or locations where the ENGINEER deems additional testing is required. The CONTRACTOR shall perform such additional testing up to 15 percent above the frequency and total number of tests specified at no additional cost to the OWNER.
- J. Verbal and hand-written test results shall be provided to the ENGINEER and CONTRACTOR immediately following the field testing. Written test data sheets including daily reports shall be provided to the ENGINEER by close of business the day the tests were completed. Typed lab test results shall be provided to the ENGINEER not more than 3 calendar days following completion of the tests; however, the results must be reviewed and approved by the ENGINEER prior to placing the material in the trenches or incorporating it in the Work.
- K. CONTRACTOR'S independent testing laboratory and geotechnical consultant shall provide a final project soils testing and observation report prior to final acceptance and release of payment in accordance with the contract requirements.
- L. Any location where a failing test occurs shall be recompacted and retested until a passing test is obtained. Specified testing values are minimums and no tests shall be accepted below the specified minimums. No material shall be placed over the failing test area until the failing material is recompacted and a passing test is obtained, and the area is approved by the ENGINEER. The limits of the failing test shall be assumed to be halfway between the failing location and the nearest passing location. Additional tests may be taken to determine the limits of unsatisfactory compaction.
- M. Along with the monthly progress pay application submittal, the CONTRACTOR shall provide to the ENGINEER a typed summary of all tests performed for the previous month including test location by station or location, elevation, depth below finished grade, material tested, wet density, moisture content, dry density, maximum density curve used, and percent relative compaction. Lab test results shall also be included in the monthly report with clear description of material tested, intended use on the Project, and a statement of compliance or noncompliance with the Project requirements..
- N. Any material which does not meet the Specifications shall be removed from the site and replaced with material in compliance.

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- O. Material which has been softened or modified prior to placing the overlying lift shall be removed down to material which is in compliance.

### 3.12 DISPOSAL OF EXCAVATED MATERIALS

- A. Material removed from the excavations that does not conform to the requirements for fill or is in excess of that required for backfill shall be hauled away from the project site and disposed of by CONTRACTOR in compliance with ordinances, codes, laws and regulations at no additional cost to the OWNER.
- B. Except and delineated on drawings, a site is not available to dispose of excess material.
- C. CONTRACTOR shall provide the OWNER a letter of acceptance from the property owner of any offsite location where CONTRACTOR temporarily or permanently stores excavated materials removed from the project site.

+ + END OF SECTION + +

## SECTION 02360

### MECHANICALLY STABILIZED EARTH FOUNDATION IMPROVEMENT SYSTEM

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. Mechanically Stabilized Earth (MSE) foundation improvement system having structural geogrids and liners that interact with cohesionless soil to create a stiffened, high modulus raft foundation. Work consists of:
  - 1. Providing supplier representative for pre-construction meeting with Contractor and Engineer.
  - 2. Furnishing structural geogrid reinforcement as specified herein and shown on the construction drawings.
  - 3. Storing, cutting and placing structural geogrid reinforcement as specified herein and as shown on the construction drawings.
  - 4. Placement and compaction of reinforced fill within the MSE foundation improvement system as specified herein and as shown on the Drawings.
  - 5. Incidental earthwork as necessary to complete the MSE foundation improvement system specified herein and as shown on the construction drawings.
  - 6. Installing liners as per the construction drawings.
- B. Related Sections
  - 1. Section 02200 - Site Preparation
  - 2. Section 02300 - Earthwork
- C. Alternates
  - 1. Geotextile materials will not be considered as an alternate to geogrid materials for the MSE foundation improvement system. A geotextile may be used in the cross-section to provide separation, filtration or drainage; however, no structural contribution will be attributed to the geotextile.
  - 2. Alternate geogrid materials shall not be used unless submitted to the Engineer and approved in writing by the Engineer at least 7 business days before the bid opening. Polyester geogrids, whether coated or uncoated, will not be approved for use in calcareous, alkaline, or highly acidic environments including lime-treated or cement-treated soils, crushed limerock, or soils potentially exposed to leachate from cement, lime, or de-icing salts. In no case shall polyester geogrids be used in soils with a pH > 9.
  - 3. To be considered, submittal packages for alternate geogrid materials must include:
    - a. A sample of the alternate geogrid material and certified specification sheets.
    - b. Recommended installation instructions.
    - c. An explanation of engineering techniques used, and sample design drawings and calculations prepared and sealed by a Professional Engineer licensed in the State, and if applicable, the company registration information.
    - d. Additional information as required by the Engineer.
  - 4. Engineer approval of alternative systems and suppliers will be based upon the following considerations:
    - a. The reinforcement for the system has been reviewed and pre-approved for use.

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- b. The supplier has a large enough operation, adequate financial resources, and necessary experience to supply and support the construction on a reliable and timely basis.
- c. The material supplier/manufacturer has adequate Professional Engineers' Errors and Omissions insurance to cover the potential liability incurred as designer of record for the system.

## 1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM)
- B. D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft<sup>3</sup> (2,700 kN-m/m<sup>3</sup>))
- C. Tensar International Corporation, Inc. (TIC)
  - 1. Dimension™ Solution Software version 2.x

## 1.3 DEFINITIONS

- A. Geogrid - A polymeric grid formed by a regular network of integrally connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock, or earth and function primarily as reinforcement.
- B. Multi-Layer Geogrid - A geogrid product consisting of multiple layers of grid which are not integrally connected throughout.
- C. Resistance to Long-Term Degradation - Resistance to loss of load capacity or structural integrity when subjected to chemically aggressive environments measured via EPA 9090 immersion testing. Values shown are typical values.
- D. Reinforced Fill - Compacted structural fill placed above and below the layers of geogrid, the reinforced fill boundaries shall be defined as the limits of the MSE foundation system as indicated on the construction drawings.

## 1.4 SYSTEM DESCRIPTION

- A. Design Requirements - The MSE foundation improvement system shall have been designed using the Dimension Solution Software or other approved methodology.
- B. Performance Requirements for the MSE Foundation Improvement System - Design calculations should substantiate that the proposed MSE foundation improvement system satisfies the allowable total and differential settlement and bearing capacity factor of safety design parameters as shown in the construction drawings or as required by the Engineer.

## 1.5 SUBMITTALS

- A. Submit geogrid product data sheet and certification from the manufacturer.
- B. Submit manufacturer's installation instructions and general recommendations.
- C. Working Drawings for Alternative Foundation Support Systems or Materials.

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1. Complete details, including working drawings and supporting design calculations, for any alternative approved foundation support systems or materials shall be submitted by the Contractor to the Engineer for review at least 4 weeks before construction. The Contractor shall submit 6 sets of detailed design calculations, construction drawings, and shop drawings for approval. The calculations and drawings shall be prepared and sealed by a Professional Engineer licensed in the State. The design submittal provided by the Contractor shall indicate the procedures by which the geogrid soil reinforcement will be installed. Working drawings and calculations shall include the following:
  - a. Existing ground elevations that have been verified by the Contractor for each location involving construction of a foundation system.
  - b. Complete design calculations substantiating that the proposed design satisfies the design parameters shown in the construction drawings or as required by the Engineer.
  - c. Complete details of all elements required for the proper construction of the system.
  - d. Earthwork requirements including specifications for material and compaction of backfill.
  - e. Other information requirements shown in the construction drawings or called out by the Engineer.
2. The Contractor shall not start work on any alternative foundation improvement system or material until such drawings have been approved by the Engineer. Approval of the working drawings shall not relieve the Contractor of any of his/her responsibility under the contract for the successful completion of the work.

#### **1.6 QUALITY ASSURANCE**

- A. Designer - The design of the MSE foundation improvement system shall be performed by a Professional Engineer who is registered in the State where the project is located and who is familiar with geotechnical engineering.
- B. Pre-Construction Conference - Before construction of the MSE foundation improvement system, hold a meeting at the site with the geogrid supplier, Contractor, and the Designer to review the construction procedure. Notify the Owner, the Engineer, and/or Architect at least 3 business days in advance of the time of the meeting. The representative of the geogrid supplier shall be available on an "as needed" basis during construction.

#### **1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Storage and Protection
  1. Prevent excessive mud, wet concrete, epoxy, or other deleterious materials from coming in contact with and affixing to the geogrid materials.
  2. Store at temperatures above -20 degrees F (-29 degrees C).
  3. Rolled materials may be laid flat or stood on end.

### **PART 2 - PRODUCTS**

#### **2.1 MANUFACTURERS**

- A. Geogrid:
  1. The Tensar Corporation, Morrow, GA,

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2. Or Equal.

## 2.2 MATERIALS

- A. Structural Soil Reinforcement Geogrid – The geogrid component of the MSE foundation improvement system shall be TriAx™ TX5 or TX7 and shall be integrally formed and produced from a punched sheet of polypropylene which is then oriented in three substantially equilateral directions so that the resulting ribs shall have a high degree of molecular orientation, which continues at least in part through the mass of the integral node.
- B. The resulting geogrid structure shall have apertures that are triangular in shape, and shall have ribs with a depth-to-width ratio greater than 1.0.
- C. The geogrid shall have the nominal characteristics shown in the table below, and shall be certified in writing by the manufacturer to be TX5 or TX7:

TX5				
Properties	Longitudinal	Diagonal	Transverse	General
Rib pitch, mm (in)	40 (1.60)	40 (1.60)	-	
Mid-rib depth, mm (in)	-	1.3 (0.05)	1.2 (0.05)	
Mid-rib width, mm (in)	-	0.9 (0.04)	1.1 (0.04)	
Rib shape				rectangular
Aperture shape				triangular

**TX7**

<b>Properties</b>	<b>Longitudinal</b>	<b>Diagonal</b>	<b>Transverse</b>	<b>General</b>
Rib pitch, mm (in)	40 (1.60)	40 (1.60)	-	
Mid-rib depth, mm (in)	-	2.0 (0.08)	1.6 (0.06)	
Mid-rib width, mm (in)	-	1.0 (0.04)	1.3 (0.05)	
Rib shape				rectangular
Aperture shape				triangular

**2.3 BACKFILL MATERIALS**

- A. Reinforced Backfill - The fill material in the reinforced fill zone shall be cohesionless material with a maximum particle size of 2 inches, have less than 15 percent passing the No. 200 Sieve, and an internal friction angle of at least 30 degrees. In addition, if gravel is used as the fill material, it shall be well graded.

**2.4 CONSTRUCTION DOCUMENTATION**

- A. The Contractor shall establish and maintain quality control for foundation construction operations to assure compliance with contract requirements and maintain detailed records of their quality control for all construction operations. Three copies of all records of inspections and tests, and all of the records of corrective action taken, shall be furnished to the Engineer on a monthly basis when work under this section is being performed.

**PART 3 - EXECUTION****3.1 EXAMINATION**

- A. The Contractor shall check the geogrid upon delivery to verify that the proper material has been received. The geogrid shall be inspected by the Contractor to be free of flaws or damage occurring during manufacturing, shipping, or handling.

**3.2 FOUNDATION PREPARATION**

- A. Brush, trees, logs, topsoil, and other debris shall be removed as specified in the contract documents. No fill shall be placed on frozen ground. After clearing, grade smooth, compact, and establish the proper elevations as shown on the construction drawings or as directed by the Engineer.

**3.3 STRUCTURAL GEOGRID INSTALLATION**

- A. Structural geogrid shall be laid at the proper elevation and alignment as shown on the construction drawings.
- B. For square or rectangular footings, the structural geogrid shall be oriented such that the roll direction runs perpendicular to the roll direction of the previous layer of

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geogrid. For strip footings, the structural geogrid shall be oriented such that the roll length runs parallel to the footing direction. A minimum of 2 layers of structural geogrid are required for the MSE foundation improvement system.

- C. Geogrid may be temporarily secured in place with staples, pins, sand bags or backfill as required by fill properties, fill placement procedures or weather conditions, or as directed by the Engineer.
- D. Overlap
  - 1. Structural geogrid sections shall be overlapped as indicated on the construction drawings or as directed by the Engineer.
  - 2. Minimum overlap is 1 foot (300 millimeters).
  - 3. Care shall be taken to ensure that structural geogrid sections do not separate at overlaps during construction. To prevent separation, simple joining methods may be utilized, such as wire ties, plastic ties, hog rings, staples or hooks. Joint spacings of 20 to 30 feet are normally adequate to prevent grid separation at overlaps.

### 3.4 GRANULAR FILL PLACEMENT OVER STRUCTURAL GEOGRID

- A. The fill in the reinforced zone shall be placed in lift thickness as directed in the construction drawings or as directed by the Engineer. The fill in the reinforced zone shall be compacted to a density of at least 95 percent maximum density as determined by Modified Proctor Test (ASTM D1557). Otherwise, the fill in the reinforced zone shall be placed in lifts and compacted as directed under Section 02300. Granular fill material shall be placed, spread and compacted in such a manner that minimizes the development of wrinkles in the geogrid and/or movement of the geogrid.
- B. A minimum loose fill thickness of 6 inches is required prior to operation of tracked vehicles over the geogrid. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the fill and damaging the geogrid. When integrally-formed geogrids are used, rubber-tired equipment may pass over the geogrid reinforcement at slow speeds (less than 10 mph). When coated geogrids or geogrids composed of small-diameter fibers are used, rubber-tired equipment shall not be allowed directly on the geogrid. Sudden braking and sharp turning movements shall be avoided.
- C. Pre-wet granular fill below the tank concrete floor slab and wall footing to a saturated surface dry condition immediately prior to pouring concrete.

### 3.5 REPAIR

- A. Any geogrid damaged during installation shall be replaced by the Contractor at no additional cost to the Owner.
- B. Coated geogrids shall not be used if the coating is torn, shedding, cracked, punctured, flawed or cut, unless a repair procedure is carried out as approved by the Engineer. The repair procedure shall include placing a suitable patch over the defective area or applying a coating solution identical to the original coating.

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- C. Dewater measures, as discussed in the project specifications, should be constructed to maintain groundwater at least two feet below subgrade and to maintain a dry, firm, and unyielding work area.

### 3.6 PROTECTION

- A. Follow the Manufacturer's recommendations regarding protection from exposure to sunlight.

### 3.7 MEMBRANE LINER INSTALLATION

- A. Prior to placing the top 1-foot of coarse aggregate, the compacted subgrade base and leak detection trench shall be lined with 30-mil thick sheeting as specified in this Section using waterproof joints.
- B. Laps shall be sealed by glue at all joints in accordance with the manufacturer's instructions.
- C. Placement of the 30 mil sheeting shall start at the outside circumference of the tank and be carried into the center of the tank.
- D. The Contractor shall not drive stakes through the membrane unless an acceptable method of membrane repair is utilized.

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## **SECTION 02390**

### **RIPRAP**

#### **PART 1 - GENERAL**

##### **1.1 SUBMITTALS**

- A. Administrative Submittals: Trip tickets showing source, type, and weight of each load of material delivered to site.
- B. Quality Control Submittals:
  - 1. Certified Test Results for Each Class of Riprap for Each Quarry Used to Supply Material:
    - a. Gradation.
    - b. Abrasion resistance.
    - c. Bulk density.

#### **PART 2 - PRODUCTS**

##### **2.1 GEOTEXTILES**

- A. Provide geotextile under all Riprap.
- B. Geotextile shall be non-woven, synthetic, UV resistant fabric.

##### **2.2 RIPRAP**

- A. Riprap shall conform to the following specification:
  - 1. Conforming to Section 72-2 of the CalTrans Standard Specifications
- B. Free of roots and other organic or deleterious matter.
- C. Hard and durable quarry stone free from fractures, bedding planes, pronounced weathering, and earth or other adherent coatings.
- D. Minimum Dimension of Individual Pieces: Not less than 1/3 maximum dimension.
- E. Abrasion Resistance: Maximum 35 percent wear as determined in accordance with ASTM C535.
- F. Bulk Density: Minimum 150 pounds per dry cubic foot.
- G. Gradation: Smaller pieces shall generally fill voids between larger pieces without either excess or deficiency of one or more sizes of stone.

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## **PART 3 - EXECUTION**

### **3.1 PLACING RIPRAP**

- A. Utilize power and hand tools to produce a subgrade that is true to the slope or grades indicated.
- B. Place geotextile prior to placing riprap. Overlap seams at least 24 inches.
- C. Place riprap as follows:
  - 1. Intermix different sizes of pieces to eliminate segregation and to fill voids between larger pieces with smaller pieces and work surface free from irregularities.
  - 2. Use placement and intermixing methods that avoid disturbing prepared subgrade or damaging existing facilities, completed Work, or adjacent property.

+ + END OF SECTION + +



## SECTION 02770

### ASPHALT CONCRETE PAVING

#### **PART 1 - GENERAL**

##### **1.1 SUBMITTALS**

###### A. Information Submittals:

1. Asphalt Concrete Mix Formula:
  - a. Submit minimum of 15 days prior to start of production.
  - b. Submittal to include the following information:
    - 1) Gradation and portion for each aggregate constituent used in mixture to produce a single gradation of aggregate within specified limits.
    - 2) Bulk specific gravity for each aggregate constituent.
    - 3) Measured maximum specific gravity of mix at optimum asphalt content determined in accordance with ASTM D2041.
    - 4) Percent of asphalt lost due to absorption by aggregate.
    - 5) Percentage of asphalt cement, to nearest 0.1 percent, to be added to mixture.
    - 6) Optimum mixing temperature.
    - 7) Optimum compaction temperature.
    - 8) Temperature-viscosity curve of asphalt cement to be used.
2. Test Report for Asphalt Cement:
  - a. Submit minimum 10 days prior to start of production.
  - b. Show appropriate test method(s) for each material and the test results.
3. Statement of qualification for independent testing laboratory.
4. Test Results:
  - a. Mix design.
  - b. Asphalt concrete core.
  - c. Gradation and asphalt content of uncompacted mix.

##### **1.2 QUALITY ASSURANCE**

###### A. Qualifications:

1. Independent Testing Laboratory: In accordance with ASTM E329.
2. Asphalt concrete mix formula shall be prepared by approved certified independent laboratory under the supervision of a certified asphalt technician.

##### **1.3 ENVIRONMENTAL REQUIREMENTS**

- A. Temperature: Do not apply asphalt materials or place asphalt mixes when ground temperature is lower than 10 degrees C (50 degrees F) or air temperature is lower than 4 degrees C (40 degrees F). Measure ground and air temperature in shaded areas away from heat sources or wet surfaces.
- B. Moisture: Do not apply asphalt materials or place asphalt mixes when application surface is wet.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Asphalt Material: Conform to the following specification:
  - 1. Asphalt Material shall be a hot mix asphalt concrete, consisting of a mixture of mineral aggregate and paving asphalt conforming to Section 92 of the Caltrans Standard Specifications, PG 64-10.
  - 2. Seal coat material shall be conforming to Section 37 of the Caltrans Standard Specifications.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Traffic Control:
  - 1. In accordance with all applicable specification sections and laws.
  - 2. Minimize inconvenience to traffic but keep vehicles off freshly treated or paved surfaces to avoid pickup and tracking of asphalt.
- B. Driveways: Repave driveways from which pavement was removed. Leave driveways in as good or better condition than before start of construction.

### **3.2 LINE AND GRADE**

- A. Provide and maintain intermediate control of line and grade, independent of underlying base, to meet finish surface grades and minimum thickness.
- B. Shoulders: Construct to line, grade, and cross-section shown.

### **3.3 PREPARATION**

- A. Prepare subgrade as specified.
- B. Thoroughly coat edges of contact surfaces with emulsified asphalt or asphalt cement prior to laying new pavement. Prevent staining of adjacent surfaces.

### **3.4 PAVEMENT APPLICATION**

- A. General: Place asphalt concrete mixture on approved, prepared base in conformance with this section.
- B. Pavement Mix:
  - 1. Prior to Paving:
    - a. Sweep primed surface free of dirt, dust, or other foreign matter.
    - b. Patch holes in primed surface with asphalt concrete pavement mix.
  - 2. Place asphalt concrete pavement mix in one single lift.
  - 3. Total Compacted Thickness: As shown on Drawings.
  - 4. Apply such that meet lines are straight and edges are vertical.
  - 5. Collect and dispose of segregated aggregate from raking process. Do not scatter material over finished surface.

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6. After placement of pavement, seal meet line by painting a minimum of 150 millimeters (6 inches) on each side of joint with cut-back or emulsified asphalt. Cover immediately with sand.
- C. Compaction: Roll until roller marks are eliminated and density of 92 percent of measured maximum density determined in accordance with ASTM D2041.
- D. Tolerances:
1. General: Conduct measurements for conformity with crown and grade immediately after initial compression. Correct variations immediately by removal or addition of materials and by continuous rolling.
  2. Completed Surface or Wearing Layer Smoothness:
    - a. Uniform texture, smooth, and uniform to crown and grade.
    - b. Maximum Deviation: 1/8 inch from lower edge of a 3.6-meter (12-foot) straightedge, measured continuously parallel and at right angle to centerline.
    - c. If surface of completed pavement deviates by more than twice specified tolerances, remove and replace wearing surface.
  3. Transverse Slope Maximum Deviation: 1/4 inch.
- E. Seal Coat:
1. General: Apply seal coat of paving grade or emulsified asphalt to finished surface at longitudinal and transverse joints, joints at abutting pavements, areas where asphalt concrete was placed by hand, patched surfaces, and other areas as directed by ENGINEER.
  2. Preparation:
    - a. Surfaces that are to be sealed shall be maintained free of holes, dry, and clean of dust and loose material.
    - b. Seal in dry weather and when temperature is above 2 degrees C (35 degrees F).
  3. Application:
    - a. Fill cracks over 1.5 millimeters (1/16 inch) in width with asphalt-sand slurry or approved crack sealer prior to sealing.
    - b. When sealing patched surfaces and joints with existing pavements, extend minimum 150 millimeters (6 inches) beyond edges of patches.

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## SECTION 02810

### IRRIGATION SYSTEM

#### **PART 1 - GENERAL**

##### **1.1 SCOPE OF WORK**

- A. Work includes all labor, material, equipment, appliances, fixtures and tests necessary for a new operating landscape irrigation system as indicated on the Drawings and as specified herein.
- B. Work included in this Section:
  - 1. Preparation
  - 2. Installation
  - 3. Temporary repairs
  - 4. Field quality control
  - 5. Irrigation system operation demonstration
  - 6. Cleanup
  - 7. Site observation before acceptance
- C. All irrigation system work shall be in accordance with City of Roseville Recycled Water System Construction Standards and all associated requirements.
- D. Irrigation system shall be for use with City of Roseville Recycled Water System, including all requirements of ON-SITE RECYCLED WATER FACILITIES per section 141-12 of City of Roseville Recycled Water System Construction Standards.

##### **1.2 SUBMITTALS**

- A. Provide System Irrigation Plan for review by ENGINEER.
  - a. Irrigation system quantities shown on the Drawings are for estimation only. Provide the actual materials and equipment quantities.
  - b. Shop drawing showing proposed irrigation system location and depths of proposed system components.
  - c. List of all proposed materials and equipment to be used indicated by description, manufacturer and model number, if applicable. Include catalog cuts where applicable (see Materials and Equipment submittal requirements this section).
  - d. Written documentation that the irrigation system materials and equipment listed on the Drawings is available and in compliance with requirements herein and City standards. Any substitutions required due to unavailability must be requested in writing before confirmation of ordering.
  - e. A schedule identifying system component procurement, storage, and anticipated delivery dates for review and approval.
- 2. In addition to ENGINEER review of plan in accordance Section 01330 Submittal Procedures, CONTRACTOR's plan will be reviewed City of Roseville Parks and Recreation Department.
  - a. CONTRACTOR shall submit, upon request by ENGINEER, an additional submittal addressing City of Roseville Parks and Recreation Department submittal review comments and format requirements.

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- B. Materials and Equipment: Submit the data on the following materials and equipment in accordance with Section 01330, Submittal Procedures.
1. Pipe and fittings
  2. Pipe solvent and primer
  3. Wire
  4. Wire connectors
  5. Valves
  6. Valve boxes
  7. Drip emitters
  8. Irrigation controllers

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Use only new materials of brands and types noted on the Drawings, specified herein, or equals as approved by the Engineer
- B. Pipe and Fittings
1. All exposed irrigation pipe shall be Steel Pipe:
    - a. Galvanized standard weight schedule 40 steel water pipe complying with ASTM A53 with threaded, galvanized standard weight malleable iron fittings and/or couplings.
  2. All buried irrigation pipe shall be PVC Pipe:
    - a. Pipe: Schedule 40 Polyvinyl Chloride (PVC). Type I, Grade I or Class 12454-B conforming to ASTM D1784 and ASTM D1785.
    - b. Fittings: Schedule to match pipe above, ASTM D2466 and ASTM D2467 for socket weld type and Schedule 80 ASTM D2464 for threaded type.
    - c. Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.
    - d. Solvent Cement: As recommended by the pipe and fitting manufacturer conforming to ASTM D2564.
- C. Valves and Valve Boxes
1. Shutoff valves: PVC ball valves:
    - a. Service: Water.
    - b. Features:
      - 1) Rated 150 psi at 73 degrees F
      - 2) ASTM D1784, Type I, Grade 1 polyvinyl chloride body, ball, and stem, end entry
      - 3) Double union design, solvent-weld socket ends
      - 4) EPDM or Teflon seat
      - 5) EPDM O-rings and stem seals
    - c. Manufacturers and Products:
      - 1) Nibco; Chemtrol Tru-Bloc.
      - 2) ASAHI/America; Duo-Bloc.
      - 3) Or Equal.
  2. Automatic control valves:
    - a. Electrically remote-control valves shall be Rain Bird PESB-D Series, or equal, size as noted on the Drawings. Valve shall include a pressure-regulating module.
    - b. Each valve for drip irrigation system shall also include a Rain Bird PRB-QKCHK-100 filter set immediately downstream of the control valve

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- c. Each electric remote control valve shall be provided with a PVC ball valve for manual flow adjustment
- 3. Valve Boxes
  - a. 12" x 17" x 12" deep rectangular box for electrical remote control valves as manufactured by Carson Products, Inc., Model 1419-12, with bolt-down cover, or approved equal.
- D. Sprinkler Heads and Drip Emitters
  - 1. Drip Emitters:
    - a. Rain Bird pressure-compensating modules, point-source emission devices, threaded inlet model PC-24, orange, 24 gph, or equal.
    - b. Set emitters on riser nipples
- E. Automatic irrigation controller
  - 1. The automatic controller shall be Irri-trol MC-4 4-station controller, or equal.
  - 2. Transformer input: 120 VAC, 60 Hz
  - 3. Transformer output: 24 VAC
  - 4. Enclosure:
    - a. Provide a vandal-resistant controller enclosure made of cold-rolled steel. Enclosure shall be Model No. SB-18CR, manufactured by V.I.T. Products, or equal.
    - b. Enclosure shall be painted with powder-coated finish, forest green color. Finish shall be applied by the enclosure manufacturer before delivery to the project site. Submit color sample for approval before ordering.
- F. Control Wiring
  - 1. Connections between the automatic controller and the electric control valves shall be made with direct burial copper wire, AWG-UF 600 volt.
  - 2. Control wire shall be a different color wire for each control valve. Common wire shall be white. Wire color shall be continuous over its entire length.
  - 3. Install wires in accordance with the valve manufacturer's specifications and wire charts.
  - 4. Wire size shall not be less than #14 gauge for control wires and no less than #12 gauge for common wire.
  - 5. Wire Splices shall be made with either Scotch-Lok #3576 "Connector Sealing Packs", Rain Bird "Snap Tite" wire connectors, or approved equal. Use one splice per connector sealing pack.
  - 6. Field wire splices between the automatic controller and the electrical control valves shall not be allowed without prior approval of Engineer.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Trenching
  - 1. Trenching shall be conducted in a manner that minimizes impacts on any retained vegetation.
  - 2. Excavate trenches straight and support pipe continuously on bottom of trench. Lay pipe to an even grade. Trenching excavation shall follow the layout as indicated on the Drawings.
  - 3. Cover: Provide the following minimum soil cover:
    - a. 18" for pressure supply lines
    - b. 12" for non-pressure lines

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- c. 18" for control wire
- d. 24" for sleeve pipe and conduit

B. Backfilling

- 1. Backfill material and compaction requirements shall conform to the requirements of Section 02300 and the pipe trench standard detail.

C. Irrigation Assemblies

- 1. Routine of irrigation lines as indicated on the Drawings is diagrammatic only. Install lines and various assemblies in such a manner as to conform to the Drawings.
- 2. At no time shall multiple assemblies be installed in plastic lines. Provide each assembly with its own outlet.
- 3. PVC pipe and fittings shall be thoroughly cleaned of dirt, dust and moisture before installation. Installation and solvent welding methods shall be as recommended by the pipe and fitting manufacturer.
- 4. On PVC to metal pipe connections, work the metal connections first. Teflon tape or approved equal shall be used on all threaded PVC to PVC and threaded PVC to metal joints. Apply a light wrench pressure only. Where threaded PVC connections are required, use threaded PVC adapters into which the pipe may be solvent welded.

D. Control Wire Installation

- 1. Wiring shall occupy the same trench and shall be installed along the same route as pressure supply or lateral lines, wherever possible.
- 2. Wiring shall be set at a minimum 6" distance from pipes.
- 3. Where more than one wire is placed in a trench, the wires shall be taped together at intervals of 10 feet.
- 4. An expansion curl shall be provided within 3 feet of each wire connection. Expansion curl shall be of sufficient length at each splice connection at each electric control valve so that in case of repair the valve bonnet may be brought to the surface without disconnecting the control wires. Control wires shall be laid loosely in the trench without stress or stretching control wire conductors.
- 5. When control wiring is trenched separately from main-line trenches, continuous warning tape shall be installed with the wiring.

E. Drip Irrigation

- 1. Install drip irrigation systems to adequately water the plant materials at locations shown on the Drawings and as prescribed herein.
- 2. The major portions of the irrigation system shall be installed before the installation of any plants. Irrigation of all plants shall begin the same day as plant installation and shall meet the requirements of this section.
- 3. All irrigation installation operations must be conducted in coordination with plant location field marking and planting hole excavation. Plant locations must be field marked and approved, and planting holes must be excavated before installation of individual drip emitters.
- 4. PVC piping and fittings shall connect drip nozzles to lateral line pipe. Provide the required couplings and fittings for emitter to pipe connections. All PVC lateral line piping shall be set below grade. At no time shall flexible tubing be used.
- 5. After its pipe installation is complete, each drip system shall first be flushed for 30 minutes minimum, to ensure that debris, rocks and dirt are removed. Ensure that all sites are being irrigated and that flow is continuous. The drip systems shall be capped while the system is still operating to ensure that no debris, rocks, or dirt enter the pipes. The drip systems shall then have the emitters installed.

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6. Drip emitters shall be set on grade at plant locations. Before installation, stake and mark the locations of the drip risers for approval by the Engineer. For all container plants, drip emitters shall be set within the planting basin. Provide 2 drip emitters per plant, offset 180-degrees.
7. Emitters shall be connected to the PVC piping at the individual planting locations. Emitters shall be installed while the system is operating to ensure that no debris enters the lines. The emitters shall be placed adjacent to the root crown after plant installation. After all the emitters have been installed on each run, that line shall be rechecked under pressure for leaks around the emitter or emitter coupler. Any leaks shall be repaired to ensure a fully-operational system.

F. Controller

1. Controller location shall be as shown on the Drawings.
2. The controller shall be installed according to the manufacturer's specifications inside the vandal-proof controller enclosure.
3. Connect all control wires from the valves
4. All wires required above ground shall be placed in metal conduits painted flat black.

### 3.2 TESTING

- A. Test pressure piping under hydrostatic pressure of 150 psi for a period of 2 hours. Testing of pressure pipe shall occur before installation of any electric control valves. Allowable leakage is specified in Section 15990.

### 3.3 IRRIGATION SYSTEM OPERATION DEMONSTRATION

- A. The entire irrigation system shall be under complete and automatic operation for a period of 7 days before beginning of planting.
- B. Operation will be witnessed by Engineer.

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## **SECTION 02830**

### **CHAIN LINK FENCES AND GATES**

#### **PART 1 - GENERAL**

##### **1.1 SUBMITTALS**

- A. Shop Drawings: Detailed information and specifications for materials, finishes, and dimensions.
- B. Samples: Approximately 6 inches square, or 6 inches long of posts, rails, braces, fabric, wire, ties, and fittings.
- C. Quality Control Submittals:
  - 1. Manufacturer's recommended installation instructions.
  - 2. Evidence of Supplier and installer qualifications.

##### **1.2 SCHEDULING AND SEQUENCING**

- A. Complete necessary site preparation and grading before installing chain link fence and gates.

#### **PART 2 - PRODUCTS**

##### **2.1 GENERAL**

- A. Match style, finish, and color of each fence component with that of other fence components.

##### **2.2 CHAIN LINK FENCE FABRIC**

- A. PVC-coated galvanized fabric conforming to ASTM F668, Class 1 or 29.
  - 1. Color: Black.
  - 2. Manufacturers and Products:
    - a. Colorbond Corp., Raritan, NJ; Colorbond II.
    - b. Cyclone Fence, United States Steel, Chicago, IL; Cyclone Color Fence System.
- B. Height: 72 inches, unless otherwise shown.
- C. Wire Gauge: No. 9.
- D. Pattern: 2-inch diamond-mesh.
- E. Diamond Count: Manufacturer's standard and consistent for fabric furnished of same height.
- F. Loops of Knuckled Selvages: Closed or nearly closed with space not exceeding diameter of wire.
- G. Wires of Twisted Selvages:

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1. Twisted in a closed helix three full turns.
2. Cut at an angle to provide sharp barbs that extend minimum 1/4-inch beyond twist.

H. Privacy Slats:

1. HDPE or PVC Top Lock slats sized for No. 9 gauge 2-inch mesh, approximately 1 3/32-inches wide.
2. Length to match the fabric height minus 2 inches.
3. Color selected by OWNER.

## 2.3 POSTS

A. General:

1. Strength and Stiffness Requirements: ASTM F669, Heavy Industrial Fence, except as modified in this section.
2. Steel Pipe: ASTM F1083.
3. Roll-Formed Steel Shapes: Roll-formed from ASTM A570, Grade 45, steel.
4. Protective Coatings:
  - a. Zinc Coating: ASTM F1234, Type A external and internal coating.
5. Color Coating: ASTM F1043, minimum 10 mils thickness over zinc coating to match color of chain link fabric.

B. Line Posts:

1. Steel Pipe:
  - a. Outside Diameter: 2.375-inch.
  - b. Weight: 3.65 pounds per foot.
2. Roll-Formed Steel C Shape:
  - a. Outside Dimensions: 2.25-inch by 1.625-inch.
  - b. Weight: 2.70 pounds per foot.
3. Steel H-Section:
  - a. Outside Dimensions: 2.25-inch by 1.70-inch.
  - b. Weight: 3.26 pounds per foot.

C. End, Corner, Angle, and Pull Posts:

1. Steel Pipe:
  - a. Outside Diameter: 2.875-inch.
  - b. Weight: 5.79 pounds per foot.

D. Posts for Removable Fence Panels: As specified for end, corner, angle, and pull posts.

E. Posts for Swing Gates:

1. Material: ASTM F1043 Group IA ASTM F1083 schedule 40 pipe.
2. Gate Post Size per ASTM F900:

<b>For gate fabric height up to and including 6 feet</b>	
Gate Leaf Width	Post Outside Diameter
Up to 4 ft	2.375-inch
Over 4 ft to 10 ft	2.875-inch
Over 10 ft to 18 ft	4.0-inch
<b>For gate fabric height over 6 feet to 12 feet</b>	
Up to 6 ft	2.875-inch
Over 6 ft to 12 ft	4.0-inch
Over 12 ft to 18 ft	6.625-inch
Over 18 ft to 24 ft	8.625-inch

- a. Roll-formed steel shapes may be substituted for steel pipe posts for gate leaf widths up to 6 feet and fabric heights up to 8 feet.
  - 1) Outside Dimensions: 3.5-inch by 3.5-inch.
  - 2) Weight: 4.85 pounds per foot.

#### 2.4 TOP RAILS AND BRACE RAILS

- A. Galvanized steel pipe or roll-formed steel C shapes, color-coated.
- B. Protective Coatings: As specified for posts.
- C. Color Coating: ASTM F1043, minimum 10 mils thickness over zinc coating to match color of chain link fabric.
- D. Strength and Stiffness Requirements: ASTM F669, Top Rail, Heavy or Light Industrial Fence.
- E. Steel Pipe:
  - 1. ASTM F1083.
  - 2. Outside Diameter: 1.66-inch.
  - 3. Weight: 2.27 pounds per foot.
- F. Roll-Formed Steel C Shapes:
  - 1. Roll formed from ASTM A570, Grade 45.
  - 2. Outside Dimensions: 1.625-inch by 1.25-inch.
  - 3. Weight: 1.40 pounds per foot.

#### 2.5 FENCE FITTINGS

- A. General: In conformance with ASTM F626, except as modified by this article.
- B. Post and Line Caps: Designed to accommodate passage of top rail through cap, where top rail required.
- C. Tension and Brace Bands: No exceptions to ASTM F626.
- D. Tension Bars:
  - 1. One-piece.
  - 2. Equal in length to full height of fabric.
- E. Truss Rod Assembly: 3/8-inch diameter.
- F. Barb Arms: 45-degree arms for supporting three strands of barbed wire.

#### 2.6 TENSION WIRE

- A. Zinc-coated steel marcelled tension wire conforming to ASTM A824, Type II, Class 2.

#### 2.7 GATES

- A. General:
  - 1. Gate Operation: Opened and closed easily by one person.

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2. Welded Steel Joints: Paint with zinc-based paint.
  3. Chain Link Fabric: Attached securely to gate frame at intervals not exceeding 15 inches.
- B. Swing Gates: ASTM F900.
1. Hinges:
    - a. Furnished with large bearing surfaces for clamping in position.
    - b. Designed to swing either 180 degrees outward, 180 degrees inward, or 90 degrees in or out, as shown, and not twist or turn under action of gate.
  2. Latches: Plunger bar arranged to engage stop, except single gates of openings less than 10 feet wide may each have forked latch.
  3. Gate Stops: Mushroom type or flush plate with anchors, suitable for setting in concrete.
  4. Locking Device and Padlock Eyes: Integral part of latch, requiring one padlock for locking both gate leaves of double gates.
  5. Hold-Open Keepers: Designed to automatically engage gate leaf and hold it in open position until manually released.
- C. Fabric Salvage: Knuckled.
- D. Appurtenances and Framework: As specified.

## 2.8 REMOVABLE FENCE PANELS

- A. Panel Length:
1. Equal division of total length of removable fence section.
  2. Maximum 10 feet.
- B. Frames: ASTM F1184, Type I.

## 2.9 CONCRETE

- A. Provide as specified in Section 03300, CAST-IN-PLACE CONCRETE.

# **PART 3 - EXECUTION**

## 3.1 GENERAL

- A. Install chain link fences and gates in accordance with ASTM F567, except as modified in this section, and in accordance with fence manufacturer's recommendations, as approved by ENGINEER. Erect fencing in straight lines between angle points.
- B. Provide all necessary hardware for a complete fence and gate installation.

## 3.2 PREPARATION

- A. Establish locations of fence lines, gates, and terminal posts.

## 3.3 POST SETTING

- A. Driven posts are not acceptable.

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- B. Post Hole Depth:
  - 1. Minimum 3 feet below finished grade.
  - 2. 2 inches deeper than post embedment depth below finish grade.
- C. Backfill post holes with concrete to 2 inches above finished grade.
- D. Before concrete sets, crown and finish top of concrete to readily shed water.

#### 3.4 BRACING

- A. Brace gate and corner posts diagonally to adjacent line posts to ensure stability.

#### 3.5 TOP RAILS

- A. Install top rail sleeves with springs at 105 feet maximum spacing to permit expansion in rail.

#### 3.6 CHAIN LINK FABRIC

- A. Do not install fabric until concrete has cured minimum 7 days.
- B. Install fabric with twisted and barbed selvage at top.

#### 3.7 GATES

- A. Hang gates and adjust hardware so gates operate satisfactorily from open or closed position.
- B. Set gate stops in concrete to engage center drop rod or plunger bar.

#### 3.8 ELECTRICAL GROUNDING

- A. Ground fences in accordance with applicable requirements of IEEE C2, National Electrical Safety Code.

#### 3.9 FIELD QUALITY CONTROL

- A. Gate Tests: Prior to acceptance of installed gates and gate operator systems, demonstrate proper operation of gates under each possible open and close condition specified.

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## **SECTION 02850**

### **FABRICATED STEEL GATES AND OPERATORS**

#### **PART 1 - GENERAL**

##### **1.1 SUBMITTALS**

- A. Shop Drawings: Detailed drawings, information and specifications for materials, finishes, and dimensions.
- B. Quality Control Submittals:
  - 1. Manufacturer's recommended installation instructions.
  - 2. Evidence of Supplier and installer qualifications.

##### **1.2 SCHEDULING AND SEQUENCING**

- A. Complete necessary site preparation and grading before installing fabricated steel gates and operators.

#### **PART 2 - PRODUCTS**

##### **2.1 FABRICATED STEEL GATES**

- A. Fabricate steel access gates and person gates as shown on the Drawings.
- B. Shop fabricate steel gates and deliver to site completely finished and painted.
  - 1. Clean all weld residue and grind welds smooth prior to painting.
  - 2. Paint with System 300, as described in Section 09900 PAINTING.
- C. Steel Frame: Provide steel fabricated in accordance with Section 05500 MISCELLANEOUS METALS.
- D. Metal Panel:
  - 1. Galvanized steel sheet meeting ASTM A653, G-60. Provide profile and thickness shown on the Drawings.

##### **2.2 FABRICATED STEEL GATE OPERATORS**

- A. Provide gate operators as shown on the Drawings, suitable for operation of the gates, as shown on the drawings.
- B. Features:
  - 1. Motor: 1 HP, 460 volt, three phase, 60 Hz. Provide size "O" contactor type magnetic starter, reversing, prewired with overcurrent and overload protection.
  - 2. Speed Reduction: Heavy duty sprockets, belt and drive chain, permanently lubricated.
  - 3. Housing: Heavy gage, weather-resistant, lockable, galvanized steel, NEMA 3R enclosure.
  - 4. Drive Chain: No. 50 minimum. Provide all mounting hardware required to connect to gate.

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5. Safety Clutch: Adjustable friction type, designed to slip if gate meets obstruction.
6. Magnetic Brake: Solenoid activated disc type, designed to reduce gate coasting.
7. Emergency Operation: Manual no tool disconnect in case of power failure.
8. Limit Switches: Adjustable rotary type, full-open and full-closed limit switches.
9. Audible Warning: Provide audible warning signal during gate operation, suitable for outdoor installation.
10. Capable of operating 1200 pound gate.

C. Controls:

1. All controls shall be suitable for operation of a 120 volt, single phase, 60 hertz power supply. Provide a fused 480/120 volt transformer, 125 percent sized, to provide power to all controls and devices. Provide all controls, transformers, relays and other equipment as necessary for a complete and functional system installed in a NEMA 3R enclosure.
2. Gate operators shall be controlled as follows:
  - a. Local Operation Station: Provide key-operated local operation station, mounted on wall outside of gate location.
  - b. Time Delay System: Close on entry after set time delay.
  - c. Magnetic Vehicle Detectors: Automatic open on vehicle exit.
3. Manufacturer of the automatic gate operators and controls shall provide a "total system" with all accessories required to operate according to the following:
  - a. Magnetic "loop" vehicle ejector shall prevent premature gate closure. The vehicle detection system shall hold the gate in an open position until the vehicle clears the gate area. When the vehicle clears the gate area, the gate operator shall automatically close the gate, after a pre-set period, adjustable from 3 to 90 seconds. Should the gate be closing as a vehicle reaches the gate area, the gate shall automatically reverse to the open position and the timer shall reset for a full time cycle.
  - b. Provide maximum run timer to limit time of operation in any one direction to a maximum of 90 seconds and to delay reversal of gate 1.5 seconds when signaled from magnetic vehicle detection system.

D. Product and Manufacturer:

1. Model 570 for cantilever sliding gate, with all accessories and controls required to provide operation described herein by Stanley Vemco Division of the Stanley Works.
2. Model LSG for cantilever sliding gate, with all accessories and controls required to provide operation described herein by Robot Industries, Incorporated.
3. Or equal.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install all gates level, plumb and in-line for smooth operation.
- B. Install gate operators to provide smooth operation of gate, as described above.
- C. Provide all miscellaneous fittings and accessories required for a complete installation of all gates.
- D. Provide padlock hasps for all gates, attached to adjacent fencing to provide for a secure gate system utilizing OWNER's padlocks.

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- E. Touch up all damaged paint after installation.

### 3.2 FIELD QUALITY CONTROL

- A. Gate Tests: Prior to acceptance of installed gates and gate operator systems, demonstrate proper operation of gates under each possible open and close condition specified.

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## SECTION 02900

### LANDSCAPE PLANTING

#### **PART 1 - GENERAL**

##### **1.1 SCOPE OF WORK**

- A. Furnish all materials, labor, transportation, services, and equipment necessary to install landscape planting as shown on the Drawings and as specified herein. Any and all permits, fees, bonds, and observations necessary to perform and complete portion of the work shall be included.
- B. Work included in this Section:
  - 1. Verification of Existing Conditions
  - 2. Surface Drainage of Planting Areas
  - 3. Preparation
  - 4. Plant Installation
  - 5. Watering
  - 6. Cleanup
  - 7. Site Observation Before Acceptance
  - 8. Site Observation Schedule

##### **1.2 REQUIREMENTS OF REGULATORY AGENCIES**

- A. All Federal, State, and local laws and regulations governing this work are hereby incorporated into and made part of this Section. When this Section calls for certain materials, workmanship or a level of construction that exceeds the level of Federal, State, or local requirements, the provisions of this Section shall take precedence.

##### **1.3 REFERENCE STANDARDS**

- A. All plant material shall be true to botanical and common name as indicated in:
  - 1. McClintock, E. M., and A. T. Leiser. 1979. *An Annotated Checklist of Woody Ornamental Plants of California, Oregon, and Washington*. University of California, Division of Agricultural Sciences. Berkeley, CA.
  - 2. American Nursery & Landscape Association. 2004. *American Standard for Nursery Stock*. ANSI Z60.1-2004. Washington, DC.
  - 3. L. H. Bailey Hortorium of Cornell University. 1976. *Hortus Third: A Concise Dictionary of Plants Cultivated in the United State and Canada*. Macmillan. New York, NY.
  - 4. Hickman, J.C. (ed.). 1993. *The Jepson Manual: Higher Plants of California*. University of California Press. Berkeley, CA.
  - 5. U.S. Natural Resources Conservation Service. 2011. Plants Database. Available: <<http://plants.usda.gov>>. Last updated May 16, 2011.
- B. All plant material shall conform to the California State Department of Agriculture's regulations for nursery observations, rules and ratings.
  - 1. Quality Control
- C. Manufacturer's directions and drawings shall be followed in all cases where the manufacturers of articles used in this Specification furnish directions covering points not shown in the Drawings and Specifications.

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- D. Upon execution of the order, the Engineer has the option of either inspecting the plant material at the nursery, requesting representative color photos or inspecting the material as it is being delivered to the site for conformity to the Drawings and Specifications.
  - 1. Such approvals shall not impair the right of additional observations during further progress of the Work.
- E. Any tagging of plant material by the Engineer does not constitute his/her approval of the plant materials' health and vigor. The health and vigor of the plant material is the sole responsibility of the Contractor.
- F. The Engineer reserves the right to refuse observation, if in his judgment; a sufficient quantity of plant material is not available for observation at that time.
- G. All planting shall be for use with City of Roseville Recycled Water System as irrigation water source.

#### 1.4 QUALIFICATIONS

- A. The nursery that supplied planting materials shall be a reputable nursery.

#### 1.5 SUBMITTALS

- A. Provide Planting Plan for review by ENGINEER.
  - 1. Submittal shall include at minimum the following:
    - a. List of all proposed materials and equipment to be used indicated by description, manufacturer and model number, if applicable. Include catalog cuts where applicable.
    - b. A copy of the plant procurement order from the nursery including the name, address, and phone number of said nursery.
    - c. Plant quantity list.
    - d. Plant quantities shown on the Drawings are for estimation only. Provide the actual planting quantities.
    - e. List all plants indicated by botanical name, common name, quantity, size, nursery and location and any specific remarks, (e.g., "unable to locate," "photo submitted," etc.).
    - f. Written documentation that the plant material listed on the Drawings is available. Any substitutions required due to unavailability must be requested in writing before confirmation of ordering.
    - g. A schedule identifying plant procurement, storage, and anticipated delivery dates for review and approval.
    - h. Compliance with State of California and federal quarantine restrictions.
  - 2. In addition to ENGINEER review of plan in accordance Section 01330 Submittal Procedures, CONTRACTOR's plan will be reviewed City of Roseville Parks and Recreation Department.
  - 3. CONTRACTOR shall submit, upon request by ENGINEER, an additional submittal addressing City of Roseville Parks and Recreation Department submittal review comments and format requirements.

## 1.6 PROJECT CONDITIONS

- A. Perform planting operations only when weather and soil conditions are suitable in accordance with locally accepted practice.

## 1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery
  - 1. Deliver all planting materials with legible and durable identification labels.
  - 2. Deliver fertilizer to the site in original, unopened containers bearing the manufacturer's name, guaranteed chemical analysis, and its conformance to California State Law.
  - 3. Notify the Engineer within 7 days of the delivery of plant materials to the site. Indicate the quantity and type of plant materials in each delivery.
- B. Storage
  - 1. Store planting materials in the shade and protect from the weather.
  - 2. Maintain and protect plants not planted within 4 hours of delivery.
- C. Protection
  - 1. Protect plants during delivery to the site and after, in order to prevent damage to the root balls or desiccation of leaves.
- D. Handling
  - 1. Take extreme care in the loading and unloading of plants. Do not lift or move container plants by their stems or trunks.
  - 2. Any plant materials that are damaged due to mishandling shall be removed and replaced with new material at no additional cost.

## 1.8 REJECTION OF PLANT MATERIAL

- A. All plant material not conforming to the requirements herein shall be considered defective.
  - 1. The Engineer shall mark such plants, whether in place or not, as rejected and the materials shall be immediately removed from the site and replaced with new material at no additional cost.
  - 2. Replacement plant material shall be of the same size, species and condition as that indicated on the Drawings.

## 1.9 PROTECTION OF THE SITE

- A. Protect previously installed work and materials which may be affected by work of this Section. Provide safeguards and exercise caution against injury or defacement of existing site improvements.
- B. Repair damage and return the areas to the previous condition at no additional cost.

## 1.10 COORDINATION

- A. Coordinate operations with other contractors on or adjacent to the project site.

- B. Exercise extreme care in excavating and working near existing utilities. Repair any damages to these utilities at no additional cost. Check existing utility drawings for existing utility locations.
- C. Coordinate installation of all planting materials to avoid interference with utilities, other construction elements, and any existing vegetation.

#### **1.11 GUARANTEE**

- A. The manufacturer's warranty shall not relieve the Contractor of its own liability under the guarantee. Such warranties shall only supplement the guarantee.
- B. All plant material installed under this Contract shall be guaranteed against poor, inadequate and inferior quality and installation for a period of 1 year from the date of Final Acceptance.
  - 1. Any plant material not meeting the satisfaction of the Engineer as per the performance standards in Section 02970, Landscape Maintenance, shall immediately be removed and replaced at no cost to the Owner.
  - 2. Replaced plant material shall also be guaranteed for a period of 1 year upon installation.
- C. Replace without cost to the Owner and as soon as weather permits, all dead plants and all plants not found in a vigorous, thriving condition, as determined by the Engineer during and at the end of the plant warranty period.
  - 1. Replacement of plants shall closely match adjacent specimens of the same species and shall be subject to all requirements of this section.
- D. Repair damage to adjacent plant material at no cost to the Owner. All repairs shall be made with materials, varieties and sizes "in kind" with adjacent existing materials.

### **PART 2 - PRODUCTS**

#### **2.1 GENERAL**

- A. Procure all plant materials and incidentals required for this project.
- B. All plant material delivered to the site shall have a normal habit of growth and be well formed and shaped, healthy, vigorous, and free of any insects, diseases, sunscalds, windburn, abrasions of the bark, or other objectionable disfigurements.
- C. The size of the plant material shall correspond with that normally expected for species and variety of commercially available nursery stock or as specified on the Drawings.
- D. Plant material shall be grown under climatic conditions similar to those in the locality of the project unless approved otherwise by the Engineer.
- E. Plant material larger than that specified on the Drawings may be used pending approval from the Engineer. However, there will be no change in the Contract amount if the larger plant material is approved and used.

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## 2.2 MATERIALS

- A. Planting soil and backfill for all planting pits shall be existing topsoil.
- B. Trees and Shrubs
  - 1. Tree and shrub trunks shall be sturdy and well hardened with vigorous and fibrous root systems which are not root-bound.
  - 2. In the event of a disagreement as to the condition of the root system, the root conditions of the plants will be determined by the removal of soil around the roots of not less than 10 plants or more than 2 percent of the total number of plants of each species.
  - 3. When container-grown plants are supplied from several sources, the roots of not less than 10 plants of each species from each source will be observed.
    - a. In case the plants sampled are found to be defective, the Engineer has the right to reject the entire lot represented by the defective sample.
    - b. Any plant material rendered unsuitable for use because of this observation will be considered as samples and will be provided at no additional cost.
- C. Container-Grown Stock
  - 1. Container-grown stock shall be in a vigorous and healthy condition and not root bound or with the root system hardened off.
    - a. Container-grown stock shall be grown under climatic conditions similar to that found in the locality of the site.
- D. Ground Cover Stock
  - 1. Ground cover stock shall be well-established in removable containers or come from formed homogenous soil sections.
  - 2. Ground cover stock shall be grown under climatic conditions similar to that found in the locality of the site.
- E. Fertilizers
  - 1. Planting Tablets (20-10-5), shall be 21-gram, 24-month release, non-burning tablets containing the following percentages of nutrients by weight:

20 percent	Nitrogen
10 percent	Phosphoric Acid
5 percent	Potash
10 percent	Humus
2 percent	Humic Acids
  - 2. Acceptable product – “Gro-Power Planting Tablets,” as manufactured by Gro-Power (800/473-1307), or approved equal.

## 2.3 TREE SUPPLIER

- A. Trees shall be provided from a local nursery.
  - 1. Green Acres
  - 2. Mallard Creek
  - 3. Or approved equal

## **PART 3 - EXECUTION**

### **3.1 VERIFICATION OF EXISTING CONDITIONS**

- A. Before performing the work in this Section, examine previously installed work from other trades and verify that such work is complete and as required to the point where this installation may begin properly.
- B. Remove all rocks, stones, sticks and debris larger than 1-inch in diameter from the surface of the planting areas.
- C. Obtain approval of fine grading by the Engineer before starting planting operations.

### **3.2 SURFACE DRAINAGE OF PLANTING AREAS**

- A. Ensure proper drainage of all planting areas. Any discrepancy in the Drawings or Specifications, obstructions on the site, or prior work done by another contractor, which could preclude the establishment of proper drainage, shall be brought to the immediate attention of the Engineer for correction or relief of said responsibility.

### **3.3 PREPARATION**

- A. Planting Layout
  - 1. Verify with the Owner's site superintendent and local governing agencies the location and depth of all underground utilities.
  - 2. If any underground construction or utility lines are encountered in the excavation of planting holes, alternative planting locations may be selected by the Engineer.
  - 3. Locations for all shrubs and trees shall be marked on the ground either by flagged grade stakes indicating plant type and size or the actual plants themselves for the Engineer's review and approval before planting. Trees and shrubs will be located according to the layout shown on the Drawings.
  - 4. Groundcover plant locations shall be in straight rows, evenly, triangular spaced, and at the on-center spacing indicated on the Drawings.
- B. General Planting Guidelines
  - 1. Plant only as many plants as can be planted and watered on that same day within a given planting area.
  - 2. Protect the planting area from excessive vehicle compaction.
  - 3. Face plant material with fullest growth into the prevailing wind and/or the primary direction of view.
- C. Container Removal
  - 1. Plant container shall be opened and removed in such a manner that the soil surrounding the rootball shall not be broken.
  - 2. Do not injure the root ball while removing the container. After removing plant, superficially cut edge roots with a knife on 3 sides.

### **3.4 PLANT INSTALLATION**

- A. Excavate planting pit 12 inches below the bottom of the rootball and to a diameter of twice the diameter of the rootball. Planting pits shall have vertical sides and roughened surfaces.

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- B. Before planting, place the required amount of planting tablets per plant size on top of each root ball while the plants are still in their containers so that the Engineer can easily verify their existence and quantity.
- C. After obtaining approval by the Engineer on plant tablet quantity and after water has completely drained from the planting pit, add plant tables to the planting pits in the following quantities:

1-gallon	1 tablet
5-gallon	3 tablets
15-gallon	5 tablets
24-inch box	5 tablets

Place the specified amount of plant tablets between the bottom of the rootball but not higher than 1/3 of the way up the rootball. Space the plant tablets equally around the perimeter of the rootball approximately 2 inches from the rootball.

- D. Center plant material in the planting pit.
- E. Apply backfill mix to the planting pit up to ½ the height of the rootball. Add water to the top of the remaining planting pit and let soak in before completing remainder of backfilling. Finish backfilling with planting soil of the planting pit by tamping the soil firmly around the rootball and watering thoroughly.
- F. Each rooted ground cover plant shall be planted with its proportional amount of soil.
- G. Water Retention Basins
  - 1. After final backfilling, construct a water retention basin around the base of each tree and shrub planting (only) to a 30-inch diameter with backfill mix sufficient to hold 3-inches of water. Water retention basins are not required for groundcover plantings.
- H. Wood Mulch Topdressing
  - 1. Spread a 2-inch deep layer of wood mulch in all tree, shrub, and ground cover planting pits, not including seeding areas.
- I. Plant Settling
  - 1. Any plant material that has settled deeper than the surrounding grade shall be raised to the correct level.

### 3.5 WATERING

- A. All planting and seeding areas shall be watered immediately after installation. After the first watering, water shall be applied to all plants and seeded areas as conditions may require keeping the vegetation in a healthy and vigorous growing condition until the completion of the Contract.

### 3.6 CLEANUP

- A. Remove all trash caused from the work on a weekly basis throughout the duration of the Project.

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- B. Upon completion of work under this Section, remove all rubbish, waste and debris to an off-site location or as directed by the Engineer.
- C. Repair all scars, ruts or other marks in the ground caused by the work.

Remove all equipment and implements of service, and leave the entire work area in a neat and clean condition as accepted by the Engineer. All sidewalks and other paving areas shall receive a broom-clean treatment.

### 3.7 SITE OBSERVATION BEFORE ACCEPTANCE

- A. Corrective actions shall be in strict conformance with the Drawings and these Specifications and according to the Engineer, and shall be completed at the Contractor's expense.
- B. The Engineer will perform progress observations of the work and construction operations on completion of construction stages. The Engineer, the Contractor, and others designated by the Owner shall be agreed upon the construction stages for this Specification before starting work and be present on mutually agreed-on dates for the observations for each stage.
- C. If, after an observation, the Engineer is satisfied with the construction to date and its conformance to the Drawings and Specifications, the Engineer will grant written notice of provisional acceptance for that construction stage.
- D. If, after an observation, the Engineer is dissatisfied with the construction to date and its conformance to the Drawings and the Specifications, the Engineer will prepare a written punch list of necessary corrective action on defective work for the construction stage. All corrections must be completed and will be reobserved by the Engineer within 10 working days from the date of the initial observation.
- E. Project observations shall not occur until all punch list items from previous observations shall not occur until all punch list items from previous observations are corrected. Failure to correct problems in the time specified by the Engineer may result in a delay of payment for the said tasks until the items in question are remedied per the engineer's direction.
- F. The Contractor shall be charged for any additional construction observations and punch lists required from the Engineer for unscheduled and necessary reobservation of the work due to unsatisfactorily or incompletely addressing previous punch lists.

### 3.8 SITE OBSERVATION SCHEDULE

- A. Provide the Engineer with 48 hours of advance notification, except as otherwise noted, for required stage acceptance observations including, but not limited to, the following:
  - 1. Plant materials at nursery(s) before delivery to project site.
  - 2. Plant materials after delivery to project site and before planting.
  - 3. Plant locations layout before planting pit excavation.
  - 4. Planting operations, one complete installation of each plant size before installation of remaining plants.
  - 5. Progress container planting operations.
  - 6. Completed container planting operations.
  - 7. Progress seeding operations.

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8. Completed seedling operations.
9. Substantial Completion Observation: Final installation observation before the start of the Landscape Maintenance Period (provide 10 working days of advance written notice).

+ + END OF SECTION + +

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## SECTION 02936

### HYDROSEEDING

#### **PART 1 - GENERAL**

##### **1.1 DESCRIPTION**

- A. This specification includes hydroseeding areas indicated and maintaining seeded areas until acceptance of the Work.

#### **PART 2 - PRODUCTS**

##### **2.1 MATERIALS**

- A. Topsoil: Furnish from the project site, Topsoil shall be reasonably free from subsoil, refuse, heavy or stiff clay, stones larger than one inch in size and other deleterious substances. Break all lumps and clods before the soil is spread.
- B. Erosion control slurry: A hydromulch type consisting of the following ingredients per acre:

Water	3,000 gal.
Fertilizer	320 lbs.
Seed	50 lbs.
Fiber	1,500 lbs.
Stabilizer	100 lbs.

- C. Commercial fertilizers: Conform to the requirements of the California Food and Agricultural Codes uniform in composition with the guaranteed chemical analysis of 16-20-0. Soluble potash shall be a form that will rapidly dispense in the slurry; Sentinel by Albright and Towne; or equal.
- D. Seed:
1. Seed: Latest crop, tagged and labeled in sealed containers in accordance with California Food and Agricultural Code. Pure live seed content shall exceed 90 percent for each variety specified and less than 0.5 percent weed seed. The seed mix shall consist of the following quantities and types per acre:

<u>Seed Name</u>	<u>Lbs./Acre</u>
Blando brome grass	30
Palestine orchard	6
Zorro annual foxtail	2
Rose clover	34
Alfalfa	10

- E. Fiber mulch: Green colored, fibrous, wood cellulose mulch containing no growth or germination inhibiting factors. Mulch shall, after addition and agitation in slurry tanks with fertilizer, seed, water, and other approved additives, uniformly suspend fibers to form a homogeneous slurry; and when hydraulically sprayed on the ground, the material will form a blotter-like ground cover impregnated uniformly with seed. After

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application, mulch shall allow the absorption of moisture and allow the rainfall to percolate to underlying soil.

1. Cellulose: Certified to indicate laboratory and field testing has been accomplished and that it meets all foregoing requirements. Weight specifications from suppliers and for application shall be the air dry weight of the fiber material.
  2. Absolute air dry weight is based on the normal standards of the Technical Association of the Pulp and Paper Industry for wood cellulose and is considered equivalent to 10 percent moisture. Each package of the cellulose fiber shall be marked by the manufacturer to show the air dry weight content.
- F. Stabilizing agent: A mixture of 100 percent organic, water soluble alginic acids derived from cold-water keeps.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION AND APPLICATION**

- A. Restore all areas damaged by erosion, construction activities, or other causes before beginning hydroseeding activities. Restoration shall include filling depressions and gullies, establishing level grades and slopes, and compacting soils to prevent wind erosion. Only native fill shall be used for restoration.
- B. Place and spread native fill a minimum depth of three inches over the areas shown to be hydroseeded, except that sloped areas greater than 1 horizontal to 2 vertical shall not receive this native fill.
- C. The equipment for application of erosion control slurry shall have a minimum tank capacity of 500 gallons, a built-in agitation system of sufficient operating capacity to produce an homogeneous slurry, and a discharge system with a set of spray nozzles which will deliver slurry to the areas to be seeded in a continuous and uniform rate, without misses, waste or erosion. Slurry distribution lines shall be large enough to prevent stoppage and the equipment shall be capable of being propelled.
- D. Prepare slurry at the Project site. Fill the tank with water to the quarter mark and agitate well before adding seed and fertilizer. Agitate slurry during mixing period to assure fast, homogeneous mixing, but seed shall not be added more than twenty minutes before spraying. Continue agitation at one-half optimum rpm until all material is dispersed.
- E. Using the green color of the mulch as a guide, apply slurry in sweeping motions in an arched stream so as to fall like rain. Allow materials to build on each other until a good coat is achieved and slurry is spread at the required rate per acre. In areas difficult to reach, apply in a more controlled manner.
- F. Should slurry cover any object not to be covered, wash with clear water immediately. Apply slurry as soon as practicable on cut slopes; apply to filled and graded areas as directed by the Engineer. Slurry shall not be applied during rain or high wind conditions.

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### 3.2 TIMING

- A. Time for hydroseeding shall be scheduled so that seed will be planted in time for the first germination-causing rain. Unless approved by Engineer, planting shall be not earlier than October 15 nor later than October 31.

### 3.3 MAINTENANCE

- A. Maintenance shall include repair of erosion, replacement of mulch, and incidental work necessary.
- B. CONTRACTOR to hydroseed and then maintain and water it until confirmed that it germinates with two-week, four-week, six-week and eight week germination field checks by owner representative with contract representative present. CONTRACTOR required to maintain hydroseeding through the confirmation of documented germination.

+ + END OF SECTION + +

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**SECTION 02950**  
**BIORETENTION AREA**

**PART 1 - GENERAL**

**1.1 SCOPE OF WORK**

- A. Furnish all materials, labor, transportation, services, and equipment necessary to install areas as shown on the Drawings and as specified herein.
- B. Work included in this Section:
  - 1. Procurement of materials
  - 2. Construction of areas
- C. If there is a conflict between Section 02950 herein and other Codes or portions of the Contract Documents, the provisions of Section 02950 shall take precedence.
  - 1. Reference Section 02300, Earthwork, for additional earthwork requirements.
  - 2. Reference Section 02900, Landscape planting, for additional planting requirements.
  - 3. Reference Section 15100, Pipe and Fittings, for additional drainage pipe requirements.

**1.2 REQUIREMENTS OF REGULATORY AGENCIES**

- A. All Federal, State, and local laws and regulations governing this work are hereby incorporated into and made part of this Section. When this Section calls for certain materials, workmanship or a level of construction that exceeds the level of Federal, State, or local requirements, the provisions of this Section shall take precedence.

**1.3 REFERENCE STANDARDS**

- A. West Placer Storm Water Quality Design Manual, Latest Edition.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01330:
  - 1. List of all proposed materials and equipment to be used indicated by description, manufacturer and model number, if applicable. Include catalog cuts where applicable.
  - 2. A copy of the plant procurement order from the nursery including the name, address, and phone number of said nursery.
  - 3. Plant quantity list.
    - a. List all plants indicated by botanical name, common name, quantity, size, nursery and location and any specific remarks, (e.g., "unable to locate," "photo submitted," etc.).
  - 4. Written documentation that the plant material listed on the Drawings is available. Any substitutions required due to unavailability must be requested in writing before confirmation of ordering.
  - 5. A schedule identifying plant procurement, storage, and anticipated delivery dates for review and approval.
  - 6. Compliance with State of California and federal quarantine restrictions.
- B. Bioretention Soil Mix

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1. Samples: Submit a 1-gallon bag of soil mix.

#### 1.5 PROJECT CONDITIONS

- A. Perform construction and planting operations only when weather and soil conditions are suitable in accordance with locally accepted practice.

#### 1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery
  1. Deliver all planting materials with legible and durable identification labels.
  2. Notify the Engineer within 7 days of the delivery of plant materials to the site. Indicate the quantity and type of plant materials in each delivery.
- B. Storage
  1. Store planting materials in the shade and protect from the weather.
  2. Maintain and protect plants not planted within 4 hours of delivery.
- C. Protection
  1. Protect plants during delivery to the site and after, to prevent damage to the root balls or desiccation of leaves.
- D. Handling
  1. Take extreme care in the loading and unloading of plants. Do not lift or move container plants by their stems or trunks.
  2. Any plant materials that are damaged due to mishandling shall be removed and replaced with new material at no additional cost.

#### 1.7 REJECTION OF PLANT MATERIAL

- A. All plant material not conforming to the requirements herein shall be considered defective.
  1. The Engineer shall mark such plants, whether in place or not, as rejected and the materials shall be immediately removed from the site and replaced with new material at no additional cost.
  2. Replacement plant material shall be of the same size, species and condition as that indicated on the Drawings.

#### 1.8 PROTECTION OF THE SITE

- A. Protect previously installed work and materials which may be affected by work of this Section. Provide safeguards and exercise caution against injury or defacement of existing site improvements.
- B. Repair damage and return the areas to the previous condition at no additional cost.

#### 1.9 GUARANTEE

- A. The manufacturer's warranty shall not relieve the Contractor of its own liability under the guarantee. Such warranties shall only supplement the guarantee.

- B. All plant material installed under this Contract shall be guaranteed against poor, inadequate and inferior quality and installation for a period of 1 year from the date of Final Acceptance.
  - 1. Any plant material not meeting the satisfaction of the Engineer as per the performance standards in Section 02970, Landscape Maintenance, shall immediately be removed and replaced at no cost to the Owner.
  - 2. Replaced plant material shall also be guaranteed for a period of 1 year upon installation.
- C. Replace without cost to the Owner and as soon as weather permits, all dead plants and all plants not found in a vigorous, thriving condition, as determined by the Engineer during and at the end of the plant warranty period.
  - 1. Replacement of plants shall closely match adjacent specimens of the same species and shall be subject to all requirements of this section.
- D. Repair damage to adjacent plant material at no cost to the Owner. All repairs shall be made with materials, varieties and sizes "in kind" with adjacent existing materials.

## **PART 2 - PRODUCTS**

### **2.1 PLANTS**

- A. General
  - 1. Procure all plant materials and incidentals required for this project.
  - 2. All plant material delivered to the site shall have a normal habit of growth and be well formed and shaped, healthy, vigorous, and free of any insects, diseases, sunscalds, windburn, abrasions of the bark, or other objectionable disfigurements.
  - 3. The size of the plant material shall correspond with that normally expected for species and variety of commercially available nursery stock or as specified on the Drawings.
  - 4. Plant material shall be grown under climatic conditions similar to those in the locality of the project unless approved otherwise by the Engineer.
  - 5. Plant material larger than that specified on the Drawings may be used pending approval from the Engineer. However, there will be no change in the Contract amount if the larger plant material is approved and used.
- 6. Trees and Shrubs
  - a. Tree and shrub trunks shall be sturdy and well hardened with vigorous and fibrous root systems, which are not root-bound.
  - b. In the event of a disagreement as to the condition of the root system, the root conditions of the plants will be determined by the removal of soil around the roots of not less than 10 plants or more than 2 percent of the total number of plants of each species.
  - c. When container-grown plants are supplied from several sources, the roots of not less than 10 plants of each species from each source will be observed.
    - 1) In case the plants sampled are found to be defective, the Engineer has the right to reject the entire lot represented by the defective sample.
    - 2) Any plant material rendered unsuitable for use because of this observation will be considered as samples and will be provided at no additional cost.
- 7. Container-Grown Stock
  - a. Container-grown stock shall be in a vigorous and healthy condition and not root bound or with the root system hardened off.

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- 1) Container-grown stock shall be grown under climatic conditions similar to that found in the locality of the site.
8. Ground Cover Stock
  - a. Ground cover stock shall be well-established in removable containers or come from formed homogenous soil sections.
  - b. Ground cover stock shall be grown under climatic conditions similar to that found in the locality of the site.
- B. Plant Species
  1. All plants chosen must be included in the West Placer Storm Water Quality Design Manual Final Draft, Fact Sheet TR 1, Sacramento Valley Native Plant List. Plant species chosen will achieve the following design criteria for the bioretention area:
    - a. A variety of trees, shrubs, and herbaceous plant materials must be used
    - b. Emphasis to incorporate native grass meadows, which are highly effective at controlling and treating storm water
    - c. Moisture tolerant plants will be utilized for the bottom of the bottom retention area.
    - d. Plants capable of tolerating drought and fluctuating water conditions will be utilized for the side edges of the bioretention area
    - e. Must meet the general landscape design set forth by the Placer County Landscape Design Guidelines (Placer County Planning Services Division)

## 2.2 MATERIALS

- A. References
  1. Reference Section 02300, Earthwork, for the following material requirements:
    - a. Drain Pipe Granular Bedding
    - b. Impermeable Liner
    - c. Drain Rock
    - d. Granular Fill
    - e. Coarse Sand
  2. Reference Section 15100, Pipe and Fittings, for Drainage Pipe requirements.
- B. Bioretention Soil Media (BSM):
  1. Minimum 18" thick mixture of 60%-70% sand
  2. Must meet American Society for Testing and Materials (ASTM) C33
  3. 30%-40% compost may be used to provide filtration of runoff
  4. Use of native soil or amendment of native soil may be possible if the following criteria are met:
    - a. Evaluation of the criteria set forth in "Section 3 – Site Assessment" of the West Placer Storm Water Quality Design Manual
    - b. Structural needs evaluation by licensed Geotechnical Engineer
- C. Mulch:
  1. Initial excavation depth shall anticipate the total combined media depth to ensure that mulch is accommodated at final grades
  2. Wood chips or other material that can flow will not be permitted
  3. Installation of mulch just before or the rainy season shall not be permitted
  4. Well-aged shredded hardwood bark mulch shall be used and shall meet the following criteria:
    - a. Must not contain more than 0.1 percent of deleterious materials such as rocks, glass, plastics, metals, clods, weeds, weed seeds, coarse objects, sticks larger

- than the specified particle size, salts, paint, petroleum products, pesticides or other chemical residues harmful to plant or animal life
- b. Shredded bark mulch must be a blend of loose, long, thin wood or bark pieces derived from trees with a high length-to-width ratio. A minimum of 95 percent of the wood strands must have lengths from 2 to 8 inches, with a width and thickness from 1/8 to 1-1/2 inches.

### **PART 3 - EXECUTION**

#### **3.1 DEISGN CRITERIA**

- A. The bioretention area shall be installed per the Contract Drawings.
- B. All earthwork construction, including but not limited to: excavation, membrane liner installation, and fill/backfill shall be performed in accordance with Section 02300, Earthwork.
- C. Install Drainage Pipe in accordance with Section 15100, Pipe and Fittings.
- D. BSM Placement
  1. BSM delivery ticket(s): Delivery tickets shall show that the full delivered amount of BSM matches the product type, volume and manufacturer named in the submittals. Each delivered batch of BSM shall be accompanied by a certification letter from the supplier verifying that the material meets specifications and is supplied from the approved BSM stockpile.
  2. Visual match with submitted samples: Delivered product will be compared to the submitted 1-gallon sample, to verify that it matches the submitted sample. The ENGINEER may inspect any loads of BSM on delivery and stop placement if the soil does not appear to match the submittals; and require sampling and testing of the delivered soil to determine if the soil meets the specified requirements before authorizing soil placement.
  3. Inspection of the aggregate storage layer, underdrain, and overflow structure installation, where included on the plans. BSM placement, grading and consolidation shall not occur when the BSM is excessively wet, or has been subjected to more than 1/2 inch of precipitation within 48 hours prior to placement. Excessively wet is defined as being at or above 22 percent soil moisture by a General Tools & Instruments DSMM500 Precision Digital Soil Moisture Meter with Probe (or equivalent). A minimum of three readings with the soil moisture probe will be used to determine the average percent soil moisture reading per each truck load. There should be no visible free water in the material.
  4. The Contractor shall place BSM loosely with a conveyor belt or with an excavator or loader from a height no higher than 6 feet, unless otherwise approved by the Engineer/Landscape Architect (i.e., do not dump material directly from truck into cell). Soil shall be placed upon a prepared subgrade in accordance with these Specifications and in conformity with the lines, grades, depth, and typical cross-section shown in the Drawings or as established by the Engineer/Landscape Architect.
  5. Excessively dry BSM may be lightly and uniformly moistened, as necessary, to facilitate placement and workability.
  6. Compact BSM using non-mechanical compaction methods (e.g., boot packing, hand tamping, or water consolidation) to 83 percent (+/- 2 percent) of the maximum dry density per modified Proctor test (ASTM D1557), or as directed by the Geotechnical Engineer. Determination of in-place density shall be made using a nuclear gauge per

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ASTM D6938. Moisture content determination shall be conducted on a soil sample taken at the location of the nuclear gage reading per ASTM D2216.

7. Grade BSM to a smooth, uniform surface plane with loose, uniformly fine texture. Rake, remove ridges, and fill depressions to meet finish grades.
8. Final soil depth shall be measured and verified only after the soil has been compacted. If after consolidation, the soil is not within +/- 3/4 inch of the grades and slopes specified on the Plans, add material to bring it up to final grade and raked.
9. The BSM shall be inspected and accepted for placement and finish grade by the Engineer/Landscape Architect prior to the installation of planting and mulch. Any BSM that does not conform to this Specification shall be remediated to the satisfaction of the Engineer/Landscape Architect, or removed and replaced with acceptable BSM, at the Contractor's expense.

E. Install Irrigation System in accordance with Section 02810, Irrigation.

### 3.2 PLANTING PREPARATION

#### A. General

1. Ensure proper drainage of all planting areas. Any discrepancy in the Drawings or Specifications, obstructions on the site, or prior work done by another contractor, which could preclude the establishment of proper drainage, shall be brought to the immediate attention of the Engineer for correction or relief of said responsibility.
2. Remove all rocks, stones, sticks and debris larger than 1-inch in diameter from the surface of the planting areas.
3. Obtain approval of site conditions by the Engineer before starting planting operations.

#### B. Planting Layout

1. Groundcover plant locations shall be in straight rows, evenly, triangular spaced, and at the on-center spacing indicated on the Drawings.

#### C. General Planting Guidelines

1. Plant only as many plants as can be planted and watered on that same day within a given planting area.
2. Protect the planting area from excessive vehicle compaction.
3. Face plant material with fullest growth into the prevailing wind and/or the primary direction of view.

#### D. Container Removal

1. Plant container shall be opened and removed in such a manner that the soil surrounding the rootball shall not be broken.
2. Do not injure the root ball while removing the container. After removing plant, superficially cut edge roots with a knife on 3 sides.

### 3.3 PLANT INSTALLATION

- A. Excavate planting pit 12 inches below the bottom of the rootball and to a diameter of twice the diameter of the rootball. Planting pits shall have vertical sides and roughened surfaces. Once excavated, drench planting pit with water.
- B. After obtaining approval by the Engineer, and after water has completely drained from the planting pit, place plant material in the center of the moist planting pit.



- C. Apply backfill mix to the planting pit up to ½ the height of the rootball. Add water to the top of the remaining planting pit and let soak in before completing remainder of backfilling. Finish backfilling with planting soil of the planting pit by tamping the soil firmly around the rootball and watering thoroughly.
- D. Each rooted ground cover plant shall be planted with its proportional amount of soil.
- E. Wood Mulch Topdressing
  - 1. Spread a 4-inch deep layer of wood mulch across entire area as shown on Contract Drawings.
- F. Plant Settling
  - 1. Any plant material that has settled deeper than the surrounding grade shall be raised to the correct level.

### 3.4 PLANTING DENSITY

- A. Provide the following planting density per 100 square feet:
  - 1. 100 herbaceous plants, 1-foot on center spacing, ½-gallon container size.
  - 2. 4 shrubs, evenly spaced, 1-gallon container size.

### 3.5 WATERING

- A. All planting and seeding areas shall be watered immediately after installation. After the first watering, water shall be applied to all plants and seeded areas as conditions may require keeping the vegetation in a healthy and vigorous growing condition until the completion of the Contract.

### 3.6 CLEANUP

- A. Remove all trash caused from the work on a weekly basis throughout the duration of the Project.
- B. Upon completion of work under this Section, remove all rubbish, waste and debris to a legal location.
- C. Repair all scars, ruts or other marks in the ground caused by the work.
- D. Remove all equipment and implements of service, and leave the entire work area in a neat and clean condition as accepted by the Engineer. All sidewalks and other paving areas shall receive a broom-clean treatment.

### 3.7 SITE OBSERVATION BEFORE ACCEPTANCE

- A. Corrective actions shall be in strict conformance with the Drawings and these Specifications and per the Engineer, and shall be completed at the Contractor's expense.
- B. The Engineer will perform progress observations of the work and construction operations on completion of construction stages. The Engineer, the Contractor, and others designated by the Owner shall be agreed upon the construction stages for this Specification before starting work and be present on mutually agreed-on dates for the observations for each stage.

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- C. If, after an observation, the Engineer is satisfied with the construction to date and its conformance to the Drawings and Specifications, the Engineer will grant written notice of provisional acceptance for that construction stage.
- D. If, after an observation, the Engineer is dissatisfied with the construction to date and its conformance to the Drawings and the Specifications, the Engineer will prepare a written punch list of necessary corrective action on defective work for the construction stage. All corrections must be completed and will be reobserved by the Engineer within 10 working days from the date of the initial observation.
- E. Project observations shall not occur until all punch list items from previous observations shall not occur until all punch list items from previous observations are corrected. Failure to correct problems in the time specified by the Engineer may result in a delay of payment for the said tasks until the items in question are remedied per the Engineer's direction.
- F. The Contractor shall be charged for any additional construction observations and punch lists required from the Engineer for unscheduled and necessary reobservation of the work due to unsatisfactorily or incompletely addressing previous punch lists.

### 3.8 SITE OBSERVATION SCHEDULE

- A. Provide the Engineer with 48 hours of advance notification, except as otherwise noted, for required stage acceptance observations including, but not limited to, the following:
  - 1. Plant materials at nursery(s) before delivery to project site.
  - 2. Plant materials after delivery to project site and before planting.
  - 3. Plant locations layout before planting pit excavation.
  - 4. Planting operations, one complete installation of each plant size before installation of remaining plants.
  - 5. Progress container planting operations.
  - 6. Completed container planting operations.
  - 7. Progress seeding operations.
  - 8. Completed seedling operations.
  - 9. Substantial Completion Observation: Final installation observation before the start of the Landscape Maintenance Period (provide 10 working days of advance written notice).

### 3.9 USE OF BIORETENTION AREA

- A. Convey all un-stabilized site drainage around the bioretention area until the site is stabilized to prevent plugging. The area is not designed to treat runoff from areas where the hydroseeding is not established.

+ + END OF SECTION + +

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**SECTION 02970**  
**LANDSCAPE MAINTENANCE**

**PART 1 - GENERAL**

**1.1 SCOPE OF WORK**

- A. This section only applies to landscaping and not hydroseeding.
- B. After landscape planting and irrigation work have been completed, reviewed and accepted by the Owner and the Engineer, furnish materials, labor, transportation, services and equipment necessary to provide landscape maintenance as indicated on Drawings and as specified herein.
- C. Work included in this Section:
  - 1. Observation of Work Request
  - 2. General Landscape Maintenance
  - 3. Tree and Shrub Care
  - 4. Ground Cover Plant Care
  - 5. Maintaining Water Retention Basins
  - 6. Watering
  - 7. Irrigation System
  - 8. Weed Control
  - 9. Replacement Planting
  - 10. Reseeded Areas
  - 11. Cleanup
  - 12. Site Observation Before Acceptance
  - 13. Site Observation Schedule
  - 14. Final Completion

**1.2 REFERENCES**

- A. International Society of Arboriculture, pruning mature trees.

**1.3 DEFINITIONS**

- A. Healthy Plants: Healthy plants shall be those that are of good form, free of disease and insect infestation, are robust, and exhibit vigorous growth (foliage and wood). They must not be heat or water stressed.
- B. Landscape Maintenance Period: Landscape Maintenance Period will be 90 days minimum from acceptance of the completed landscape construction by the Owner and the Engineer.
  - 1. At the discretion of the Engineer, proceed into the Landscape Maintenance Period if planting and irrigation are deemed "substantially complete" by the Engineer.
  - 2. Continuously maintain areas included in this Contract during the Landscape Maintenance Period until Final Acceptance has been granted.
  - 3. Improper landscape maintenance or possible poor condition of planting at termination of the scheduled may cause the Landscape Maintenance Period to be continued at no cost to the Owner.

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4. Any day that Contractor fails to adequately perform landscape maintenance, as determined necessary by the Engineer, will not be credited as one of landscape maintenance working days.
5. The Contractor shall be responsible for establishing and maintaining all plants, including transplants, in a healthy condition throughout the Landscape Maintenance Period. The Contractor shall check the condition of each plant for symptoms of disease, size, color, wilting, defoliation, new growth, browsing by wildlife, insect damage, girdling, structural deformities, dieback, sunburn and vandalism and shall notify the Engineer of the corrective actions required.

#### 1.4 PERFORMANCE STANDARDS

- A. The target survival rate for all container plants shall be 100% survival. The target survival rate for seeded areas shall be 60% cover with native vegetation.
- B. If the percent survival is less than these standards, replacement plants shall be planted, in conformance to the Drawings and Specifications, with the minimum number of plants required to achieve the survivorship standards.
- C. Seeded areas larger than 400 square feet with less than 60% cover with native vegetation shall be reseeded.
- D. If the performance standards are not met at the time of Final Completion, the project will not be accepted until the identified remedial actions are implemented as directed by the Engineer. These may include additional weed control and/or additional planting, using adaptive management to identify those plants best suited to the site. All remedial actions shall be conducted in strict coordination with, and upon the approval of the Engineer.

#### 1.5 QUALIFICATIONS

- A. The applicator of all weed control materials shall be licensed by the State of California as a Pest Control Operator and a Pest Control Advisor in addition to any subcontractor licenses that are required.

#### 1.6 SUBMITTALS

- A. At least 30 days before starting landscape maintenance, submit the following to the Engineer:
  1. A schedule of activities planned during the Landscape Maintenance Period. This schedule must be accepted by the Engineer before start of landscape maintenance. During the Landscape Maintenance Period, document scheduled changes and obtain acceptance by the Engineer.
  2. A written schedule for watering, including rate and length of application for each event over the duration of the Landscape Maintenance Period.
  3. The Pest Control Advisor shall submit a list of the weed control materials and quantities per acre intended for use in controlling the weed types prevalent and expected on the site. Weed control information shall include:
    - a. Data to demonstrate the compatibility of the weed control materials and methods with the intended planting and seed varieties.
    - b. A written list of the proposed herbicide application equipment to be used in performance of the weeding work, including descriptive data and calibration tests. Include the herbicide trade name, chemical composition, formulation, concentration, application rate of active ingredients and methods of application

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- for all materials furnished, as well as the name and State license number of the State certified applicator.
- c. Records of manufacturer's literature, labels, and laboratory analytical data for verification of herbicide to be used, including the chemical makeup and application rate.
  - d. Certificates of compliance certifying that herbicide materials meet the requirements specified shall be submitted before the delivery of materials. Herbicide material shall include EPA registration number and registered uses.
  - e. A Herbicide Treatment Plan (HTP) proposing a sequence of herbicide treatments and a written delivery schedule and written Pest Control Advisor (PCA) recommendation. The herbicide trade name, chemical composition, formulation, concentration, application rate of active ingredients and methods of application for all materials furnished, and the name and state license number of the state certified applicator shall be included. Records of manufacturer's literature, labels, and laboratory analytical data for verification of herbicide to be used including the chemical makeup and application rate shall be submitted. Once approved by the Engineer, the Contractor shall receive written authorization to proceed with the treatment.
4. A list of materials that are to be used during landscape maintenance that are not specified in Section 02900 – Landscape Planting in written form to the Engineer for review and approval before purchasing or delivering to the site.
- B. Replacement Materials
1. For all replacement container plants, and upon the direction of the Engineer, submit a copy of the plant procurement order, including the plant species (by botanical and common name), sizes, and quantities ordered, from a reputable nursery as specified in Section 02900 – Landscape Planting. If the nursery is different than that used to supply the materials for the initial planting, submit the name, address, and phone number of the nursery.
  2. For any reseeding materials, submit verification of seed mix by way of mix labels from the seed mix bags and related items to be used for installing plant materials shall be included in the submittal.
  3. Submit a schedule and plan identifying replacement materials procurement and storage, and anticipated delivery dates for review and approval.
- C. Landscape Maintenance Logs
1. Landscape maintenance activities, including, but not limited to watering, pruning, and weed control shall be logged on a weekly basis and submitted for review during the progress observations.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL**

- A. Provide materials for landscape maintenance work in accordance with requirements of Section 02900, Landscape Planting, except as described herein.

### **2.2 MATERIALS**

- A. Fertilizer
1. Shall be consistent with the recommendations from the soils analysis.

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2. Shall be Gro-Power Hi-Nitrogen 14-4-9, or approved equal, commercial fertilizer at the rate of 7 ½ pounds per 1,000 square feet.
- B. Replacement Plants
1. Supply all replacement container plant materials as required during Landscape Maintenance Period. Replacement plants shall be container and seed of same species and size according to Section 02900, Planting, unless otherwise directed by the Engineer. Sources proposed for acquisition of replacement plant material must be approved by Engineer before acquisition. In no event shall plants of larger sizes than those originally planted be required.
- C. Herbicide
1. Select herbicides with low toxicity to wildlife and those that are appropriate for the desired effect (i.e., broadleaf herbicide to avoid harm to grasses).
- D. All materials need to be suitable to use per Santa Clara Valley Water District's standards.

### **PART 3 - EXECUTION**

#### **3.1 OBSERVATION OF WORK REQUEST**

- A. Request an observation of work by the Engineer to begin the Landscape Maintenance Period after planting and related work has been completed in accordance with Contract Documents. A prime requirement is that ground cover plant (including seeded areas and turf areas), shrub, and tree areas be planted and show a consistent and healthy appearance. If such criteria are met to satisfaction of the Engineer, a field report may be issued to the Owner recommending a date for beginning of the Landscape Maintenance Period.
- B. Any work conducted before the approved landscape maintenance date will not be credited as one of landscape maintenance working days.

#### **3.2 GENERAL LANDSCAPE MAINTENANCE**

- A. Furnish sufficient labor and adequate equipment to perform work during the Landscape Maintenance Period.
- B. The general landscape maintenance operations shall include, but is not limited to:
1. Maintaining planting sites and irrigation systems as described specifically herein.
  2. Provide debris removal in all landscaping areas.
  3. Maintain adequate protection of landscaping areas. Repair damaged area.
  4. Sweep clean paved areas at weekly intervals or more frequently, if deemed necessary.
  5. Replacing all dead and severely stressed plants and other materials, as required and in accordance with the performance standards.
  6. Maintaining all planting areas weed free and removing all noxious weeds from entire project site. Cultivation at intervals of not more than 10 days.
  7. Operating the irrigation system on a regular basis throughout the irrigation season and maintaining the irrigation system in a fully operational condition for the duration of the Landscape Maintenance Period, and up to the Final Completion of the project.
  8. Keeping up-to-date record, or as "As-Built" Drawings during the Landscape Maintenance Period.

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9. Providing irrigation controller charts.

### 3.3 TREE AND SHRUB CARE

- A. Watering: Refer to 3.6, Watering, this Specification section.
- B. Pruning:
  1. Pruning Objectives:
    - a. At no time shall plant material be pruned, trimmed or topped before delivery. Any alteration to a plant material's shape shall only be conducted on-site and in the presence of the Engineer.
    - b. All require pruning of plant material shall be conducted under the observation of the Engineer. Prune plant material only when necessary and under standard horticultural practices to preserve its natural character.
    - c. Select and develop permanent scaffold branches that are smaller in diameter than trunk or branch to which they are attached which have vertical spacing of from 18-inches to 48-inches and radial orientation so as not to overlay one another.
    - d. To eliminate diseased or damaged growth.
    - e. To eliminate narrow V-shaped branch forks that lack strength.
    - f. To reduce toppling and wind damage by thinning out crowns.
    - g. To maintain growth within space limitations.
    - h. To maintain a natural appearance and to balance crown with root mass.
    - i. Do not clip shrubs into balled or boxed forms unless approved initially by the Engineer.
    - j. Make pruning cuts on lateral branches or buds flush with trunk.
    - k. Do not "stub" branches.
- C. Tree Staking
  1. Restake, tighten and repair damaged tree ties.
  2. Reset to proper grades or upright (vertical position, trees that are not in their proper growing position.
  3. Inspect stakes to prevent girdling of trunks or branches and to prevent rubbing that may cause bark wounds.
- D. Weed Control: Refer to 3.8 Weed Control, this Specification section.
- E. Insect and Disease Control:
  1. Maintain insect and disease control during the Landscape Maintenance Period.
- F. Fertilization:
  1. Fertilize planting areas at the start of the Landscape Maintenance Period.
  2. Repeat fertilizer application at 30-day intervals until end of the Landscape Maintenance Period.

### 3.4 GROUND COVER PLANT CARE

- A. Weed Control: Refer to 3.8, Weed Control, this Specification section.
- B. Watering: Refer to 3.5, Watering, this Specification section.
- C. Fertilizing:
  1. Fertilize as specified under 3.3, Tree and Shrub care, this Specification section.

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- D. Edge ground cover to keep in bounds and trim trop growth as necessary to achieve an overall even appearance.

### 3.5 MAINTAINING WATER RETENTION BASINS

- A. Unless otherwise directed by the Engineer, maintain water retention basins around each plant. As directed by the Engineer, modify the basin to ensure it is capable of containing the required amount of water at each watering event at one time. The lip (or earthen berm) of the basin shall be preserved to a height as shown on the Drawings. Maintenance actions may include importing soil, reforming, and re-compacting the lip (or earthen berm) of the basin. Should water be retained within a basin for more than 4-hours, breach the berm of said basin in order to provide drainage at a given plant, especially during the rainy season and at other times as necessary. Take corrective actions to ensure positive drainage at a given plant; the berm shall then be restored to reform the water retention basin as prescribed herein.

### 3.6 WATERING

- A. The plants shall receive water by way of the installed irrigation system as shown on the Drawings and according to Section 02810, Irrigation System. When hand watering, use a water wand to break water force.
- B. The Contractor shall observe said system to ensure that it is functioning and providing adequate water to the plants. Water pressure shall be regulated to a level that applies sufficient water without causing damage to plants or erosion to the planting basin. At no time shall any water be applied in a way that will cause erosion, damage to plants, or excessive runoff. Should the watering application rates need adjustment, immediately contact the Engineer for direction. Assume full responsibility for corrective actions resulting from inappropriate water applications and failure to contact the Engineer for direction. Watering shall consist of the application of water in a manner that is sufficient to wet the soil and saturate the root zone and as frequent as necessary to maintain healthy growth, without damaging the plants, the surrounding grade, or the existing watering basins.
- C. Replenish wood mulch to reduce evaporation and frequency of watering. Throughout warm weather conditions, the plants may require additional watering events. The beginning and ending dates and a schedule for watering shall be determined collaboratively by the Contractor and the Engineer. If most of the plants appear to be stressed and in danger of perishing, consult the Engineer to determine the frequency and duration of additional or decreased watering. If modifications are made to the watering schedule, provide the Engineer with 2 copies of the adjusted watering schedule within 2 weeks of receiving the Engineer's verbal acceptance plus subsequent written approval of the modifications. Regulate irrigation watering times to minimize erosion and gullyng.

### 3.7 IRRIGATION SYSTEM

- A. Provides maintenance of irrigation system consisting of cleaning and adjusting sprinkler and nozzles, and drip emitters, repairing damaged equipment, servicing valves, programming controllers and other activities required during the Landscape Maintenance Period.
- B. Irrigation Controller Charts

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1. "As-Built" Drawings shall be approved by the Engineer before Irrigation Controller Charts are prepared.
2. Provide one Irrigation Controller Chart for each irrigation controller supplied.
3. Each Irrigation Controller Chart shall show the area controlled by that automatic irrigation controller and shall be the maximum size that fits through the irrigation controller door will allow.
4. The Irrigation Controller Chart is to be a reduced "As-Built" Drawings of the irrigation system. In the event that the Irrigation Controller Chart is not legible when the chart is reduced, the text on the "As-Built" Drawing may be enlarged to a size that will be readable when reduced.
5. The Irrigation Controller Chart shall be a monochromatic "Xerox" copy on #20 bond with each valve station represented by a different color.S
6. When completed, hermetically seal the Irrigation Controller Chart between two pieces of 10 mil. plastic laminate.
7. Irrigation Controller Charts shall be completed and approved by the Engineer before the Final Completion.

C. Refer to Section 02810 – Irrigation System for additional requirements.

### 3.8 WEED CONTROL

- A. Weed control shall consist of maintaining the individual planting sites, areas between individual planting sites, and all areas within planting boundaries (as shown on the Drawings) free of weeds for the duration of the Landscape Maintenance Period.
- B. At individual planting site, weeds shall be removed within a 36-inch diameter of each plant. Weed removal at the trunks of individual plants shall be conducted by hand pulling. At no time shall weed removal disrupt the root systems of the installed plants.
- C. Observe the project site weekly during the Landscape Maintenance Period to evaluate potential weed problems. Any invasive weed species shall be targeted for removal and long-term control through manual or chemical methods. Manual removal by hand-pulling shall be the preferred weed eradication method.
  1. Mechanical methods (such as mowing) or spot herbicide applications may be considered upon receipt of an HTP and approval from the Engineer before application. If approved, herbicide applications shall be conducted according to the approved HTP and under the direction of the Engineer. At no time shall weed control include burning.
  2. Avoid frequent soil cultivation that destroys shallow surface roots.
  3. Replenish lost wood or straw mulch to reduce weed growth.

### 3.9 REPLACEMENT PLANTING

- A. Material replacement shall be in strict conformance to the Drawings, these Specifications, and the Engineer's direction, and shall be completed at no additional expense.
- B. Plant material that has no easily observable viable aboveground living matter, or is of consistently poor vigor and form as determined by the Engineer, shall be considered dead and must be replaced according to the Drawings and the Specifications. Dead plants shall be removed before installation of replacement plants. All dead plants shall be removed offsite according to State and local regulations at no additional expense.

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- C. Replace plant losses due to inundation, mortality, or poor health and vigor at a rate of 1 replacement plant for each plant lost in accordance with the performance standards described herein. The replacement plants must be similar in size to the current size of the existing plants. If transplants require replanting, the size of the replacements must be approved by the Engineer before ordering or purchase.
- D. All materials determined to be salvaged shall be handled and removed with care. All replacement plant containers and racks shall be salvaged and recycled offsite or returned to the suppliers at no additional cost.

### 3.10 CLEANUP

- A. Upon completion landscape maintenance, remove rubbish, waste and debris.
- B. Repair scars, ruts or other marks in landscaped areas.
- C. Remove equipment, implements of service and leave landscaping areas in a neat and clean condition as accepted by the Engineer. Sweep clean paved areas.

### 3.11 SITE OBSERVATION BEFORE ACCEPTANCE

- A. Corrective actions shall be in strict conformance with the Drawings and these Specifications and according to the Engineer, and shall be completed at the Contractor's expense.
- B. The Engineer will perform progress observations of the maintenance work on a weekly basis. The Engineer, the Contractor, and others designated by the Owner shall be present on for the weekly observations.
- C. If, after observation, the Engineer is satisfied with the construction to date and its conformance to the Drawings and the Specifications, the Engineer will grant written notice of acceptance.
- D. If, after an observation, the Engineer is dissatisfied with the maintenance work to date and its conformance to the Drawings and the Specifications, the Engineer will prepare a written punch list of necessary corrective action on defective work. All corrections must be completed by the Contractor and reobserved by the Engineer at the following weekly inspection.
- E. Failure to correct problems in the time specified by the Engineer may result in a delay of payment for the said tasks until the items in question are remedied per the Engineer's direction.
- F. The Contractor shall be charged for any additional observations and punch lists required from the Engineer for unscheduled and necessary reobservation of the Contractor's work due to unsatisfactorily or incompletely addressing previous punch lists.

### 3.12 SITE OBSERVATION SCHEDULE

- A. Progress observations of the maintenance work shall be one per week. The Engineer and the Contractor shall agree upon a regular day and time for the weekly observations.

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### 3.13 FINAL ACCEPTANCE

- A. At completion of the Landscape Maintenance Period, schedule a Final Completion observation with the Engineer. Provide 10 working days of advance written notice for the requested date.
- B. The Owner, Engineer, Contractor, and others deemed necessary by the Engineer may be present at the Final Completion observation.
- C. Before requesting Final Completion observation, replacement planting shall be completed.
- D. If during the Final Completion observation the Engineer is of opinion that landscape maintenance has been substantially completed in accordance with this Specification, written notice of recommendation to allow Contractor to be released from Project will be submitted to the Owner for approval. This report will note any incomplete punch list items from Final Completion observation and a date on which these items must be completed. Remaining punch list items shall be completed within 5 working days after the final Acceptance observation was performed by the Engineer.
- E. If during the Final Completion observation the Engineer is of opinion that landscape maintenance has not been substantially completed in accordance with this Specification, the Engineer will prepare a written punch list of necessary corrective action on defective work. All corrections must be completed by the Contractor and reobserved by the Engineer within 10 working days from the date of the initial Final Completion observation. Written notice of recommendation to allow Contractor to be released from Project will not be submitted to the Owner for approval until all corrective actions have been addressed to the satisfaction of the Engineer.
- F. Corrective actions shall be in strict conformance with the Drawings and these Specifications and according to the Engineers, and shall be completed at the Contractor's expense.

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**SECTION 03100**  
**CONCRETE FORMWORK**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section includes: Falsework and formwork, as required to construct cast-in-place concrete, including placing of all items such as sleeves, anchor bolts, inserts and all other items to be embedded in concrete for which placement is not specifically provided under other Sections.
- B. REFERENCES
  - 1. American Concrete Institute (ACI)
    - a. ACI 301, Specifications for Structural Concrete for Buildings.
    - b. ACI 347, Guide for Concrete Formwork.

**1.2 SYSTEM DESCRIPTION**

- A. Coordination:
  - 1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the formwork.
  - 2. Coordinate formwork specifications herein with the requirements for finished surfaces specified in Section 03300, Cast-In-Place Concrete.

**1.3 SUBMITTALS**

- A. Submit for information purposes the following: Copies of manufacturer's data and installation instructions for all proprietary materials, including form coatings, manufactured form systems, ties and accessories.
- B. Shop Drawings: Forming, shoring and bracing drawings for footings, walls and roofs.
- C. Calculations: Calculations verifying the selection of form ties, horizontal and vertical stiff-backs or braces for wall panels, forming and form openings, falsework or roof forms, or any other part of forming, shoring or bracing which may be considered critical by the ENGINEER. The drawings, with supporting calculations, must be signed and sealed by a Civil or Structural Engineer registered in the State of California.

**1.4 QUALITY ASSURANCE**

- A. Allowable Tolerances: Construct formwork to provide completed concrete surfaces complying with tolerances specified in ACI 347, Chapter 3.3, except as otherwise specified.
- B. Furnish and install all items for permanent or temporary facilities in accordance with manufacturer's instructions.

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## **PART 2 - PRODUCTS**

### **2.1 FORM MATERIALS**

- A. Forms for Exposed Finish Concrete: Unless otherwise shown or specified, construct formwork for exposed concrete surfaces with plywood overlaid with MDO or HDO specifically designed for concrete forms, metal, metal-framed plywood-faced or other acceptable panel materials, to provide continuous, straight, smooth as-cast surfaces. Furnish in largest practical sizes to minimize number of joints. Provide form material with sufficient thickness to remain watertight and withstand pressure of newly placed concrete without bow or deflection.
- B. Forms for Unexposed Finish Concrete: Form concrete surfaces that will be unexposed in the finished structure with plywood, lumber, metal, or other acceptable material. Provide lumber that is dressed on at least 2 edges and 1 side.
- C. Form Ties:
  - 1. Form ties on exposed surfaces shall be located in a uniform pattern or as indicated on the Drawings. Form ties shall be constructed so that the tie remains embedded in the wall, except for a removable portion at each end. Form ties shall have conical or spherical type inserts, inserts shall be fixed so that they remain in contact with forming material, and shall be constructed so that no metal is within 1 inch of the concrete surface when the forms, inserts, and tie ends are removed. Wire ties will not be permitted. Ties shall withstand all pressures and limit deflection of forms to acceptable limits.
  - 2. Flat bar ties for panel forms shall have plastic or rubber inserts having a minimum depth of 1 inch and sufficient dimensions to permit proper patching of the tie hole.
  - 3. Ties for water-holding structures or dry structures with access such as basements, pipe galleries, etc., that are below finish grade, shall have either an integral steel water stop 0.103 inch thick and 0.625 inch in diameter that is tightly and continuously welded to the tie, or a neoprene water stop 3/16-inch thick and 15/16 inch in diameter whose center hole is 1/2 the diameter of the snap tie, or a molded plastic water stop of comparable size. Flat snap ties complying with above requirements and other sections of this Specification may be used. The water stop shall be considerably larger in area than the tie cross sectional area, and shall be oriented perpendicular to the tie and symmetrical about the center of the tie. The ties shall be constructed to provide a positive means of preventing rotation or disturbance of the center portion of the tie during removal of the ends.
- D. Alternative Form Ties – Through-Bolts:
  - 1. Alternate form ties consisting of tapered through-bolts at least 1 inch in diameter at smallest end, or through-bolts that utilize a removable tapered sleeve of the same minimum size may be used at the CONTRACTOR's option. Clean and roughen, fill, and seal form tie hole as shown on the Drawings; or where not shown on the Drawings, the CONTRACTOR shall provide a shop drawing submittal of his proposed method of sealing the through-bolt hole by sandblasting or mechanically cleaning and roughening the entire interior surface of the hole, epoxy coating the roughened surface and driving a vinyl plug and then dry packing the entire hole on each side of the plug with nonshrink grout, meeting these Specifications. Dry packing shall be done while the epoxy is tacky or remove the epoxy by mechanical means and reapply new epoxy. The CONTRACTOR shall be responsible for watertightness and any repair needed. Any leaks or dampness on the exterior of through-bolt patches during or after water testing shall require repair or replacement of the patch.

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2. The elastic plug to be inserted into the form tie hole as shown on the Drawings shall be a Dayton Sure Plug, or approved equal, sized to allow insertion using the insertion tool to elongate the plug, place it at the correct location, and allow the plug to return to its original length and diameter upon removal to form a watertight seal. The plugs shall be as manufactured and supplied by Dayton Superior, Dayton OH, phone: 888/977-9500.
- E. Forms Coatings: Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatment of concrete surfaces requiring bond or adhesion, nor impede the wetting of surfaces to be cured with water or curing compounds.
  1. For concrete structures which will be in contact with potable water, the manufacturer shall certify that the form coating used is NSF 61 approved.

## 2.2 DESIGN OF FORMWORK

- A. The CONTRACTOR shall design all formwork prior to fabrication. The design shall account for all the tolerances, form ties, finishes, architectural features, rebar supports, construction joint locations, and other features and other nonstructural formwork requirements specified. Forms shall contain pouring and observation windows to allow placement of concrete through windows or shall be staged to allow visual observation at all times of the fresh concrete to ensure correct placement and vibration. Provide a formwork and placement design that will limit free fall of concrete in forms 8-inch or less in width to 5 feet; and for forms wider than 8 inches, limit this fall to 8 feet, except as hereinafter specified. Review methods with ENGINEER prior to start of work. Use placement devices, such as chutes, pouring spouts, pumps, as required.
- B. Wall forms shall be designed such that wall sections can be poured full height without creating horizontal cold joints and without causing snapping of form ties which shall be of sufficient strength and number to prevent spreading of the forms during the placement of concrete and which shall permit ready removal of the forms without spalling or damaging the concrete.
- C. Reuse of forms will be permitted only if a "like new" condition, unless otherwise approved in writing, is maintained. The ENGINEER shall be notified 1 full working day prior to concrete placement so that the forms can be inspected. The CONTRACTOR shall correct any defective work, found in the ENGINEER's inspection, prior to delivery of concrete to the project. Formwork surfaces that were in good condition and accepted for use, but were damaged during removal and handling shall not be reused on additional pours. The CONTRACTOR is expected to take care in the handling of forms and to obtain approval of form surfaces prior to each reuse.
- D. Roof forms and falsework supports for structural slabs shall be sufficiently rigid and strong to support the wet concrete and the men and equipment necessary for its placement without appreciable deflections. A minimum of 50 PSF for live load shall be allowed in the design.
- E. All forms, falsework, shoring, and other structural formwork required shall be structurally designed by the CONTRACTOR and the design shall comply with all applicable safety regulations, current OSHA regulations, and other codes. Where federal or state agencies require a licensed engineer to prepare and/or seal all formwork, falsework or shoring designs, the CONTRACTOR shall hire this engineer and pay all costs. The designs shall be made available to any governing agency upon request. Comply with applicable

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portions of ACI 347, ACI 318 current edition, and these Specifications. All design, supervision, and construction for safety of property and personnel shall be the CONTRACTOR's full responsibility.

### **PART 3 - EXECUTION**

#### **3.1 INSPECTION**

- A. Examine the substrate and the conditions under which Work is to be performed with installer and notify ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

#### **3.2 FORM CONSTRUCTION**

- A. Construct forms complying with ACI 347; to the exact sizes, shapes, lines and dimensions shown; as required to obtain accurate alignment, location and grades; to tolerances specified; and to obtain level and plumb work in finish structures. Provide for openings, offsets, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required. Use selected materials to obtain required finishes. Finish shall be as determined by approved mock-up or sample panel, if specified.
- B. Fabricate forms for easy removal without damaging concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where the slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and assure ease of removal.
- C. Provide temporary form windows where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Brace temporary closures and set tightly to forms to prevent loss of concrete mortar. Locate form windows on forms in locations as inconspicuous as possible, consistent with requirements of the Work. Form intersecting planes of openings to provide true, clean-cut corners, with edge grain of plywood not exposed as form for concrete.
- D. Falsework:
  - 1. Erect falsework and support, brace and maintain it to safely support vertical, lateral and asymmetrical loads applied until such loads can be supported by in-place concrete structures. Construct falsework so that adjustments can be made for take-up and settlement.
  - 2. Provide wedges, jacks or camber strips to facilitate vertical adjustments. Carefully inspect falsework and formwork during and after concrete placement operations to determine abnormal deflection or signs of failure; make necessary adjustments to produce finished Work of required dimensions.
- E. Forms for Exposed To View Concrete:
  - 1. Do not use metal cover plates for patching holes or defects in forms.
  - 2. Provide sharp, clean corners at intersecting planes, without visible edges or offsets. Back joints with extra studs or girts to maintain true, square intersections.



3. Use extra studs, walers and bracing to prevent bowing of forms between studs and to avoid bowed appearance in concrete. Do not use narrow strips of form material that will produce bow.
  4. Assemble forms so they may be readily removed without damage to exposed concrete surfaces.
  5. Form molding shapes, recesses, rustication joints and projections with smooth-finish materials, and install in forms with sealed joints to prevent displacement.
- F. Corner Treatment:
1. Form exposed corners of beams, walls, foundations, bases and columns to produce smooth, solid, unbroken lines, except as otherwise shown. Except as specified below for reentrant or internal corners, exposed corners shall be chamfered.
  2. Form chamfers with 3/4"x 3/4" strips, unless otherwise shown, accurately formed and surfaced to produce uniformly straight lines and tight edge joints. Use rigid PVC chamfers for all architecturally formed concrete. Extend terminal edges to require limit and miter chamfer strips at changes in direction.
  3. Reentrant or internal corners and unexposed corners need not be formed chamfered.
- G. Openings and Built-In Work:
1. Provide openings in concrete formwork shown or required by other Sections or other contracts.
  2. Accurately place and securely support items to be built into forms.
- H. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt or other debris just before concrete is to be placed. Retighten forms immediately after concrete placement as required to eliminate mortar leaks.

### 3.3 FORM COATINGS

- A. Coat form contact surfaces with a non-staining form-coating compound before reinforcement is placed. Do not allow excess form coating material to accumulate in the forms or to come into contact with surfaces that will be bonded to fresh concrete. Apply in compliance with manufacturer's instructions.
- B. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

### 3.4 INSTALLATION OF EMBEDDED ITEMS

- A. Set and build into the formwork, anchorage devices and other embedded items, shown, specified or required by other Sections and other contracts. Use necessary setting drawings, diagrams, instructions and directions.
- B. Edge Forms and Screeds Strips for Slabs: Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in the finished slab surface. Provide and secure units to support screeds.

### 3.5 FIELD QUALITY CONTROL

- A. Before concrete placement, check the formwork, including tolerances, lines, ties, tie cones, and form coatings. Make corrections and adjustments to ensure proper size and location of concrete members and stability of forming systems.

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- B. During concrete placement check formwork and related supports to ensure that forms are not displaced and that completed Work is within specified tolerances.
- C. If forms are unsatisfactory in any way, either before or during placing of concrete, postpone or stop placement of concrete until the defects have been corrected, and reviewed by ENGINEER.

### 3.6 REMOVAL OF FORMS

- A. Conform to the requirements of ACI 301, Chapter 2 and ACI 347, Chapter 3.7 except as specified below.
  - 1. Removal of Forms and Supports: Continue curing in accordance with Section 03300, Cast-In-Place Concrete, Paragraph 3.7. Forms are to remain in-place for the time specified below following the end of concrete placement. The durations shown represent a cumulative number of days, or hours, not necessarily consecutive, during which the temperature of the air surrounding the concrete is above or below 50°F.

Temperature:	Above 50°F	Below 50°F or when retarders are used
Walls	12 hours	48 hours
Columns	12 hours	48 hours
Sides of Slabs	6 hours	12 hours
Structural Floor or Roof Slabs	Do not remove forms until site-cured test cylinders develop 100% of 28-days strength.	

- 2. When wall or column forms also support formwork for slab or beam soffits, the removal times of the latter should govern.

### 3.7 RE-USE OF FORMS

- A. Clean and repair surfaces of forms to be re-used in the Work. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable. Apply new form coating compound material to concrete contact surfaces as specified for new formwork.
- B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close all joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces. Form surfaces shall be subject to ENGINEER'S approval.

+ + END OF SECTION + +

**SECTION 03200**  
**CONCRETE REINFORCEMENT**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section includes: Fabrication and placement of reinforcement including bars, ties and supports, and encasements.

**1.2 SUBMITTALS**

- A. Shop Drawings:
1. Manufacturer's specifications and installation instructions for all materials and reinforcement accessories.
  2. Drawings for fabrication, bending, and placement of concrete reinforcement. Comply with ACI 315, Parts A and B. For walls, show elevations to a minimum scale of 1/4-inch to 1 foot. For slabs, show top and bottom reinforcing on separate plan views. Show bar schedules, stirrup spacing, diagrams of bent bars, arrangements and assemblies, as required for the fabrication and placement of concrete reinforcement, unless otherwise noted. Keep splices to a minimum. Avoid splices in regions of maximum tension stresses whenever possible.
- B. Certificates: Submit one (1) copy of steel producer's certificates of mill analysis, tensile and bend tests for reinforcing steel.

**1.3 QUALITY ASSURANCE**

- A. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:
1. American Concrete Institute (ACI):
    - a. ACI 315, Manual of Engineering and Placing Drawings for Reinforced Concrete Structures.
    - b. ACI 318, Building Code Requirements for Reinforced Concrete.
  2. Concrete Reinforcing Steel Institute:
    - a. Manual of Standard Practice, includes ASTM standards referred to herein.
- B. Allowable Placing Tolerances: Comply with ACI 318, Chapter 7 - Details of Reinforcement.

**1.4 DELIVERY, HANDLING AND STORAGE**

- A. Deliver concrete reinforcement materials to the site bundled, tagged and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings shown on placement diagrams.
- B. Store concrete reinforcement material at the site to prevent damage and accumulation of dirt or excessive rust. Store on heavy wood blocking so that no part of it will come in contact with the ground.

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## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Reinforcing Bars: ASTM A615, Grade 60 for all non-welded bars. ASTM A706, Grade 60 for welded bars.
- B. Mechanical Couplers: Reinforcement bars may be spliced with a mechanical connection. Provide a full mechanical connection which shall develop in tension or compression, as required, at least 125% of specified yield strength ( $f_y$ ) of the bar in accordance with ACI 318 Section 12.14.3.2. The locations of the connections are subject to the approval of the ENGINEER.
  - 1. Dayton Superior Bar Lock S/CA Series.
  - 2. Or approved equal
- C. Threaded Splicing Systems: Dowel Bar Splicer System shall comply with ICC Report #4028. The completed splice shall exceed 160% of the specified yield strength ( $f_y$ ) of the bar.
  - 1. Dayton Superior DB/DI parallel threaded couplers.
  - 2. Or approved equal
- D. Steel Wire: ASTM A82.
- E. Column Spirals: Hot-rolled rods for spirals, ASTM A615.
- F. Supports for Reinforcement: Bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcement in place.
  - 1. Use wire bar type supports complying with CRSI recommendations, except as specified below. Do not use wood, brick, or other unacceptable materials.
  - 2. For slabs on grade, use 5000 psi concrete blocks.
  - 3. At all formed surfaces, provide supports complying with CRSI "Manual of Standard Practice" as follows: Plastic protected or stainless-steel legs.

### **2.2 FABRICATION**

- A. General: Fabricate reinforcing bars to conform to required shapes and dimensions, with fabrication tolerances complying with CRSI, "Manual of Standard Practice". In case of fabricating errors, do not re-bend or straighten reinforcement in a manner that will injure or weaken the material.
- B. Unacceptable Materials: Reinforcement with any of the following defects will not be permitted in the Work:
  - 1. Bar lengths, bends, and other dimensions exceeding specified fabrication tolerances.
  - 2. Bends or kinks not shown on approved Shop Drawings.
  - 3. Bars with reduced cross-section due to excessive rusting or other cause.

## **PART 3 - EXECUTION**

### **3.1 INSPECTION**

- A. Examine substrate and conditions under which concrete reinforcement is to be placed with installer, and notify ENGINEER, in writing, of unsatisfactory conditions. Do not

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proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

### 3.2 INSTALLATION

- A. Comply with the applicable recommendations of specified codes and standards, and CRSI, Manual of Standard Practice, for details and methods of reinforcement placement and supports.
- B. Clean reinforcement to remove loose rust and mill scale, oil, earth, ice, and other materials that reduce or destroy bond with concrete.
- C. Position, support, and secure reinforcement against displacement during formwork construction or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers and hangers, as required.
  - 1. Place reinforcement to obtain the minimum concrete cover as shown. Arrange, space, and securely tie bars and bar supports together with 16-gage wire to hold reinforcement accurately in position during concrete placement operations. Slab and wall bars shall be tied at every intersection around the periphery of the slab or wall and not less than every 48 inches in the field at walls and 60 inches in the field at slabs.
  - 2. Bar supports shall be placed no further than 4 feet apart in each direction. Supports must be completely concealed in the concrete and shall not discolor or otherwise mar the surface of the concrete.
  - 3. Set wire ties so that twisted ends are directed away from exposed concrete surfaces.
  - 4. Do not secure reinforcing steel to forms with wire, nails or other ferrous metal. Do not permit metal supports subject to corrosion to touch or be within the required clearance to formed or exposed concrete surfaces.
- D. Provide sufficient numbers of supports of strength required to carry reinforcement. Do not place reinforcing bars more than 2-inches beyond the last leg of any continuous bar support. Do not use supports as bases for runways for concrete conveying equipment or similar construction loads.
- E. Splices: Provide reinforcement lap splices by placing bars in contact, and tying tightly with wire. Comply with requirements shown for minimum lap of spliced bars.
- F. Mechanical Couplers in Lieu of Lap Splicing:
  - 1. Provide mechanical butt splices in accordance with the recommendation of the manufacturer of the mechanical splicing device. Butt splices shall develop 125 percent of the specified minimum yield tensile strength of the spliced bars or of the smaller bar in transition splices. Flame dry bars before butt splicing. Provide adequate jigs and clamps or other devices to support, align, and hold the longitudinal centerline of the bars to be butt spliced in a straight line.
- G. Reinforcement Around Openings: Place an equivalent area of steel around the pipe or opening and extend on each side sufficiently to develop bond in each bar. See the Details on Drawings for bar extension length each side of opening. Where welded wire fabric is used, provide extra reinforcing using fabric or deformed bars.
- H. Field Bending: Field bending of reinforcing steel bars is not permitted when rebending will later be required to straighten bars. Rebending of bars at the same place where strain hardening has taken place due to the original bend will damage the bar. Consult

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with the ENGINEER prior to any pour if the CONTRACTOR foresees a need to work out a solution to prevent field bending.

### 3.3 INSPECTION OF REINFORCEMENT

- A. Do not place concrete until the reinforcing steel is inspected and permission for placing concrete is granted by ENGINEER. All concrete placed in violation of this provision will be rejected.

+ + END OF SECTION + +

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**SECTION 03230**  
**BASE RESTRAINT CABLES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Scope:
1. This section covers the work necessary to install the tank base restraint cables.

**1.2 SUBMITTALS**

- A. Shop Drawings: Submit drawings showing the quantity, location and details for approval prior to base restraint cable fabrication.
- B. Product Data: Submit copies of manufacturer's specifications and installation instructions for all materials and base restraint cable accessories.

**1.3 PRODUCT DELIVERY, STORAGE, AND HANDLING**

- A. Deliver base restraint cable materials to the site bundled, tagged and marked. Store materials at the jobsite to prevent damage and accumulation of dirt or excessive rust. Store materials on heavy wood blocking so that no part of the materials come in contact with the ground.

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

- A. Base Restraint Cables
1. Where called for on the Drawings, seismic cables consisting of seven-wire galvanized strands, meeting the minimum strength requirements on the Drawings, shall be installed to connect wall and wall footing. If no strength requirements are shown on the Drawings, the minimum ultimate strength for 3/8" diameter, 1/2" diameter and 0.60" diameter strand shall be 21,400 lbs., 38,200 lbs. and 52,800 lbs., respectively.
  2. The strands shall be hot-dipped galvanized before stranding with a minimum zinc coating of 0.85 oz./ft<sup>2</sup>.
  3. Galvanized strands for base restraint cables shall meet the quantity and spacing outlined on the Drawings.
- B. Closed Cell Neoprene Base Restraint Cable Sleeves
1. Neoprene sleeves for base restraint cables, which encase the galvanized strands, shall conform to the minimum dimensions shown on the Drawings to permit unrestrained flexing of the strands inside the sleeves under the maximum projected radial wall movements.
  2. The material shall be medium grade closed cell neoprene conforming to 2A3 of ASTM D1056 and shall meet the requirements of Specification 03251, Concrete Joints Section 2.4.A.

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C. Steel Reinforcing Bars

1. Steel reinforcing bars used for the support of the base restraint cables shall conform to the requirements of Specification 03200, Reinforcing Steel.

**PART 3 - EXECUTION**

**3.1 PREPARATION**

- A. Examine the conditions under which the base restraint cables are to be placed with the installer, and notify ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

**3.2 INSTALLATION**

- A. Base Restraint Cables
  1. The cables may be cut to length with a burning torch.
  2. Where necessary, the strands shall be pre-bent before placing the units in wall and wall footings, as called for on the Drawings.
  3. The strands shall be tied to circumferential reinforcing as required and as shown on the Drawings.
  4. In the footing, the strands shall be tied to the radial footing bars.

+ + END OF SECTION + +



## **SECTION 03251**

### **CONCRETE JOINTS**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. Section includes installation of concrete joints including, construction joints, expansion joints and fillers, waterstops, and contraction (control) joints.

##### **1.2 REFERENCES**

- A. American Concrete Institute (ACI)
  - 1. ACI 301, Specifications for Structural Concrete for Buildings.
- B. American Society for Testing and Materials (ASTM)
  - 1. ASTM A36, Standard Specification for Structural Steel.
  - 2. ASTM D1752, Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
  - 3. ASTM D570, Standard Test Method for Water Absorption of Plastics.
- C. NSF/ANSI Standard 61 Drinking Water Systems Components.

##### **1.3 SYSTEM DESCRIPTION**

- A. All joints subject to hydrostatic pressure shall be provided with continuous waterstop.

##### **1.4 SUBMITTALS**

- A. Product Data: Submit for approval, Manufacturer's specifications and installation instructions for all materials required.
- B. Shop Drawings: Submit for approval:
  - 1. Layout of all construction joint locations prior to the submittal of steel reinforcing drawings. The concrete pour sequence and placement schedule shall be stated in the construction joint shop drawing layout.
  - 2. Detail for joining polyvinyl chloride waterstops.
- C. Samples: Submit for approval:
  - 1. Waterstops for joints.
  - 2. Expansion joint fillers.
  - 3. Neoprene bearing pads.
  - 4. Closed cell neoprene pads.

##### **1.5 QUALITY ASSURANCE**

- A. Install all manufactured items in accordance with manufacturer's instructions.
- B. Store materials off the ground and protected from moisture, dirt and other contaminants. Protect installed and uninstalled materials from UV exposure in accordance with manufacturer's instruction.

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## **PART 2 - PRODUCTS**

### **2.1 WATERSTOPS**

#### **A. Polyvinyl Chloride:**

1. NSF-61 Certified PVC waterstops.
2. Reference Standard: ASTM D570.
3. Construction Joints: Minimum of 3/8" thick, ribbed, width as shown, or if not shown, 6-inch minimum, center bulb type may be provided but is not required.
4. Control Joints: Minimum of 3/8" thick, ribbed, center bulb type, width as shown, or if not shown, 6-inch minimum.
5. Expansion Joints: Minimum thickness of 3/8" and 9" minimum width. Provide with "O" or "U" shaped center bulb. The "O" shall have an outside diameter of 3/4" minimum.
6. Base of prestressed tank walls: Minimum thickness of 3/8" and 9" minimum width. Provide a center bulb with an outside diameter equal to the bearing pad thickness, unless shown otherwise.
7. Product and Manufacturer: Provide polyvinyl chloride waterstops of one of the following:
  - a. W.R. Meadows, Incorporated.
  - b. Greenstreak Group, Incorporated.
  - c. Or approved equal.

#### **B. Hydrophilic:**

1. Provide chloroprene rubber waterstops, 3/8-inch thick.
2. Product and Manufacturer: Provide one of the following:
  - a. Sika Hydrotite.
  - b. Or approved equal.

#### **C. Injectable Waterstop Hose System:**

1. Provide injection hose system with colored vent ends, junction boxes, anchor clips, closure plugs, and all other accessories for a complete injectable waterstop hose system.
2. The injection hose shall have staggered discharge openings and a one-way valve arrangement for uniform discharge of the injection grout. The hose must be of appropriate size and construction for the injection of water-soluble hydrophilic acrylate ester resin. The construction of the hose shall permit free discharge of the specified injectable waterstop into the concrete, without backwash, for the entire length of the hose (with the exception of the vent ends).
3. The vent ends shall be reinforced, color-coded PVC and internally connected to the injectable waterstop hose with shrink-on sleeves.
4. Junction boxes shall be heavy duty plastic made for embedment in concrete and of adequate size for housing and protection of the injection hose vent ends. Boxes shall be securely fitted with temporary knock-out covers to be used during concreting operations. Where exposed to view, boxes shall be fitted with covers mounted flush with the surrounding area.
5. The hoses shall be cut and fitted with vent ends in lengths to suit field measured conditions, with a maximum of 40 linear feet for each hose, including vent ends. Longer lengths shall be fabricated in accordance with the manufacturer's recommendations.
6. Product and Manufacturer:
  - a. SikaFuko ECO 1, Sika Greenstreak.
  - b. Or approved equal.

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D. Injectable Waterstop Injection Grout:

1. Provide NSF-61 approved water soluble, hydrophilic, acrylate ester resin. In the uncured state, resin shall be water soluble, non-water reactive, and solvent free. Resin shall have viscosity of less than 20 mPas and be easily pumped, flushed, and vacuumed during the injection process with the injectable waterstop hose. All procedures shall be performed within the set time of the injected material. In the cured state, material shall be solid, hydrophilic, and flexible with reversible swelling action in excess of its initially installed volume. Cured material shall be resistant to common ground water contaminants, stable in the presence of acids, alkaline solutions, solvents and fuels, and resistant to permanent water pressure and salt-water environments.
2. Product and Manufacturer:
  - a. Sika Greenstreak.
  - b. Polymer Systems.
  - c. Or approved equal.

## 2.2 PREFORMED EXPANSION JOINT FILLER

- A. Preformed joint filler material shall be of the preformed non-extruding type joint filler constructed of cellular neoprene sponge rubber or polyurethane of firm texture. Bituminous fiber type will not be permitted. All non-extruding and resilient-type preformed expansion joint fillers shall conform to the requirements and tests set forth in ASTM D1752 for Type 1.

## 2.3 NEOPRENE BEARING PADS

- A. Neoprene pads shall be of dimensions and hardness shown on the Drawings and shall be made by an approved manufacturer. Provide neoprene bearing pads that conform to ASTM D2000 with the following properties:
1. Neoprene bearing pads shall have a hardness of 40 to 50 durometer, a minimum tensile strength of 2,000 psi, a minimum elongation of 500%, and a maximum compressive set of 35%.
- B. Manufacturer: Provide one of the following:
1. Kirkhill Manufacturing Company.
  2. West American Rubber Company, Inc.
  3. Dacon Industries Company.
  4. Or approved equal.

## 2.4 CLOSED CELL NEOPRENE PADS

- A. Closed cell neoprene pads shall be used as a filler material in the flexible joints between the wall and wall footing and between the wall and roof connection in the areas not taken up by the solid neoprene bearing pads and waterstops. The materials shall be medium grade closed cell neoprene conforming to 2A3 of ASTM D1056 and as further specified here-in and on the Drawings.

Compression deflection	: 9 – 13 psi
Shore 00 durometer	: 60 – 80 pcf
Density	: 12 – 28 pcf
Water absorption by weight	: 5%
Temperature range:	
Low (flex without cracking)	: -30°F
High continuous	: 150°F

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High intermittent	: 200°F
Heat aging (7 days @ 158°F)	
lineal shrinkage (max)	: 5%
Tensile strength	115 psi min
Elongation	: 180% min
Resilience (bayshore % rebound average ½" thickness @ 72°F)	: 20% - 40%

B. Manufacturer: Provide one of the following:

1. Dacon Industries Co
2. Stockwell Elastomerics
3. Proxis Products LLC

## 2.5 SOFT MASTIC

- A. Soft mastic shall be installed in all voids and cavities around bearing pads, waterstops, and seismic cable sleeves. Such material shall be installed with a consistency that will not adversely affect the quality of waterstop and neoprene materials. Soft mastic shall be an approved joint sealant as specified in Section 07900, Joint Sealants.

## 2.6 CONCRETE CONSTRUCTION JOINT ROUGHENER

- A. Provide a water-soluble non-flammable, surface-retardant roughener.
- B. Product and Manufacturer: Provide one of the following:
1. Rugasol-S, as manufactured by Sika Corporation for horizontal joints.
  2. MBT EAC-S, as manufactured by Master Builders for horizontal joints.
  3. MBT Tuf-Cote (Deep Etch), as manufactured by Master Builders for vertical joints.
  4. Or approved equal.

## 2.7 EPOXY BONDING AGENT

- A. Provide an epoxy-resin bonding agent, two component type.
- B. Product and Manufacturer: Provide one of the following:
1. Sikadur 32 Hi-Mod LPL, as manufactured by Sika Corporation.
  2. Eucopoxy LPL, as manufactured by the Euclid Chemical Company.
  3. Epoxite Binder (Code # 2390), as manufactured by A.C. Horn, Incorporated.
  4. Or approved equal.

## 2.8 RUBBER BONDING AGENT

- A. Product and Manufacturer: Where bonding agent is subject to contact with potable water, bonding agent shall be NSF-61 Certified. Provide one of the following:
1. Scotch-Grip 1300 Rubber Adhesive, as manufactured by 3M Company.
  2. Sikaflex-1a, as manufactured by Sika Corporation.
  3. Or approved equal.

## 2.9 MORTAR

- A. Mortar must be composed of cement, sand and water. Materials for mortar must comply with Section 03300. The proportion of sand to cement measured by volume must be 2 to 1 respectively. Mortar must contain only enough water to allow placing.

## 2.10 BOND BREAKER

- A. Tape for Joints: Adhesive-backed glazed butyl or polyethylene tape, same width as joint that will adhere to premolded joint material or concrete surface.

## **PART 3 - EXECUTION**

### 3.1 INSPECTION

- A. Examine substrate and conditions under which Work is to be performed with installer and notify ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

### 3.2 CONSTRUCTION JOINTS

- A. Comply with ACI 301, Chapter 2.2, and as specified below.
- B. Locate and install construction joints as shown. Locate additional construction joints as required to satisfactorily complete all Work.
- C. Horizontal Joints Below Prestressed Concrete Tank Column Footings:
  - 1. Roughen existing concrete at the interface of the bottom of the footing and top of the slab by sandblasting. Roughen the existing slab surface to the greatest extent possible by sandblasting, but 1/4-inch is not required to be achieved at these joints. Remove accumulated concrete from the exposed column rebar.
  - 2. Saturate existing slab concrete to a saturated surface dry condition just prior to placing footing concrete.
- D. Other Horizontal Joints:
  - 1. Roughen concrete at the interface of construction joints by sandblasting to expose the aggregate (1/4-inch minimum amplitude) and remove accumulated concrete on rebar immediately subsequent to form stripping. When sandblasting adjacent to installed waterstops, shield installed waterstops from the sandblasting operation. Immediately before placing fresh concrete, thoroughly clean the existing contact surface using a stiff brush or other tools and a stream of water under pressure. The surface shall be clean and wet, but free from pools of water at the moment the fresh concrete is placed.
  - 2. Remove laitance, waste mortar or other substance that may prevent complete adhesion.
- E. Vertical Joints:
  - 1. Remove accumulated concrete on rebar.
  - 2. Roughen concrete at the interface of the construction joints to expose the aggregate (1/4-inch minimum amplitude) through one of the following:
    - a. Apply roughener to the form in a thin, even film by brush, spray or roller in accordance with the manufacturer's instructions. After roughener is dry, concrete may be placed. When concrete has been placed and the form removed, wash loosened material off with high-pressure water spray to obtain roughened surface subject to approval by ENGINEER.
    - b. Sandblast after concrete has fully cured.
    - c. Waterblast after concrete has partially cured.
    - d. Perform cleaning so as not to damage waterstop, if one is present.

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### 3.3 EXPANSION JOINTS

- A. Locate and install expansion joints as shown. Install preformed joint filler or bearing pads in accordance with manufacturer's instructions. Install caulking and sealants as specified in Section 07900, Joint Sealants.

### 3.4 WATERSTOPS

- A. General:
  - 1. Comply with ACI 301, Chapter 2, and as specified below. Make all joints in accordance with manufacturer's instructions.
  - 2. Obtain ENGINEER'S approval for waterstop locations not shown.
  - 3. Provide waterstops in all basements, tanks and other substructures up to an elevation at least 12" above grade or to an elevation at least 12" above highest liquid level in tanks, whichever is higher, except where otherwise shown or noted.
- B. Polyvinyl Chloride Waterstop:
  - 1. Install waterstop in accordance with the manufacturer's printed installation instructions.
  - 2. Tie waterstops to reinforcing steel at 12-inches on center, in each direction, so that it is securely and rigidly supported in the proper position, centered in the joint, during concrete placement. Hog rings shall be used to facilitate placing and tying of waterstops to reinforcing steel forms or form-ties.
  - 3. Continuously inspect waterstops during concrete placement to ensure their proper positioning.
  - 4. Provide fused waterstops using equipment as supplied by or recommended by the manufacturer. Joints shall be inspected for strength and pinholes after splicing. Splices shall be strong enough to develop a pulling force of 75 percent of the strength of the waterstop, and shall be watertight.
  - 5. Any waterstop punctured or damaged shall be repaired or replaced.
  - 6. Cover and protect installed waterstops from UV if the pour of concrete will be delayed more than 30 days.
  - 7. Shield installed waterstops from sandblasting when performing surface roughening adjacent to installed waterstops.
- C. Hydrophilic Waterstop: Install where shown in accordance with manufacturer's recommendations.
- D. Injectable Waterstop Hose System:
  - 1. All installation, inspection, and injection operations shall be in strict accordance with the injectable hose system manufacturer's instructions and shall be done by an approved applicator of the injectable hose system manufacturer or under the direct supervision of the injectable hose system manufacturer's representative.
  - 2. Protect all injectable hoses from flame, sparks, oil, dirt, concrete splatter and damage prior to concrete pour.
  - 3. Concrete surfaces where injectable hoses are to be installed are to be clean, dry, smooth, and free from dirt and debris.
  - 4. Hoses must be located with at least 4 inches of concrete cover. Install as close as possible to centerline of wall or slab, with only the vent ends crossing over the injectable hose. Only vent ends should leave the joint.
  - 5. Do not fasten injectable hoses to reinforcing steel.
  - 6. Visible honeycombs at the surface should be patched directly after dismantling formwork to avoid loss of injection material during the injection operation.

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- E. Injectable Waterstop Injection Grout:
1. Allow concrete to cure for 28 days prior to injection work.
  2. If any leakage is evident at construction joints, inject approved injection material as a remedial measure to stop such leaks and seal the joint area.
  3. Prepare injection material and perform actual injection in strict accordance with the manufacturer's printed instructions and specifications regarding mixing, injection procedures, application pot-life, and equipment requirements.
  4. Initial injection pressure should be approximately 200-300 psi. Once the injection material has filled the joint area and is no longer flowing, gradually increase the pressure to 500-600 psi. Maintain this pressure for 3-5 minutes, allowing for the injection material to thoroughly penetrate the joint area.
  5. Once maximum pressure is maintained for the allotted time frame, disconnect the pump and follow connection procedures to inject hose from opposite end. Injection procedures must be completed within the gel time of the injection material and in accordance with the manufacturer's specifications.
  6. If injection material penetrates concrete surfaces, wipe clean with water.
  7. Piston type pumps (not diaphragm) shall be used with hydrophilic resin injections.

### 3.5 BEARING AND FILLER PADS

- A. General:
1. Bearing and filler pads shall be installed as indicated on the Drawings.
  2. Bearing and filler pads shall be glued to the concrete with an approved rubber cement material, NSF 61 approved, to prevent uplift of the pads during concrete pouring.
  3. In addition, all pads shall be held down with approved plastic shim plates placed under the reinforcing steel.
  4. Nailing down pads will not be permitted
  5. All voids and cavities between bearing and filler pads, waterstop and seismic cable sleeves, irrespective of whether these voids are large or small, shall be filled with a soft mastic / joint sealant.
  6. Closed cell neoprene shall be ordered at least 1/4 inch wider than theoretically required to facilitate placing and to reduce development of voids between filler pads, bearing pads and waterstops.
  7. Contractor's workmanship shall be such that no cement grout or concrete seepage will occur through the bearing and filler pad area resulting in a restraint of radial wall movements.
  8. A continuous neoprene pad and one or more sponge filler pads are required between the top of the wall and the underside of the roof. Any void areas between such pads shall be caulked and sealed to prevent any mortar from the roof pour to come in contact with the wall top.

### 3.6 BONDING WITH EPOXY ADHESIVE

- A. Use adhesive for the following:
1. Bonding of fresh concrete to concrete cured at least 45 days or to existing concrete.
  2. Bonding of horizontal surfaces, which will receive a topping.
- B. Handle and store epoxy adhesive in compliance with the manufacturer's printed instructions, including safety precautions.
- C. Mix the epoxy adhesive in complete accordance with the instructions of the manufacturer.

- D. Before placing fresh concrete, thoroughly roughen and clean hardened concrete surfaces and coat with epoxy adhesive not less than 1/16" thick. Place fresh concrete while the epoxy material is still tacky, without removing the in-place grout coat, and as directed by the epoxy manufacturer.

+ + END OF SECTION + +



**SECTION 03300**  
**CAST-IN-PLACE CONCRETE**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section includes: Place, finish, cure, strip, and repair concrete.

**1.2 REFERENCES**

- A. American Concrete Institute (ACI)
1. ACI 211.1, Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.
  2. ACI 214, Recommended Practice for Evaluation of Strength Test Results of Concrete.
  3. ACI 301, Specifications for Structural Concrete for Buildings, (includes ASTM Standards referred to herein).
  4. ACI 304, Guide for Measuring, Mixing, Transporting and Placing Concrete.
  5. ACI 305, Hot Weather Concreting.
  6. ACI 306, Cold Weather Concreting.
  7. ACI 309, Guide for Consolidation of Concrete.
  8. ACI 311, Guide for Concrete Inspection.
  9. ACI 318, Building Code Requirements for Reinforced Concrete.
  10. ACI 347, Guide to Formwork for Concrete
  11. ACI 350, Environmental Engineering Concrete Structures.

**1.3 SYSTEM DESCRIPTION**

- A. Class A Concrete shall be steel reinforced and includes:
1. Foundations.
  2. Walls.
  3. Slabs.
  4. Columns.
  5. Equipment bases.
  6. Pipe supports.
  7. Encasements connected to foundations.
- B. Class B Concrete shall be placed without forms or with simple forms, with little or no reinforcing, and includes:
1. Concrete fill.
  2. Curbs and gutters.
  3. Sidewalks.
  4. Thrust blocks.
  5. Encasements not connected to foundations.

**1.4 SUBMITTALS**

- A. Samples: Submit samples of materials as specified and as otherwise may be requested by ENGINEER, including names, sources and descriptions.
- B. Product Data: Submit for approval the following:

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1. Manufacturer's specifications with application and installation instructions for proprietary materials and items, including admixtures and bonding agents.
  2. List of concrete materials and concrete mix designs proposed for use. Include the results of all tests performed to qualify the materials and to establish the mix designs.
- C. Laboratory Test Reports: Submit copies of laboratory test reports for materials and mix design tests
- D. Delivery Tickets: Furnish to ENGINEER copies of all weighmaster certificate delivery tickets for each load of concrete delivered to the site. Provide items of information as specified in ASTM C94, Section 16. Delivery tickets shall be signed by a Certified Weighmaster.

## 1.5 QUALITY ASSURANCE

- A. Tests for Concrete Materials: Submit written reports to ENGINEER, for each material sampled and tested, prior to the start of Work. Provide the Project identification name and number, date of report, name of CONTRACTOR, name of concrete testing service, source of concrete aggregates, material manufacturer and brand name for manufactured materials, values specified in the referenced specification for each material, and test results. Indicate whether or not material is acceptable for intended use.
- B. If the concrete mix designs specified herein have not been used previously by the ready-mix supplier, mix proportions and concrete strength curves for regular cylinder tests shall be established by an approved ready-mix supplier or an independent testing laboratory based on the relationship of 7, 14 and 28 day strengths versus slump values of 2, 4 and 6 inches, all conforming to these Specifications. A laboratory, independent of the ready-mix supplier, shall be required to prepare and test all concrete cylinders. The costs for preparation of mix designs, not previously used by the ready-mix supplier, and testing of concrete and materials shall be borne by CONTRACTOR.

## **PART 2 - PRODUCTS**

### 2.1 CONCRETE MATERIALS

- A. Cement:
1. Portland cement, ASTM C150, Type II; or blended hydraulic cement, ASTM C595, Type 1P (MS).
  2. Do not use cement which has deteriorated because of improper storage or handling.
- B. Aggregates: ASTM C33 and as herein specified.
1. Do not use aggregates containing soluble salts, substances such as iron sulfides, pyrite, marcasite, ochre, or other materials that can cause stains on exposed concrete surfaces.
  2. Fine Aggregate: Provide clean, sharp, natural sand free from loam, clay, lumps or other deleterious substances.
  3. Coarse Aggregate: Provide clean, uncoated, processed aggregate containing no clay, mud, loam, or foreign matter, as follows:
    - a. Crushed stone, processed from natural rock or stone.
    - b. Coarse Aggregate Size: Size to be ASTM C33, Nos. 57 or 67, except that No. 467 may be used for footings, foundation mats and walls 16" or greater in thickness.

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- C. Water: Clean, free from injurious amounts of oils, acids, alkalis, organic materials or other substances that may be deleterious to concrete or steel.

## 2.2 CONCRETE ADMIXTURES

- A. Provide admixtures produced by established reputable manufacturers, and use in compliance with the manufacturer's printed instruction. Do not use admixtures that have not been incorporated and tested in the accepted mixes, unless otherwise authorized in writing by ENGINEER.
- B. Air-Entraining Admixtures: ASTM C260.
1. Product and Manufacturer: Provide one of the following:
    - a. Sika AER, as manufactured by Sika Corporation.
    - b. MasterAir AE 200, as manufactured by BASF.
    - c. Daravair, as manufactured by W.R. Grace & Conn.
    - d. Or approved equal.
- C. High-Range Water-Reducing Admixture ("Superplasticizer"): ASTM C494, Type F/G.
1. Superplasticizer shall be used in all Class A Concrete. Do not use high range water-reducing admixture containing more chloride ions than are contained in municipal drinking water. Add only at the job site to concrete in compliance with the manufacturer's printed instruction.
  2. Product and Manufacturer: Provide one of the following:
    - a. Sikament 320, as manufactured by Sika Corporation.
    - b. MasterGlenium, as manufactured by BASF.
    - c. Daracem-100, as manufactured by W.R. Grace & Conn.
    - d. Or approved equal.
- D. Water-Reducing Admixture: ASTM C 494, Type A.
1. A water-reducing, aqueous solution of a modification of the salt of polyhydroxylated organic acids. Do not use admixture containing any lignin, nitrates or chlorides added during manufacture.
  2. Product and Manufacturer: Provide one of the following:
    - a. Eucon WR-75, as manufactured by The Euclid Chemical Company.
    - b. MasterPozzoloth, as manufactured by BASF.
    - c. WRDA series, as manufactured by W.R. Grace & Conn.
    - d. Or approved equal.
- E. Pozzolanic Admixtures:
1. Pozzolanic admixtures shall not be used in structures with concrete in contact with potable water, but may be used in other concrete.
  2. Provide Mineral admixtures, when used, meeting the requirements of ASTM C618 Class F.
  3. A substitution by weight, of the portland cement by pozzolan, so that the total tricalcium aluminate content of the resulting cement plus pozzolan is not greater than 8%, will be considered. However, the pozzolan shall not exceed 20% by weight of the cement plus pozzolan.
- F. Set-Control Admixtures: ASTM C494, as follows:
1. Type B, Retarding.
  2. Type C, Accelerating.
  3. Type D, Water-reducing and Retarding.
  4. Type E, Water-reducing and Accelerating.

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5. Type F, Water-reducing, high range admixtures.
  6. Type G, Water-reducing, high range, and retarding admixtures.
- G. Calcium Chloride: Do not use calcium chloride in concrete, unless otherwise authorized in writing by ENGINEER. Do not use admixtures containing calcium chloride where concrete is placed against galvanized steel.

### 2.3 NSF/ANSI 61 CERTIFICATION

- A. Concrete that comes in direct contact with potable water shall include the following:
1. Admixtures shall be NSF-61 Certified.
  2. Concrete with admixtures not meeting NSF-61 water quality standards will be rejected.

### 2.4 PROPORTIONING AND DESIGN OF MIXES

- A. Prepare design mixes of concrete. Mixes subject to the following limitations:
1. Class A Concrete
    - a. Specified 28-day Compressive Strength:
      - 1) Prestressed Tank core walls and all Vault walls: 5,000 psi minimum.
      - 2) All other Class A Concrete: 4,000 psi minimum. 5,000 psi mix may be used.
    - b. Air content: 2.5%  $\pm$  1%.
    - c. Slump, before addition of superplasticizer: 3½"  $\pm$  ½"
    - d. Slump, after addition of superplasticizer: 8" maximum

Coarse Aggregate Size	Cementitious Content-Pounds Per Cubic Yard	Water-Cement Ratio by Weight
¾"	625 min, 800 max	0.38
1"	600 min, 800 max	0.39

- e. Use superplasticizer in all Class A Concrete. Use water reducers in combination with superplasticizers as required for mixing.
  - f. Use ASTM C494, Type B set retarding admixture in all Class A Concrete used for wall construction in the amounts recommended by the additive manufacturer whenever the air temperature during the pour exceeds 85°F.
2. Class B Concrete
- a. Specified 28-day Compressive Strength: 2,500 psi.
  - b. Maximum Water-Cement Ratio by Weight: 0.49.
  - c. Slump: 3" Minimum, 5" Maximum.
- B. The total chloride ion content of hardened concrete shall not be more than 0.06 percent by weight of cement.
- C. Use an independent testing facility acceptable to ENGINEER for preparing and reporting proposed mix designs.
- D. Admixtures:
1. Use amounts of admixtures as recommended by the manufacturer for climatic conditions prevailing at the time of placing. Adjust quantities and types of admixtures as required to maintain quality control.

## 2.5 EPOXY BONDING AGENT

- A. For use in all dry-packed holes, concrete repair and for unplanned cold-joints.
- B. Provide an epoxy-resin bonding agent, two component, polysulfide type.
- C. Product and Manufacturer: Provide one of the following:
  - 1. Sikadur 32, Hi-Mod LPL, as manufactured by Sika Corporation.
  - 2. Eucopoxy LPL, as manufactured by the Euclid Chemical Company.
  - 3. Or approved equal.

## 2.6 CONCRETE CURING MATERIALS

- A. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 10 ounces per square yard and complying with AASHTO M182, Class 3.
- B. Moisture-Retaining Cover: One of the following, complying with ASTM C171.
  - 1. Waterproof paper.
  - 2. Polyethylene film.
  - 3. White burlap-polyethylene sheet.
- C. Curing Compound:
  - 1. Where compound is used on potable water bearing structures provide NSF-61 Certified:
    - a. Product and Manufacturer: Provide one of the following:
      - 1) Quantum-Cure 61, as manufactured by Atlas Tech Products.
      - 2) Or approved equal.
  - 2. Where compound is used on non-potable concrete surfaces: ASTM C309 Type 1-D (water retention requirements):
    - a. Product and Manufacturer: Provide one of the following:
      - 1) Super Aqua Cure VOX, as manufactured by The Euclid Chemical Company.
      - 2) Sealtight 1100, as manufactured by W.R. Meadows, Incorporated.
      - 3) Or approved equal.

## 2.7 EMBEDDED ITEMS

- A. Provide and install items such as plates, angles, inserts, bolts and similar items not specified elsewhere under this Section. Carbon steel embedded items shall be hot dip galvanized after fabrication.

## **PART 3 - EXECUTION**

### 3.1 CONCRETE MIXING

- A. Provide concrete produced by the ready-mixed process.
- B. Comply with the requirements of ASTM C 94, and as herein specified. Proposed changes in mixing procedures, other than herein specified, must be accepted by ENGINEER before implementation.
  - 1. Plant equipment and facilities: Conform to National Ready- Mix Concrete Association "Plant and Delivery Equipment Specification."

2. Mix concrete in revolving type truck mixers that are in good condition and which produce thoroughly mixed concrete of the specified consistency and strength.
3. Do not exceed the proper capacity of the mixer.
4. Mix concrete for a minimum of two minutes after arrival at the job site, or as recommended by the mixer manufacturer.
5. Mix concrete during transit only as recommended by the mixer manufacturer.
6. Mix at proper speed until concrete is discharged.
7. Maintain adequate facilities at the job site for continuous delivery of concrete at the required rates.
8. Provide access to the mixing plant for ENGINEER at all times.

### 3.2 TRANSPORTING CONCRETE

- A. Transport and place concrete not more than 90 minutes after water has been added to the dry ingredients or before 250 revolutions of the drum or blades, whichever occurs first.
- B. If an admixture is used to retard the set time and the concrete temperature does not exceed 85 degrees F, the travel and placing time may be extended to 120 minutes or 300 revolutions of the drum or blades, whichever occurs first.
- C. Take care to avoid spilling and separation of the mixture during transportation.
- D. Do not place concrete in which the ingredients have been separated.
- E. Do not retemper partially set concrete.
- F. Use suitable and approved equipment for transporting concrete from mixer to forms.

### 3.3 CONCRETE PLACEMENT

- A. Pre-wet granular fill below concrete floor slabs and footings to a saturated surface dry condition immediately prior to pouring concrete.
- B. General: Place concrete continuously so that no concrete will be placed on concrete, which has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, provide construction joints as specified in Section 03251, Concrete Joints. Deposit concrete as nearly as practical in its final location to avoid segregation due to rehandling or flowing. Do not subject concrete to any procedure that will cause segregation.
  1. Screed concrete that is to receive other construction to the proper level to avoid excessive skimming or grouting.
  2. Do not use concrete which becomes non-plastic and unworkable, or does not meet the required quality control limits, or which has been contaminated by foreign materials. Do not use retempered concrete. Remove rejected concrete from the job site and dispose of it in an acceptable location.
  3. Do not place concrete until all forms, bracing, reinforcement, and embedded items are in final and secure position.
  4. Do not place in cold weather, unless adequate precautions are taken against frost action.
  5. Do not place footings or slabs on frozen soil.
  6. Unless otherwise approved, place concrete only when ENGINEER is present.

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7. Allow a minimum of 3 days of curing before placing new concrete against a slab or wall already in place.
- C. Concrete Conveying:
1. Handle concrete from the point of delivery and transfer to the concrete conveying equipment and to the locations of final deposit as rapidly as practical by methods that will prevent segregation and loss of concrete mix materials.
  2. Provide mechanical equipment for conveying concrete to ensure a continuous flow of concrete at the delivery end. Provide runways for wheeled concrete conveying equipment from the concrete delivery point to the locations of final deposit. Keep interior surfaces of conveying equipment, including chutes, free of hardened concrete, debris, water, ice and other deleterious materials.
  3. Pumping concrete is permitted, however do not use aluminum pipe for conveying.
- D. Placing Concrete into Forms:
1. Deposit concrete in forms in horizontal layers not deeper than 24" and in a manner to avoid inclined construction joints. Where placement consists of several layers, place concrete at such a rate that concrete that is being integrated with fresh concrete is still plastic.
  2. Do not permit concrete to free fall within the form from a distance exceeding 8'-0", except as noted in Section 03100. Use "elephant trunks" or "wall pipes" to prevent free fall and excessive splashing on forms and reinforcement.
  3. Remove temporary spreaders in forms when concrete placing has reached the elevation of such spreaders.
  4. Consolidate concrete placed in forms by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with the applicable recommended practices of ACI 309. Vibration of forms and reinforcing will not be permitted.
  5. Vibrators shall have a frequency of at least 8,000 vpm, with amplitude required to consolidate the concrete in the section being placed. At least one stand-by vibrator in operable condition shall be at the placement site prior to initiating placement of the concrete.
  6. Do not use vibrators to transport concrete inside of forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate the layer of concrete and at least 6" into the preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit the duration of vibration to the time necessary to consolidate the concrete and complete embedment of reinforcement and other embedded items without causing segregation of the mix.
  7. The forms shall contain sufficient windows or be limited in height to allow visual observation of the concrete and the vibrator operators shall be required to see the concrete being consolidated to ensure good quality workmanship or the CONTRACTOR shall have a person who is actually observing the vibration of the concrete at all times and advising the vibrator operators of any changes needed to assure complete consolidation.
  8. Do not place concrete in beam and slab forms until the concrete previously placed in columns and walls is no longer plastic.
  9. Force concrete under pipes, sleeves, openings and inserts from one side until visible from the other side to prevent voids.
  10. The following minimum equipment, which must be in excellent working condition, shall be available on the site for every concrete placement operation on prestressed concrete floor, wall and roof:

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- a. Conveying: 2 pumps, or 2 cranes, or 1 pump and 1 crane (for floor and roof decks only).
  - b. Vibrating: 3 vibrators of 14,000 vibrations per minute (minimum).
  - c. Trowelling: 2 power operated troweling machines (for floor and roof decks only).
  - d. ENGINEER shall be the sole judge as to the acceptability of the equipment as to its condition and capacity. CONTRACTOR shall assume complete responsibility for having adequate equipment.
- E. Placing Concrete Slabs and Footings:
- 1. Deposit and consolidate concrete in a continuous operation, within the limits of construction joints, until the placing of a panel or section is completed.
  - 2. Consolidate concrete during placing operations using mechanical vibrating equipment, so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
  - 3. Consolidate concrete placed in beams and girders of supported slabs, and against bulkheads of slabs on ground, as specified for formed concrete structures.
  - 4. Bring surfaces to the correct level. Smooth the surface, leaving it free of humps or hollows. Do not sprinkle water on the plastic surface. Do not disturb the surfaces prior to beginning finishing operations.
- F. Bonding for Next Concrete Pour: Per Section 03251, Concrete Joints.
- G. Quality of Concrete Work:
- 1. Make all concrete solid, compact and smooth, and free of laitance, cracks and cold joints.
  - 2. All concrete for liquid retaining structures, and all concrete in contact with earth, water, or exposed directly to the elements shall be watertight.
  - 3. Cut out and properly replace to the extent ordered by ENGINEER, or repair to the satisfaction of ENGINEER, surfaces which contain cracks or voids, are unduly rough, or are in any way defective. Thin patches or plastering will not be acceptable.
  - 4. Repair all leaks through concrete, and cracks, holes or other defective concrete in areas of potential leakage and make watertight.
  - 5. Repair, remove, and replace defective concrete as ordered by ENGINEER at no additional cost to OWNER.
- H. Cold Weather Placing:
- 1. Protect all concrete Work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures, in compliance with the requirements of ACI 306 and as herein specified.
  - 2. When the air temperature has fallen to or may be expected to fall below 40°F, provide adequate means to maintain the temperature, in the area where concrete is being placed, at between 50°F and 70°F for at least seven days after placing. Provide temporary housings or coverings including tarpaulins or plastic film. Maintain the heat and protection, if necessary, to ensure that the ambient temperature does not fall more than 30°F in the 24 hours following the seven-day period. Avoid rapid dry-out of concrete due to overheating, and avoid thermal shock due to sudden cooling or heating.
  - 3. When air temperature has fallen to or is expected to fall below 40°F, uniformly heat all water and aggregates before mixing as required to obtain a concrete mixture temperature of not less than 55°F and not more than 85°F at point of placement.
  - 4. Do not use frozen materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials. Ascertain that forms,

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reinforcing steel, and adjacent concrete surfaces are entirely free of frost and ice before placing concrete.

5. When temperatures are expected to be below 32°F the night before the concrete is placed, then all reinforcing steel, forms and the ground shall be preheated, for a minimum of 12 hours, under a minimum temperature of 50°F.
  6. Do not use salt and other materials containing antifreeze agents or chemical accelerators, or set-control admixtures, unless approved by ENGINEER, in mix designs.
  7. Weather predictions made by the nearest NOAA station, and corrected for the local elevation and environmental conditions, may be used to determine whether cold weather protection shall be required. Thermometers will be used by ENGINEER and these readings shall determine whether cold weather protection shall be required and whether cold weather protection is adequate.
- I. Hot Weather Placing:
1. When hot weather conditions exist as any combination of high air temperature, low relative humidity and wind velocity that would seriously impair the quality and strength of concrete, place concrete as recommended by ACI 305 and as herein specified.
  2. Cool ingredients before mixing to maintain concrete temperature at time of placement below 85°F. No concrete shall be placed if its temperature exceeds 90°F. Mixing water may be chilled, or chopped ice may be used, or liquid nitrogen may be added. Ice, when introduced into the mixer shall be in such form that it will be completely melted and dispersed throughout the mix at the completion of the mixing time. The addition of ice shall not increase the specified water to cement ratio.
  3. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that the steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
  4. Thoroughly wet forms before placing concrete. Forms shall be free of standing water when concrete is placed.
  5. Do not use set-control admixtures, unless approved by ENGINEER in mix designs.
  6. Fog spray shall be used during finishing operations whenever necessary to avoid surface plastic shrinkage cracking. Fog spray shall also be used after finishing and before the specified curing is commenced to avoid surface plastic shrinkage cracking.
  7. Obtain ENGINEER'S approval of other methods and materials proposed for use.
- J. Removal of Forms:
1. The CONTRACTOR shall be responsible for all damage resulting from improper and premature removal of forms. Satisfy all applicable OSHA requirements with regard to safety of personnel and property.
  2. Forms and shoring for elevated structural slabs shall remain in place in accordance with ACI 318, Chapter 6, and until the concrete has reached a compressive strength equal to 100% of the specified 28-day compressive strength as determined by test cylinders, unless noted otherwise in Section 03100 - Concrete Formwork. Removal of all supports prior to obtaining adequate field cured cylinder results and reshoring shall not be permitted.
- K. Backfill Against Walls:
1. Do not place backfill against walls until the concrete has obtained a compressive strength equal to the specified 28-day compressive strength and prestressing is complete. Where backfill is to be placed on both sides of the wall, the backfill shall be placed simultaneously on both sides to prevent differential pressures.

2. Since the walls of some structures are laterally restrained or supported by suspended slabs and/or slabs on grade and are not designed as cantilever retaining walls, the CONTRACTOR shall submit a schedule of wall shoring, bracing, and backfilling that is coordinated with the concrete curing, test cylinder reports and the design assumptions and obtain a review from the ENGINEER prior to proceeding.

L. Patching:

1. Patching of concrete shall provide an acceptable and structurally sound surface finish uniform in appearance or the CONTRACTOR shall upgrade the finish by other means at no additional cost.
2. Tie Holes: All tie holes, except where sealant is indicated, shall be filled with dry pack nonshrink grout. White cement shall be added as needed so the color of grout after curing matches the color of adjacent concrete. Tie holes shall be thoroughly sandblasted or roughened. Flush the patch area with water and allow to dry. Coat the surface of the existing concrete with an approved bonding agent prior to filling with nonshrink grout. Complete the repair in the time duration specified by the bonding agent manufacturer. The grout shall be rammed into place in thin layers and leveled to the plane of the surrounding concrete. Cure in accordance with the manufacturer's recommendations.
3. Defective Areas: Remove all defective concrete such as honeycombed areas and rock pockets out to sound concrete. Small shallow holes caused by air entrapment at the surface of the forms shall not be considered defects unless the amount is so great as to be considered not the standard of the industry and due primarily of poor workmanship. If chipping is required, the edges shall be perpendicular to the surface. Feather edges shall not be permitted. The defective area shall be filled with a nonshrink, nonmetallic, grout. Use an approved bonding agent on horizontal patches prior to placing nonmetallic, non shrink grout. Since some bonding agents may not be compatible for some vertical surface patching techniques, demonstrate all methods for repair of vertical surfaces using the actual materials, methods, and curing procedures required by the manufactures of the materials on the project site. The CONTRACTOR shall consult with representatives of the bonding agent manufacturer and the nonshrink grout manufacturer, and these representatives shall be onsite and assist in the demonstration.
4. Blockouts at Pipes or Other Penetrations: Conform to details shown or submit proposed blockouts for review. Use nonshrink, nonmetallic grout.

### 3.4 FINISH OF FORMED SURFACES

A. Abrasive Blasting:

1. The exterior surface of poured concrete wall areas, which will receive strand wrapped prestressing/shotcrete or paint, if any, shall be abrasive blasted, regardless of the forming method used, by a mechanical etching or shot blast system combined with a vacuum recovery system, or a self-contained water blasting system.
2. The surface shall be blasted sufficiently to remove all laitance, form oil or other type coatings.
3. The surface shall be cut sufficiently to provide a good mechanical bond between the shotcrete covercoat and the concrete wall. The surface shall be cut to a minimum CSP5 profile, was established by the International Concrete Repair Institute (ICRI), over a minimum 90% of the area as measured over any one-foot square area.
4. Systems that have not been used in the past to prepare circular tank wall surfaces for shotcreting and strand wrapping or systems which rely on sandblasting or steel shot without a vacuum system will not be allowed.

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5. All abrasive blasting shall be done to the satisfaction of ENGINEER, and this work shall not be started before the completion date of the curing period or before all the tie holes have been dry packed.
- B. Rough Form Finish:
1. Standard rough form finish is with concrete surface having the texture imparted by the form material, with tie holes and defective areas repaired and patched with mortar of 1 part cement to 1½ parts sand & all fins and other projections exceeding 1/4" in height rubbed down or chipped off.
  2. Use rough form finish for the following:
    - a. Where not abrasive blasted, exterior vertical surfaces up to 1' below grade.
- C. Smooth Form Finish:
1. Provide a surface finish Environmental Surface Finish 2.0, ESF-2.0, per ACI 350.5-12 which includes patching voids greater than 3/4-in wide or 1/4-inch deep, removing projections greater than 1/4-in, and patching tie holes. Abrupt irregularities shall be measured within 1-inch of the irregularity. Gradual surface irregularities shall be measured by determining the gap between concrete and near surface of a 5-foot vertical straightedge, measured between contact points. Finish shall be approved using a mockup demonstration of the concrete surface showing the appearance and texture.
  2. Except where surfaces have been previously covered as specified above, use smooth finish for the following:
    - a. Interior walls and other interior vertical surfaces.
    - b. Undersides of suspended slabs.
    - c. Other areas shown.
- D. Smooth Rubbed Finish:
1. Provide smooth, rubbed finish to concrete surfaces which have received smooth form finish as follows:
    - a. Rubbing of concrete surfaces not later than the day after form removal.
    - b. Moistening of concrete surfaces and rubbing with carborundum brick or other abrasive until a uniform color and texture is produced. Do not apply cement grout other than that created by the rubbing process.
  2. Except where surfaces have been previously covered as specified above, use smooth rubbed finish for the following:
    - a. Exterior exposed walls and other vertical surfaces down to 1' below grade.
    - b. Other areas shown.
- E. Related Unformed Surfaces:
1. At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike off smooth and finish with a texture matching the adjacent formed surfaces. Continue the final surface treatment of formed surfaces uniformly across the adjacent unformed surfaces, unless otherwise shown.

### 3.5 MONOLITHIC SLAB FINISHES

- A. Float Finish:
1. After placing concrete slabs, do not work the surface further until ready for floating. Begin floating when the surface water has disappeared or when the concrete has stiffened sufficiently. Check and level the surface plane to a tolerance not exceeding 1/4" in 10' when tested with a 10' straightedge. Cut down high spots and fill all low

spots. Uniformly slope surface to drains as shown. Immediately after leveling, refloat the surface to a uniform, smooth, granular texture.

2. Use float finish for the following:
  - a. Exterior below grade horizontal surfaces.
  - b. Surfaces to receive additional finishes, except as shown or specified.
- B. Trowel Finish:
  1. After floating, begin the first trowel finish operation using a power-driven trowel. Begin final troweling when the surface produces a ringing sound as the trowel is moved over the surface.
  2. Consolidate the concrete surface by the final hand troweling operation. Finish shall be free of trowel marks, uniform in texture and appearance, and with a surface plane tolerance not exceeding 1/8" in 10' when tested with a 10' straight edge. Grind smooth surface defects that would telegraph through applied floor covering system.
  3. Use trowel finish for the following:
    - a. Interior exposed slabs, unless otherwise shown or specified.
- C. Non-Slip Broom Finish:
  1. Immediately after float finishing, slightly roughen the concrete surface by brooming in the direction perpendicular to the main traffic route. Use fiber-bristle broom, unless otherwise directed. Coordinate the required final finish with ENGINEER before application.
  2. Use Non-Slip Broom Finish for the following:
    - a. Exterior exposed horizontal.
    - b. Interior and exterior concrete steps and ramps.

### 3.6 CONCRETE CURING AND PROTECTION

- A. General:
  1. Protect freshly placed concrete from premature drying and excessive cold or hot temperature, and maintain without drying at a relatively constant temperature for the period of time necessary for hydration of the cement and proper hardening of the concrete.
  2. Start initial curing after placing and finishing concrete as soon as free moisture and bleed water sheen has disappeared from the concrete surface. Keep concrete continuously moist during initial curing.
  3. Begin final curing procedures immediately following initial curing and before the concrete has dried. The total curing duration shall not be less than ten (10) days. Avoid rapid drying at the end of the final curing period.
- B. Use one of the following methods as approved by ENGINEER:
  1. Walls:
    - a. Method 1: Leave concrete forms in place and keep exposed concrete surfaces wet for the entire curing duration. If forms are loosened and the contact between the concrete surface and forms is broken and the forms left in place, then the entire wall shall be wet cured.
    - b. Method 2: Continuously sprinkle or fog with water 100 percent of the exposed surfaces for the curing duration immediately after removal of forms.
    - c. Method 3: When approved by ENGINEER and as noted below, apply curing compound immediately after removal of forms.
  2. Prestressed Concrete Slabs and Curbs: All horizontal, floated and troweled surfaces shall be sprayed with a curing compound at an application rate of 200 sf per gallon immediately after finishing. After the surface is dry to the touch, a moisture-retaining

covering shall be installed. The seams and ends shall be carefully taped with waterproof tape and sealed to the concrete surface and kept on such surface for as long as possible, but for at least ten (10) days after placement, to minimize the loss of moisture trapped between the cover and the concrete.

- a. Water must be introduced between the moisture-retaining cover and the concrete (after the concrete has set) whenever moist drops cannot be detected on the concrete side of the cover or the concrete surface is noticeably dry.
  - b. Immediately repair any holes or tears during the curing period using cover material and waterproof tape.
3. Slab and Curbs not including prestressed concrete tanks:
- a. Method 1: Protect surface by water ponding for the entire curing duration.
  - b. Method 2: Cover concrete surfaces and exposed edges with the specified absorptive cover, thoroughly saturating the cover with water, and keeping the absorptive cover continuously wet with sprinklers or porous hoses during the curing duration. Lap adjacent absorptive cover sections 3-inches minimum.
  - c. Method 3: Cover the concrete surfaces and exposed edges with the specified moisture-retaining cover during the curing duration. Seal edges and seams with waterproof tape, adhesive or sand berm. Water must be introduced between the moisture-retaining cover and the concrete surface whenever moist drops cannot be detected on the concrete side of the cover or the concrete surface is noticeably dry.
  - d. Method 4: Cover all exposed surfaces with 1-inch minimum layer of wet sand, earth, or sawdust and keep continuously wet for the curing duration.
  - e. Method 5: Continuously sprinkle or fog exposed surfaces for the curing duration.
  - f. Method 6: When approved by ENGINEER and as noted below, apply liquid curing compound immediately after final finishing when surface will no longer be damaged by traffic necessary to apply curing compound.
- C. Liquid curing compound:
1. Apply the specified curing compound to concrete surfaces when permitted by ENGINEER. Slabs to receive terrazzo floors, concrete/grout topping or ceramic tile, concrete of water bearing structures, and concrete that will receive coatings shall not be cured with liquid curing compound. The compounds shall be applied by power spray equipment in accordance with the manufacturer's directions. Recoat areas, which are subjected to heavy rainfall within 3 hours after initial application. Maintain the continuity of the coating and repair damage to the coat during the entire curing period. Remove curing compound from exposed surfaces at the end of the curing duration. For concrete surfaces, which will be in contact with potable water, the manufacturer shall certify that the curing compound used is NSF 61 approved.
- D. Temperature of Concrete During Curing:
1. When the nighttime low temperature may drop to 40°F or below, maintain the concrete temperature between 50°F and 70°F continuously throughout the curing period, by heating, covering, insulation or housing as required.
  2. When the daytime high temperature may rise to 90°F or above, maintain the concrete temperature at a minimum and reduce temperature variations by providing moist curing continuously for the concrete curing period.
  3. During either of the conditions specified above, the minimum curing time shall be 10 days (240 hours), after which coverings, housings, and insulation shall remain on the work for an additional 3 days, to allow gradual temperature equalization with the atmosphere.

- E. Protection from Mechanical Injury: During the curing period, protect concrete from damaging mechanical disturbances including load stresses, heavy shock, excessive vibration, and from damage caused by rain or flowing water. Protect all finished concrete surfaces from damage by subsequent construction operations.

### 3.7 FIELD QUALITY CONTROL

- A. The OWNER will employ a testing laboratory to perform field quality control testing. ENGINEER will direct the number of tests and cylinders required. Furnish all necessary assistance required by ENGINEER.
- B. Quality Control Testing During Construction:
  - 1. Perform sampling and testing for field quality control during the placement of concrete, as follows:
    - a. Sampling Fresh Concrete: ASTM C172.
    - b. Slump: ASTM C143; one test for each concrete load at point of discharge; and one for each set of compressive strength test specimens.
    - c. Compressive Strength Tests: ASTM C39; one set of 4 standard compression cylinders for each 100 cubic yards or fraction thereof, of each mix design placed in any one day; 1 specimen tested at 7 days, and 2 specimens tested at 28 days, 1 held. Cast, store and cure specimens as specified in ASTM C31.
      - 1) Adjust mix if test results are unsatisfactory and resubmit for ENGINEER'S approval.
      - 2) Concrete that does not meet the strength requirements is subject to rejection and removal from the Work, or to other such corrective measures as directed by ENGINEER, at the expense of CONTRACTOR.
      - 3) In addition to the test cylinders referred to in Section 03300.3.7.B.1.c, an additional 3 test cylinders shall be made for each day's pour, or for every 4,000 square feet of wall and roof surface, whichever provides the largest number of cylinders. They shall be cured in the same manner, and in the same location of the concrete area to be investigated. Before walls may be prestressed, or before roof forms may be stripped, at least one cylinder, of each batch of 3 cylinders, must be tested to verify whether the in place concrete strength meets the minimum specified design strength.
    - d. Concrete Temperature: Test each time a slump test is made.
  - 2. Where questionable field conditions may exist during placing concrete or immediately thereafter, strength tests of specimens cured under field conditions will be required by ENGINEER to check the adequacy of curing and protecting of the concrete placed. Specimens shall be molded at the same time and from the same samples as the laboratory cured specimens.
    - a. Provide improved means and procedures for protecting concrete when the 28-day compressive strength of field- cured cylinders is less than 85% of companion laboratory-cured cylinders.
    - b. When laboratory-cured cylinder strengths are appreciably higher than the minimum required compressive strength, field-cured cylinder strengths need not exceed the minimum required compressive strength by more than 500 psi even though the 85 percent criterion is not met.
  - 3. The testing laboratory shall submit certified copies of test results directly to ENGINEER and CONTRACTOR after tests are made.
- C. Evaluation of Quality Control Tests:

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1. Do not use concrete delivered to the final point of placement that has slump or temperature outside the specified values, nor that which is older than 90 minutes from batching, unless a retarding admixture is used as indicated in section 3.2.
  2. Compressive strength tests for laboratory-cured cylinders will be considered satisfactory if the averages of all sets of three consecutive compressive strength tests results equal or exceed the 28-day design compressive strength of the type or class of concrete; and, no individual strength test falls below the required compressive strength by more than 500 psi.
  3. If the compressive strength tests fail to meet the minimum requirements specified, the concrete represented by such tests will be considered deficient in strength and subject to replacement, reconstruction or to other action approved by ENGINEER.
- D. Testing Concrete Structure for Strength:
1. When there is evidence that the strength of the in-place concrete does not meet specification requirements, provide the services of a concrete testing service to take cores drilled from hardened concrete for compressive strength determination at no additional expense to OWNER. Provide tests complying with ASTM C42 and the following:
    - a. Take at least three (3) representative cores from each member or suspect area at locations directed by ENGINEER.
    - b. Strength of concrete for each series of cores will be considered satisfactory if their average compressive strength is at least 85% and no single core is less than 75% of the 28-day required compressive strength.
    - c. Report test results, in writing, to ENGINEER on the same day that tests are made. Include in test reports the Project identification name and number, date, name of CONTRACTOR, name of concrete testing service, location of test core in the structure, type or class of concrete represented by core sample, nominal maximum size aggregate, design compressive strength, compression breaking strength and type of break (corrected for length-diameter ratio), direction of applied load to core with respect to horizontal plane of the concrete as placed, and the moisture condition of the core at time of testing.
  2. Fill core holes solid with non-shrink, high strength grout, and finish to match adjacent concrete surfaces.
- E. Water Leakage Tests for All Water-Holding Structures:
1. For prestressed concrete tanks, reference Section 03314 - Prestressed Concrete Tanks for requirements.

### 3.8 MISCELLANEOUS CONCRETE ITEMS

- A. Filling-In: Fill-in holes and openings left in concrete structures for the passage of work by other contractors, unless otherwise shown or directed, after the work of other contractors is in place. Mix, place and cure concrete as herein specified, to blend with in-place construction. Provide all other miscellaneous concrete filling shown or required to complete the Work.
- B. Curbs:
1. Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
  2. Exterior curbs shall have rubbed finish for vertical surfaces and a broomed finish for top surfaces.

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C. Equipment Bases:

1. Unless specifically shown otherwise, provide concrete bases for all pumps and other equipment. Construct bases to the dimensions shown, or as required to meet manufacturers' requirements and drawing elevations. Where no specific elevations are shown, bases shall be 6-inches thick and extend 3-inches outside the metal equipment base or supports. Bases to have smooth trowel finish, unless a special finish is required. In those cases, provide appropriate concrete finish.
2. Include all concrete equipment base work not specifically included under other Sections.
3. In general, place bases up to 1-inch below the metal base. Properly shim equipment to grade and fill 1-inch void with non-shrink grout as specified in Section 03600, Grout.

D. Installation of embedded items

1. Install all embedded items prior to concrete placement, or, if necessary, as soon after concrete placement as possible, before concrete is set.
2. Use temporary support and bracing to keep embedded items in place while concrete cures.
3. Protect all embedded items from damage during concrete installation.

### 3.9 CONCRETE REPAIRS

A. Repair of Formed surfaces:

1. Repair exposed-to-view formed concrete surfaces that contain defects which adversely affect the appearance of the finish. Surface defects that require repair include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, and holes left by the rods and bolts; fins and other projections on the surface; and stains and other discolorations that cannot be removed by cleaning.
2. Repair concealed formed concrete surfaces that may contain defects that adversely affect the durability of the concrete. Surface defects that require repair include cracks in excess of 0.01-inch wide, cracks of any width and other surface deficiencies which penetrate to the reinforcement or completely through non-reinforced sections, honeycomb, rock pockets, holes left by tie rods and bolts, and spalls except minor breakage at corner.
3. Repair structural cracks and cracks in water-holding structures.

B. Method of Repair of Formed Surfaces:

1. Repair and patch defective areas with cement mortar immediately after removal of forms and as directed by ENGINEER.
2. Cut out honeycomb, rock pockets, voids over 1/2" diameter, and holes left by tie rods and bolts, down to solid concrete but, in no case, to a depth of less than 1". Make edges of cuts perpendicular to the concrete surface. Before placing the cement mortar, thoroughly clean, dampen with water, and brush-coat the area to be patched with the specified bonding agent.
  - a. For exposed-to-view surfaces, blend white portland cement and standard portland cement so that, when dry, the patching mortar color will match the color of the surrounding concrete. CONTRACTOR shall impart texture to repaired surfaces to match texture of existing adjacent surfaces. Provide test areas at inconspicuous locations to verify mixture, texture and color match before proceeding with the patching. Compact mortar in place and strike off slightly higher than the surrounding surface.



3. Cracks which require repair shall be pressure grouted, epoxy injected, using one of the following in accordance with Section 03740. Apply in accordance with the manufacturer's directions and recommendations.
    - a. Sikadur 35, Hi-Mod L.V. and Sikadur 31, Hi-Mod Gel, as manufactured by Sika Corporation Company.
    - b. Or approved equal.
  4. Fill holes extending through concrete by means of a plunger- type gun or other suitable device from the least exposed face, using a flush stop held at the exposed face to ensure completely filling.
  5. Sandblast exposed-to-view surfaces that require removal of stains, grout accumulations, sealing compounds, and other substances marring the surfaces. Use sand finer than No. 30 and air pressure from 15 to 25 psi.
- C. Repair of Unformed Surfaces:
1. Test unformed surfaces, such as monolithic slabs, for smoothness and to verify surface plane to the tolerances specified for each surface and finish. Correct low and high areas as herein specified.
  2. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness, using a template having the required slope. Correct high and low areas as herein specified.
  3. Repair finish of unformed surfaces that contain defects which adversely affect the durability of the concrete. Surface defects, as such, include crazing, cracks in excess of 0.01-inch wide or which penetrate to the reinforcement or completely through non-reinforced sections regardless of width, spalling, popouts, honeycomb, rock pockets, and other objectionable conditions.
  4. Repair structural cracks and cracks in water-holding structures.
- D. Methods of Repair of Unformed Surfaces:
1. Correct high areas in unformed surfaces by grinding, after the concrete has cured sufficiently so that repairs can be made without damage to adjacent areas.
  2. Correct low areas in unformed surfaces during, or immediately after completion of surface finishing operations by cutting out the low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Use one of the following. Apply in accordance with the manufacturer's directions and recommendations.
    - a. Euco Poly-Patch, as manufactured by The Euclid Chemical Company.
    - b. Sikatop 122, as manufactured by Sika Corporation.
    - c. Or approved equal.
  3. Repair defective areas, except random cracks and single holes not exceeding 2" diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts, and expose reinforcing steel with at least 3/4" clearance all around. Dampen all concrete surfaces in contact with patching concrete and brush with the specified bonding agent. Place patching concrete before grout takes its initial set. Mix patching concrete of the same materials and proportions to provide concrete of the same type or class as the original adjacent concrete. Place, compact and finish as required to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete.
  4. Repair isolated random cracks, as approved by ENGINEER, and single holes not over 2" diameter, by the dry-pack method. Groove the top of cracks, and cut out holes to sound concrete and clean of dust, dirt and loose particles. Dampen all cleaned concrete surfaces and brush with the specified bonding agent. Place dry-pack before the cement grout takes its initial set. Mix dry-pack, consisting of 1 part portland cement to 2 parts fine aggregate passing a No. 16 mesh sieve, using only enough

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water as required for handling and placing. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched areas continuously moist for not less than 72 hours.

5. Cracks which extend through the full member section, or any cracks determined by ENGINEER to require pressure grouting repair, shall be pressure grouted, epoxy injected, using one of the following in accordance with Section 03740. Apply in accordance with the manufacturer's directions and recommendations.
    - a. Sikadur 35, Hi-Mod L.V. and Sikadur 31, Hi-Mod Gel, as manufactured by Sika Corporation.
    - b. Or approved equal.
  6. Assure that surface is acceptable for flooring material to be installed in accordance with manufacturer's recommendations.
- E. Other Methods of Repair:
1. Repair methods not specified above may be used if approved by ENGINEER.

+ + END OF SECTION + +

## SECTION 03314

### PRESTRESSED CONCRETE TANK

#### **PART 1 - GENERAL**

##### **1.1 DESCRIPTION**

###### A. Scope:

1. This section covers the complete furnishing and installation of seven-wire strand and bars for circumferential and vertical prestressing, respectively, of concrete walls and the complete shotcreting operations. This section also covers the qualifications for the Contractor, the Tank Contractor, the Specialty Tank Prestressor and the Shotcreter. This section also covers general requirements for the tank and construction materials used in the tank. In the event of a discrepancy between this section of the Specifications and any other section of the Specifications, this section shall govern. The words "stressing machine" may refer to either circumferential wrapping machinery or vertical threadbar stressing equipment.
2. The Contractor shall furnish and erect a prestressed concrete tank of the capacity shown on the Drawings, consisting of a concrete roof, concrete floor and a poured in place concrete core wall, post tensioned vertically with steel rods and circumferentially with wrapped strand and protected with several coats of shotcrete and paint.
3. The tank shall conform to the dimensions and be equipped with the appurtenances shown on the Drawings and as specified herein.

##### **1.2 REFERENCES**

###### A. American Concrete Institute (ACI)

1. ACI 318, Building Code Requirements for Reinforced Concrete.
2. ACI 350, Environmental Engineering Concrete Structures.

###### B. American Water Works Association (AWWA)

1. D110-13, Wire- and Strand-Wound Circular, Prestressed Concrete Water Tanks

##### **1.3 SCOPE OF WORK**

###### A. Work by CONTRACTOR

1. Due to the nature of the project, it is the intent of these Specifications to obtain a first class product with emphasis on overall safety, quality and quality control, both during and after the construction process. Only Contractors experienced in the construction of strand wrapped prestressed concrete tanks are qualified to bid on and construct this tank project. Contractors shall have successfully completed at least five (5) circumferentially strand wrapped AWWA D110 Type 1 prestressed concrete tanks of at least 1.0 MG in capacity in the last ten (10) years. At least 2 of the above tanks shall have been in successful service for a minimum of five years. If the tank construction is subcontracted, the Tank Subcontractor, or one of its divisions, shall be required to meet the above-specified experience qualifications.

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2. In order to meet the experience requirements, the five (5) completed AWWA D110 Type 1 tanks shall be similar (i.e. freed wall base, poured-in-place core wall, externally machine strand wrapped, etc.) in design to the specified tank. Experience with tanks having fixed wall bases, mild-steel reinforced tank core walls, shotcrete tank core walls, precast tank core walls or tank core walls incorporating external solid wire wrapping systems or internal stressing systems shall not be considered in meeting the required experience requirements. All tanks listed for CONTRACTOR's experience requirements must have been built in CONTRACTOR's own name, or one of its divisions. Experience of personnel associated with CONTRACTOR or hired by the CONTRACTOR will not be considered unless CONTRACTOR can demonstrate that the work was contracted and performed directly by the listed Tank Contractor, or one of its divisions, in its business name.
3. The proposed Tank construction superintendent shall be currently employed by the qualified Tank Contractor, or one of its divisions, and shall have been the tank construction superintendent on no less than two (2) strand wrapped prestressed concrete tanks during the last five years. The qualified tank superintendent shall have been in the direct employment of the qualified Tank Contractor, or one of its divisions, for both of the tanks listed and will be required to be on the project site in responsible charge, full-time, during all tank concrete construction activities.
4. The OWNER is desirous of obtaining a prestressed concrete tank which will not develop structural and aesthetic problems. Therefore, as evidenced by these Specifications and Drawings, a strong emphasis on performance has been made to assure that desired details and proven construction methods be utilized to provide the highest quality structure available. For example, the stringent forming and pouring methods, the close tolerance continuously recorded circumferential prestressing and the automated shotcrete specified are only three of many ways that will help prevent structurally deficient problems from occurring during the service life of the tank. It is imperative that the specified features of these Documents be strictly adhered to and only bids from Contractors that have a successful performance record in prestressed concrete tank construction be considered.

B. Work by Specialty Tank Prestressor

1. No stressing system falling under any of the following requirements will be considered unless it has been successfully used on tanks of at least the same diameter, height and capacity. The Contractor shall submit with his bid the name and location of the Owner and the completion dates of ten (10) tanks on which the proposed qualifying "stressing machine" and automated shotcrete equipment has been used within the past five (5) years. All tanks listed for the Specialty Tank Prestressor's experience requirements must have been prestressed in the Specialty Tank Prestressor's own name, or one of its divisions. Experience of personnel associated with the Specialty Tank Prestressor or hired by the Specialty Tank Prestressor will not be considered unless the Specialty Tank Prestressor can demonstrate that the work was contracted and performed directly by the listed Tank Specialty Tank Prestressor, or one of its divisions in its business name. At the time of bid the qualified Tank Prestressor shall have a minimum of two operable strand wrapping and automated shotcrete machines meeting these requirements. Machines under construction shall not be considered in meeting the requirement of having two operable strand wrapping and automated shotcrete machines.

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2. Descriptive literature shall also be submitted with the bid showing the proposed machinery with the recorders and a typical copy of an actual recording of the applied forces taken from one of the jobs on which such machinery has been used. Any stressing system that will not provide the substantial equivalent of the above requirements will be rejected.
3. A bid will not be considered responsive unless such data has been submitted with the bid. This applies to the strand wrapping, threadbar stressing and automated shotcrete equipment.
4. Experience gained by the Specialty Tank Prestressor in machine single wire wrapping, internal tendon systems or external tendon systems shall not be considered in meeting the required experience requirements.
5. If subcontracted, the prestressing firm or individual(s) will be responsible to CONTRACTOR for the following phases of work:
  - a. Furnish, stress and pressure grout the vertical prestressing threadbars with epoxy.
  - b. Abrasive blast the exterior concrete core wall.
  - c. Furnish and install the horizontal prestressing strand.
  - d. Apply the shotcrete covercoat application over the strand.

#### 1.4 SUBMITTALS

- A. Experience: The following information shall be required to be submitted:
  1. The name(s) of the proposed qualified Superintendent who will be in direct charge of the tank construction for the full duration of the Contract.
  2. A list of at least two reservoir jobs successfully completed by each of the Superintendents listed by the Tank Contractor, or one of its divisions, which shall include a tank description, the name and location of the Owner and the Consultant, and the approximate completion date of each tank while directly employed by the Tank Contractor, or one of its divisions.
  3. The name and address of the Tank Contractor, if different than the Contractor, and a list of at least five circumferentially strand wrapped AWWA D110 Type 1 prestressed concrete tanks of at least 1.0 MG capacity, similar in design to the tank specified herein, successfully completed by the Tank Contractor, or one of its divisions during the last ten years in its own name.
  4. The name and address of the Specialty Tank Prestressor, if different than the Tank Contractor or the Contractor, and the name and location of the Owner and the completion dates and location of ten structures on which the proposed qualifying strand wrapping prestressing system, meeting the substance of these Specifications requirements, has been used during the last 5 years.
  5. A list of at least two reservoir jobs successfully completed by the Superintendent(s) listed by the Specialty Tank Prestressor, or one of its divisions, which shall include a tank description, the name and location of the Owner and the Consultant, and the approximate completion date of each tank while directly employed by the Specialty Tank Prestressor, or one of its divisions. The listed Specialty Tank Prestressing Superintendent and/or Operator shall be a certified shotcrete nozzleman in accordance with ACI 506.
  6. Descriptive literature of the strand wrapping, the vertical prestressing and the automated shotcrete machinery meeting all these Specification requirements. Include in such data photographs or prints of the means of recording of both the circumferential and vertical prestressing applications and copies of actual photographs, print-outs or other records of applied wrapping forces (as well as force-elongation diagrams if available) taken from jobs in which the machinery

has been used. Submit procedures for patching through floor entry tubes and the center pin bolts for the prestressing and shotcrete operations.

7. A written statement from the Specialty Tank Prestressor indicating that the Specialty Tank Prestressor, or one of its divisions has a minimum of two operable strand wrapping and automated shotcrete machines meeting these specifications.

B. Shop Drawings:

1. Contractor shall submit shop drawings of the circumferential prestressing wrapping schedule and the intermediate lock off elevations for the Engineer's approval before the wall pour is made.

C. Product Data:

1. Mill test certificates showing the dimensional and physical characteristics of each size, heat or reel of the prestressing steel he has furnished.
2. Prior to the preparation of shop drawings and installation of vertical threadbars, furnish evidence that the proposed threadbar anchorage system meets the requirements of these specifications. ENGINEER may order additional tests to be taken. Should such additional tests not meet the specifications, such expenses shall be paid for by CONTRACTOR; otherwise such expenses shall be borne by OWNER.
3. Furnish the shotcrete mix design meeting or exceeding the requirements of this specification.
4. Furnish product data for vertical threadbar ducts and vertical threadbar epoxy grout.

## 1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Prestressing steel shall be adequately packaged against intrusion of chemical contaminants (from the atmosphere or otherwise) for the protection of the steel against physical damage and corrosion during (and subsequently as the result of) shipping and storage.
- B. Prestressing steel that has sustained physical damage through rust or otherwise will be rejected.
- C. All materials and prestressing material delivered to the job site shall be stored off the ground on planks, supported by 4-inch x 4-inch timber, which must be covered with polyethylene or sizalkraft paper to prevent any moisture from coming up from the bottom.
- D. Reels of strand, prestressing threadbars, anchorages, etc., shall be stacked neatly and as compact as possible.
- E. All materials for threadbars and all fabricated tendons shall be covered with tarpaulins in such a manner that water, rain, moisture and dust are kept away.

## **PART 2 - PRODUCTS**

### 2.1 PRODUCTS

- A. Seven-Wire Strand:

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1. Hot dip galvanized seven-wire strand used for prestressing shall meet the following minimum requirements:

Item	Specification
a. Nominal strand diameter	3/8"
b. Nominal area after galv	0.089 in <sup>2</sup>
c. Nominal weight/1000 LF	303 lbs.
d. Pitch	12-16 (strand diam.)
e. Tensile strength	21,400 lbs. (min.)
f. Yield strength @ 1% extension	16,000 lbs. (min.)
g. Elongation in 24 inch at fracture	4.5% (min.)
h. Weight of zinc coating	0.85 oz./ft. <sup>2</sup> (min.)

2. Hot dip galvanized seven-wire strand shall be manufactured in accordance with ASTM A416 prior to galvanizing. Each wire of the strand shall be individually hot dip galvanized before being stranded.
3. Single wire prestressing material shall not be utilized in lieu of seven-wire strand prestressing material.

**B. High-Strength Threadbars:**

1. Deformations of the threadbars shall form a screw thread suitable for mechanically coupling lengths of thread bar and for positive attachment of anchor assemblies.
2. Deformations shall conform to ASTM A722, Type II requirements and shall be uniform such that any length of bar may be cut at any point and the internal threads of a coupling designated for that size of bar can be freely screwed on the bar. The bars and their deformations shall be hot rolled.
3. Tensile and Physical Properties shall meet the following requirements with bars being manufactured in accordance with ASTM A722, Type II:

Item	Unit	Specifications
a. Nominal diameter	inches	1.25
b. Min. tensile force	kips (min.)	187
c. Yield force at 0.2% offset	kips (min.)	150
d. Elongation in 20 bar diameters	% (min.)	4
e. Nominal cross sectional area	sq. inches	1.245
f. Nominal bar weight	lbs/ft.	4.39
g. Min. ultimate strength	ksi	150

4. Note: To provide reduced relaxation, more uniform elastic modulus and reduced residual stress in the critical thread area, only threadbars that are stress relieved after the threads are formed will be accepted. All threadbars shall be proof stressed after stress relieving and threading. Threadbars with cold rolled threads or threadbars with quenched or tempered steels will not be permitted. Threadbars shall have a maximum carbon content of 0.55 percent. Only manufacturers with not less than 5 years of experience, under their current name, in the manufacturing of post-tensioning material meeting all the requirements of this specification will be accepted.

**C. Anchorages for Vertical Post-Tensioned Threadbars:**

1. All post tensioned prestressing shall be secured at the ends by means of approved permanent anchoring devices, which shall hold the prestressing steel at a force not less than 95% of the guaranteed minimum tensile strength of the prestressing steel.

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2. The load from the vertical prestressing anchoring device shall be distributed to the concrete through steel bearing plates of dimensions and details shown on the Drawings.
3. All vertical prestressing anchor plate dimensions, all dimensions relating to the conical hole in the top and bottom of the bearing plate (35° cone angle with the vertical), all steel tubing attached to the top bearing plate, and all threadbar spacing shall strictly conform to the details shown on the Drawings.
4. Fully threaded anchor connections shall be used at both ends of the vertical prestressing bar, which shall incorporate a spherical shaped bearing surface to match the conical surface in the bearing plate.
5. The contact point of the spherical shaped vertical prestressing bearing surface to conical hole shall be approximately ¼" to ½" below the bearing plate surface.
6. Wedge anchors shall not be used for permanent anchor hardware.

D. Anchor Pockets for Vertical Threadbars

1. Anchor pockets for vertical prestressing threadbars shall consist of steel cans, hot dip galvanized after cutting (unless shown otherwise on the Drawings) and subsequently welded to the top bearing plate.
2. Anchor pockets shall be adequately sealed from moisture and concrete intrusion by wooden lids and 2 inch wide plastic adhesive tape.
3. Anchor pockets for vertical prestressing threadbars must have adequate provisions for flushing of ducts with water during concrete placement.

E. Ducts for Vertical Threadbars:

1. Duct enclosures for vertical prestressing steel shall be standard 1.25" diameter PVC pipe class 160, unless otherwise specified on the Drawings.
2. All ducts shall be provided with expandable valves to facilitate the injection of epoxy after prestressing.
3. All connection details shall be as shown on the Drawings.

F. Epoxy Grout for Vertical Threadbars:

1. The vertical threadbar system shall offer complete 2 part epoxy protection of the prestressing steel inside ducting and anchors.
2. Portland Cement grout will not be accepted.

G. Shotcrete:

1. Fine aggregates:
  - a. Fine aggregates shall meet the requirements set out in Section 03300 of these Specifications.
  - b. A well-graded coarse sand shall be used for all shotcrete applications.
  - c. Coarse sand shall generally consist of the following gradation:

Sieve Size	% Passing by Weight
3/8 inch	100
No. 4	95-100
No. 8	80-100
No. 16	50-85
No. 30	25-60
No. 50	10-30
No. 100	2-10

The fineness modulus shall fall between 2.70 and 3.00.

2. Rebound:

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- a. Rebound is defined as aggregate mixed with some cements, which ricochets off the surface during the application of shotcrete because of collision with the harder surface, reinforcement, or with the aggregate particles themselves, which amount varies with the position of the work, air pressure, cement content, maximum size and grading of aggregate, amount of reinforcing and thickness of layer.
  - b. Rebound materials may not be reused in any form for shotcrete.
- 3. Water shall meet the requirements set out in Section 03300 of these Specifications.
- 4. Fibrous Shotcrete Reinforcement
  - a. All shotcrete, unless otherwise specified herein, shall be fibrous reinforced. Such material shall consist of 100 percent virgin polypropylene fibers specifically manufactured for use as concrete/shotcrete secondary reinforcement. The required volume of fibers to be added per cubic yard of shotcrete shall be as specified below under Shotcrete Proportioning.
  - b. Polypropylene fibers will help to provide greater control of cracking from drying shrinkage and thermal expansion/contraction, a reduction of permeability, an increased impact capacity, an improved shatter/abrasion resistance and added toughness of the shotcrete.
  - c. The fibers shall be manufactured in accordance with applicable building codes and ASTM C1116 Type III.
  - d. Acceptable polypropylene fibers shall have the following physical characteristics:
    - 1) Specific gravity = 0.91
    - 2) Fiber length = graded per manufacturer
  - e. Manufacturer:
    - 1) SI Concrete Systems, Fibermesh 150.
    - 2) Or approved equal.
- 5. Shotcrete Proportioning:
  - a. Each one cubic yard of mortar in the ready mix truck or mixer shall consist of 0.1% (1.5 lbs. per cubic yards) polypropylene fibers and a mix ratio of 3 lbs. of moist sand to 1 lb. of Portland cement. W.R. Grace Recover hydration stabilizer or approved equal may be added at the option of Shotcreter during warm weather conditions.
  - b. Whenever night temperatures are expected to drop below 35°F, ASTM C150, Type III Portland cement shall be used in lieu of Type II Portland cement. Should Type III Portland cement not be available, the mix design shall consist of a moist sand- Portland cement mix ratio, by weight, no greater than 2.59.
  - c. If the batching procedure requires that smaller volumes of cement and sand be used, the required cement to sand ratio shall still be strictly adhered to.
  - d. Additives other than a hydration stabilizer shall not be used unless specifically approved by ENGINEER, after careful consideration of its corrosive influence on prestressing steels.
  - e. If used by the shotcreter, the total volumetric air content of the shotcrete before placement shall not exceed 7 percent (plus or minus one percent) as determined by ASTM C173 or ASTM C231.
  - f. Unless otherwise shown on the Drawings, shotcrete cylinder strengths at 28 days shall be no less than 4,500 psi. Higher shotcrete cylinder strengths shall not permit a reduction in the above specified cement contents. The cement content in the above mix designs may be increased should the specified 28 day strength requirement not be met. Shotcrete shall have a maximum water-cementitious materials ratio of 0.40.

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- g. The polypropylene fibers and admixtures shall be added to the shotcrete at the time it is batched and in the amounts as required herein. Such additives shall be mixed in strict conformance to the manufacturer's instructions and recommendations for uniform and complete distribution. Each certificate of delivery supplied by the shotcrete supplier shall indicate the additive trade name, manufacturer's name and amount per cubic yard added to each batch of shotcrete.
- h. Class F Fly Ash, in accordance with ASTM C618, may make up no more than 20% of the cementitious material in the shotcrete mix.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

##### **A. Circumferential Prestressing Equipment:**

1. The circumferential stressing system shall produce a continuously, electronically (or substantial equivalent) monitored permanent stress or force recording along the full length of the strand as it is being applied and the stress variation in any strand at any point around the circumference shall not be greater than  $\pm 1.5$  percent of the ultimate strength of the steel. In addition to this recording, any system which deflects the tensioned prestressing material between the tensioning device and the wall after it has left the tensioning device, shall provide a similar continuously monitored stress or force record along its full length as it is being applied to the wall. These recordings shall show that either before or after deflection, the stress variation in the prestressing material at any point around the circumference shall not be greater than  $\pm 1.5$  percent of the ultimate strength of the steel.
2. Due to prior instances of force measurement inaccuracies and the inherent problems associated with handheld stressometers, no manual recorded force readings will be accepted. This requirement shall be strictly adhered to.
3. Any wrapping that does not and/or cannot meet the stress tolerances specified, will not be accepted and will be removed at Specialty Tank Prestressor's expense. Specialty Tank Prestressor shall be responsible for all costs associated with meeting the specified tolerances.
4. Since wrapping systems which utilize single solid prestressing wire will not provide the desired bond between the prestressing wire and the shotcrete and since single solid prestressing wire will not provide an adequate safety factor against failure, only machine wrapping systems which utilize seven-wire prestressing strand wrapping will be allowed.
5. Since intermittent force applications can result in an unequal stress distribution around the wall (due to friction losses), the prestressing system shall be capable of applying a continuous wrapped force at any point around the circumference within the specified tolerances. Circumferential stressing systems based on jack operated cable or rod type tendons (such as those placed inside of ducts incorporated in the core wall or placed manually around the exterior of the core wall) will not be allowed.
6. Tank Prestressor shall submit procedures for patching through floor entry tubes and the center pin bolts for the prestressing and shotcrete operations. These procedures shall be submitted with the shop drawings for the respective items.

##### **B. Circumferential Prestressing Application:**

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1. Wrapped strand shall be anchored to the wall at least once for every coil or reel.
  2. Permanently anchoring one strand to a previously wrapped strand will not be permitted.
  3. Wrapped strand ends shall be joined by suitable splicing methods that shall develop 90% of the full strength of the strand.
  4. Use of different alloys in the splicing material will not be permitted.
  5. The minimum clear spacing between any two wrapped strands in the vertical direction shall be 1.5 strand diameters or 3/8 inch, whichever is larger.
  6. The maximum center to center spacing between any two wrapped strands in the vertical direction shall be 6 inches, except at zones designated to be free of prestressing.
  7. The wrapped strands shall be spaced at approximately equal spacing over given bands within the wrapping schedule shown in the Contract Drawings.
  8. All wrapped strands not meeting the spacing requirements shall be spread by approved methods or shall otherwise be removed.
- C. Vertical Prestressing Equipment:
1. The Specialty Tank Prestressor shall provide a continuously, electronically (or substantial equivalent), monitored permanent force-elongation record from zero to full force at the final lockoff for all of the vertical prestressing work.
  2. The ordinate of the permanent recording shall show the elongation in inches and the abscissa shall show the force in pounds or kips.
  3. Manually recorded force and elongation readings will not be accepted.
  4. The vertical threadbar stressing machinery shall have automatic electronic tensioning cut off devices or equivalent means to ensure that the specified force and elongation is not exceeded at any time during any threadbar stressing operation.
  5. The force readings at the stressed bar ends, immediately after lock off, for any stressing operation, on any tendon, shall not fluctuate more than  $\pm 1.5\%$  (of the minimum ultimate strength of the steel) from the desired average force setting.
  6. The maximum applied force, immediately after lock off for the final stressing operation on any threadbar, shall be no greater than 75% of the minimum ultimate strength of the steel.
- D. Vertical Prestressing Application:
1. All permanent anchor hardware shall have a ball shaped threaded nut that can be screwed down on to a matching cone-shaped bearing surface in the bearing plate after the desired tension on the anchor hardware and/or prestressing steel has been applied.
  2. The number and spacing of threadbars, if shown on the Drawings, shall not be altered under any condition.
  3. High strength threadbars shall be used for vertical prestressing which meet the requirements of these Specifications.
  4. All ducts shall be clean and free of water and deleterious materials that would impair bonding of the grout or interfere with grouting procedures.
  5. Grout injection pipes shall be fitted with positive mechanical shutoff valves, which shall not be removed within the first 24 hours.
  6. Grouting of threadbars shall be started at the lowest grout connection.
  7. Each vertical threadbar duct shall be pumped until the entire nut at the top anchor has been covered. Pea gravel and/or clean sand may be placed (at Specialty Prestressor's option) in the threadbar can as a filler prior to or after epoxy pumping.

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8. In cold weather, and especially during frosts, special precautions must be taken to avoid the freezing of grout. In the event that the grouting procedure cannot be postponed, the wall temperature must be kept above the freezing point with hot blankets or by other approved means.
9. Upon completion of the vertical stressing and grouting operation, all anchor pocket areas above the anchor nuts shall be dry packed with a 1 cement to 2 sand mortar mix immediately after the epoxy coating on the inside can surface has become tacky, or alternately, the metal can may filled with concrete aggregates and epoxy.
10. The inside surfaces of any metal cans to be dry packed shall be coated with a 2 part epoxy bonding agent.
11. Dry packing shall not proceed until the epoxy coat has become tacky.
12. The dry pack surface shall be finished flush with the adjoining concrete surface.
13. Vertical threadbar components shall be assembled off the ground and as detailed on the Drawings.
14. Particular attention shall be given to sufficient taping of damaged joint connections and holes in PVC tubing.
15. Vertical prestressing threadbars shall be accurately placed at the locations shown on the Drawings, or as approved by ENGINEER, and shall be securely fastened in place to reinforcing steel and form ties to prevent movement during placement of concrete.
16. All vertical threadbars shall be fully assembled before they are installed in the forms.
17. All vertical threadbars shall be flushed with water from the top immediately upon completion of the concrete vibrating operation.
18. Flushing of ducts shall proceed after the pouring and vibrating of concrete around the threadbars has been completed.
19. Water shall be introduced through a taped off hole in the wooden lids on the anchor pockets and be permitted to drain through the bottom grout tube. Flushing shall not be accomplished by introducing water through the bottom connection.
20. Upon completion of the water flushing operation of vertical threadbars, the ducts shall be given a short burst of compressed air from the top only to remove any accumulations of water at the bottom of the ducts.
21. Cleaning of threadbars with air only, or removal of water with air from the bottom connection, will not be permitted.
22. Placing of vertical threadbars shall be done to proper locations, elevations and alignments, with a maximum tolerance of plus or minus 1/4 inch.
23. All vertical threadbars shall be properly tied at the anchor plates and shall be tied with #4 bars at 2 feet intervals between the anchor plates, unless shown otherwise on the Drawings.
24. Anchor plates must be installed at right angles to the threadbar alignment near the anchor. Anchor plates must be installed with long sides, if applicable, aligned parallel with the wall forms and secured to prevent rotation while concrete is placed. The maximum permissible misalignment of anchor plate to threadbar alignment is plus or minus 2.5 degrees.
25. Unless indicated otherwise on the Drawings, the minimum concrete cover around metal anchor pockets and bearing plates shall be 1.5 inches.
26. The clearance between bottom anchor plate and waterstop in tank walls shall be no less than 2 inches nor more than 4 inches.

E. Circumferential and Vertical Prestressing Operations:

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1. The maximum initial electronically (or substantial equivalent) recorded steel stress shall not exceed 75 percent of the guaranteed minimum ultimate strength (M.U.S.) of the steel at any time during and after stressing.
2. Each vertical threadbar in the wall shall be stressed to the values shown on the Drawings.
3. An automatic, continuously electronically (or substantial equivalent) monitored permanent recording of the applied force, at any point on the strand, at any point on and around the tank wall, must be made during the entire circumferential prestressing application. All such recordings must be based on a continuous sensing of the applied force on the prestressing material between the tensioning drum and the wall when, and as, the strand is being wrapped and laid on the wall.
4. The force setting on wrapping and threadbar stressing machinery shall be such that the applied forces fall within the specified minimum or maximum stress or force limitations; the force setting shall be corrected immediately when the applied force falls outside the required force tolerance limitations.
5. In the event that the stressing machinery is incapable of holding the applied forces within the specified stress or force limitations, ENGINEER will order, at Specialty Tank Prestressor's expense, the removal and replacement of such machinery in favor of a different stressing process capable of maintaining such tolerance requirements.
6. The loss in stress in post tensioned prestressing steel due to creep and shrinkage of concrete creep of steel and sequence stressing shall be assumed as 25,000 psi.
7. The final stress is the average initial stress reduced by the stress loss of 25,000 psi.
8. The final force is the steel section multiplied by the final stress.
9. The final force shall be no less than the required working force shown on the Drawings.
10. The continuous, electronically produced force application chart during the wrapping application becomes the property of OWNER.
11. Manual, individual or intermittent force readings taken on wrapped strand in full bodily contact with the wall will not be accepted. Force readings based on anything other than instantaneous force readings, as the strand is being tensioned, and wrapped around the tank, will not be accepted.
12. An automatic, continuously electronically (or substantial equivalent) monitored and simultaneously recorded force elongation reading must be made for each vertical stressing application.
13. The force elongation reading must represent the true relationship between the elongation at any given point of the vertical stressing operation and the applied force on the prestressing steel at that same point.
14. The force elongation relationship must be constantly maintained from the beginning, starting with the removal of the slack to the point of lock off and complete release of the force on the vertical prestressing steel after retraction of the stressing piston or equivalent stressing device.
15. All electronically produced force elongation readings during the vertical threadbar stressing operations become the property of the Owner.
16. The ultimate initial prestressing force for vertical threadbars shall not be applied until the concrete compressive strength in the wall shall have reached the specified 28 day strength.
17. Wrapping may start when the concrete has reached a minimum strength of 3,000 psi; however, under no circumstance shall the compressive stress, under any condition, exceed 55%.

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18. In the event that gaps between the core wall and the wrapped prestressing material develop that exceed 3/8 inch, wrapping shall be discontinued and the wall shall be built up with shotcrete to provide the proper curvature. Alternately, if approved by ENGINEER, the gaps may be dry packed after wrapping is completed and before shotcreting is started.
19. Wrapping over intermediate shotcrete coats or built up shotcrete areas may commence 12 hours after the shotcrete has been applied or when the shotcrete has reached a minimum strength of 250 psi, whichever is later.
20. Because prestressing material exposed to excessive temperatures greatly increases the possibility of irrevocable damage, such as steel embrittlement, stress corrosion, or wire splitting, the temperature of the prestressed material during application shall not be allowed to increase by more than fifty degrees at any time during such application due to the stressing technique. No system which relies on pulling the prestressing material through a die to create a force, will be allowed.
21. All vertical prestressing threadbar ducting shall be pressure grouted with an approved 2 part water insensitive epoxy and approved epoxy grouting equipment. Circumferential prestressing anchors shall be dry packed with cement grout or epoxy, at the Contractor's option.
22. Grout injection pipes shall be fitted with positive mechanical shutoff valves, which shall not be removed within the first 24 hours.
23. Grouting of threadbars shall be started at the lowest grout connection.

F. Safety Precautions:

1. Every precaution shall be taken to keep personnel and visitors outside the danger area of breaking strands or bars.
2. At no time shall anyone stand in the line of stressed vertical threadbars or stressed strand.
3. No work shall be performed by anyone, other than the prestressing crew, within 100 feet from the wrapping operation or the application of the vertical threadbar stressing operation.
4. Where access to the site by unauthorized persons is outside the Contractor's control, while prestressing work is in progress, Contractor shall erect protective fencing to prevent breaking strand from endangering such persons.
5. There shall be no welding to anchor plates after the threadbars have been assembled, neither shall prestressing steel be used as a "ground" for welding operations.

G. Abrasive Blasting:

1. Exterior surfaces of the concrete core wall, which will receive strand wrapping shall be abrasive blasted, regardless of the forming method used, by a mechanical etching or shotblast system combined with a vacuum recovery system, or a water-blasting system. Systems that have not been used successfully in the past to prepare circular tank wall surfaces for shotcreting and strand wrapping or systems which rely on sandblasting or steel shot without a vacuum system will not be allowed. The surface shall be abrasive blasted sufficiently to remove all laitance, form oil or other type of coatings. The surface shall be cut to a minimum CSP5 profile, as established by the International Concrete Repair Institute (ICRI), over a minimum of 90% of the surface being prepared as measured over any one foot square area. The Specialty Tank Prestressor who is performing the abrasive blasting shall make available to the inspector ICRI sample coupons to assist in evaluating the abrasive cut.

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H. Shotcrete Equipment:

1. Mixing shall be done in conformance with the requirements of Section 03300, Cast in Place Concrete.
2. Delivery Equipment:
  - a. The delivery equipment shall be of an approved design and size which has given satisfactory results in similar previous work.
  - b. The equipment shall be capable of discharging mixed materials into the hose under close control and shall be able to deliver a continuous smooth stream of uniformly mixed material at the proper velocity to the discharge nozzle, free from slugs of any kind.
  - c. The equipment must allow for the concrete, water and air to be distributed to the automated shotcrete tower through a swivel pin located at the center of the tank.
  - d. The nozzle shall be of a design and size that will ensure a smooth and uninterrupted flow of materials.
  - e. Delivery equipment shall be thoroughly cleaned at the end of each shift.
  - f. Equipment parts shall be regularly inspected and replaced as required.
3. Air Supply capacity of the compressor shall be large enough that the minimum amount of air to be available at the nozzle shall be no less than 400 CFM, irrespective of whether or not air from the same air supply is used for other purposes.

I. Shotcrete Application Process:

1. Shotcrete shall be applied under the wet mix process only.
2. Nozzles shall be mounted on power driven machinery enabling the nozzle to travel parallel to the surface to be sprayed at a uniform linear or bidirectional speed.
3. The nozzle shall be kept at a uniform constant distance from the surface, always insuring a right angle spray of the material to the surface.
4. Hand operated nozzles and shotcreting operations dependent on the performance of the nozzleman will not be accepted except where additional shotcrete is needed to correct flat areas or for architectural surface treatments.
5. Grout materials shall be delivered to the jobsite in ready mix trucks from approved batching plants. However, job mixing will be accepted provided automatic weigh batch plants are used.
6. The sand, cement and water shall be premixed before being pumped through a 2" minimum hose by specially designed mortar pumps.
7. The high velocity impact shall be developed pneumatically by injecting compressed air at the nozzle.

J. Shotcrete Placing and Finishing:

1. Shotcrete shall be applied in a steady, uninterrupted flow.
2. Should the flow become intermittent for any cause, the machine operator shall direct the nozzle away from the work until it again becomes constant, or shut off the flow of materials.
3. Position of Pneumatic Nozzles: The nozzle shall be held at approximately right angles to the surface and shall be kept at the proper and the same distance from the surface dictated by good practice standards for the type of application, type of nozzle and air pressure employed.
4. Shotcreting More Than One Layer:
  - a. Sufficient time shall be allowed for each layer of shotcrete to set up so it may take the next layer without sagging.

- b. The shotcrete shall be started at the bottom of the wall until all wrapped strand has been covered. Subsequent shotcrete layers may be applied from the top down or from the bottom up at the discretion of the Shotcreter.
  - c. While the nozzle travels around the wall, the nozzle shall be raised or lowered at a uniform rate in such a manner that an adequate overlapping of coatings and a uniform finish will develop.
  - d. The nozzle shall be spiraled up or down around the tank to either the top or the bottom of the wall or to the termination of the intermediate strand layer.
5. Application of Shotcrete:
- a. To ensure proper penetration around the strand and proper conveyance of the material through the hose, a 5" to 7" slump of the mortar at the pump is recommended.
  - b. The application of the shotcrete in the number and thickness of layers specified herein is mandatory for proper penetration of shotcrete behind prestressing material and to reduce shrinkage due to more uniform in depth drying of the shotcrete. The moisture absorption by earlier applied layers is relied upon to improve the bond and strength of the material and to reduce drying shrinkage of the applied shotcrete.
6. Shotcrete Covercoats Over Wrapped Strand:
- a. Each layer of wrapped prestressing steel shall be covered with shotcrete until a minimum cover of 3/8" over the steel has been obtained.
  - b. The final covercoat, to make up for the full thickness of shotcrete over the final strand layer, shall be applied in at least 3 layers of equal thickness.
  - c. Each layer of shotcrete shall be completed for the full circumference of the tank and substantially the full height of that layer before the next layer of shotcrete may be applied.
7. Coating Thickness:
- a. All shotcrete coatings shall be built up in layers of approximately 3/8 inch in thickness until the final required thickness has been obtained.
  - b. Unless otherwise shown on the Drawings, the minimum shotcrete cover over all wrapped steel shall be 1.5 inches.
8. Finish Coat:
- a. After the minimum shotcrete cover specified over the wrapped prestressing strand has been completed by the automated shotcrete procedure, and only if such finish requirements are shown on the Drawings, the exterior surface shall be given an acceptable float finish true to line and curvature and to details shown on the Drawings.
  - b. If a float finish is required on the Drawings, plaster or hand applied shotcrete may be used to build up and level the surface and to obtain the desired surface finish and projections.
  - c. The finish coat mix (if a smooth float finish is required on the Drawings), shall consist of a minimum of one sack of cement for each 3 1/2 cubic feet of moist plaster sand.
  - d. If no finish requirements are shown on the Drawings, it is intended to have a natural original gun finish of the shotcrete covercoat.
9. Protection of Adjacent Buildings and Surface:
- a. Shotcreter shall take every possible precaution to protect adjacent buildings, concrete surfaces, vehicles, equipment, etc., from being damaged by overshooting shotcrete and by materials carried away by the wind.
  - b. Overshot shotcrete and rebound materials deposited on the roof shall be removed before it adheres to the concrete surface.



- c. CONTRACTOR shall pay for all damages caused by Shotcreter's operations under this contract.
- 10. Shotcrete tests shall be conducted in accordance with Section 03300, Cast in Place Concrete.
- K. Shotcrete Thickness Confirmation Testing
  - 1. Shotcrete thickness shall be confirmed at up to 8 different locations per prestressing layer. These locations shall be selected by OWNER or ENGINEER. The contractor shall remove the shotcrete down to the prestressing strand at the selected locations. Thickness shall be verified by placing a straight edge against the applied shotcrete and measuring the distance between the outside face of the prestressing strand and the face of the straight edge.
- L. Hand Placed Shotcrete for Repairs Only:
  - 1. To ensure a high quality shotcrete, the Shotcreter shall satisfy ENGINEER that the nozzleman has had sufficient and acceptable experience in the application of structural shotcrete.
  - 2. Experience gained on shotcrete pool and ditch construction will not be considered as experience for qualifying the nozzleman, unless approved by ENGINEER.
  - 3. The nozzleman shall be capable of applying thin coats of even and uniform thickness.
  - 4. The nozzleman shall be a certified shotcrete nozzleman in accordance with ACI 506.
- M. Restriction on Shotcrete Operation:
  - 1. Shotcrete shall not be applied under such strong wind conditions that a considerable amount of cement and moisture will be removed by the wind from the mortar spray between the nozzle and the surface on which the shotcrete is applied.
  - 2. Shotcrete may be applied in cold weather provided the surfaces are not frozen.
  - 3. The temperature during the day must be expected to rise to at least 40°F and the night temperature of the first night after the shotcrete application must not be expected to drop below 27°F.
  - 4. The use of Type III Portland cement is required (when readily available) in the event shotcrete is applied at temperatures below 40°F.
  - 5. The Shotcreter may apply shotcrete under the conditions specified herein solely at his own risk.
  - 6. Whenever rain or frost has damaged shotcrete which has not had a chance to set up, such shotcrete shall be removed and replaced.
  - 7. Shotcreter shall consult with ENGINEER to determine whether or not the shotcrete damaged by rain or frost will be accepted before applying any new layers of shotcrete.
- N. Shotcrete Water-Curing:
  - 1. Intermediate layers of shotcrete shall be kept damp by hand curing or other means no sooner than 12 hours after the shotcrete has been applied.
  - 2. This water-curing is not required should additional shotcrete be applied on the entire wall surface within the following 12 hours.
  - 3. An indiscriminate use of continuous water-cure for intermediate layers shall be avoided.
  - 4. Complete shotcrete surfaces, which do not receive any additional coatings, shall be water-cured for a period of at least seven (7) days by encapsulating the

shotcrete inside of plastic sheeting. Such plastic sheeting shall be lapped and sealed as necessary to properly cure the shotcrete. Membrane curing methods utilizing curing compounds or wax-based residuals will not be permitted.

5. Wall coatings, as specified in Section 09900, shall be applied no later than five (5) days after completion of the water-curing. If conditions make it impossible to apply coatings within the five (5) day period, shotcrete shall be water-cured for a period of ten (10) days instead of the seven (7) days specified herein.

O. Cleaning and Waterproofing:

1. After construction is completed, the interior of the tank shall be completely hosed out and cleaned of all dirt and loose material.
2. Floor, wall, footing, column and roof cracks, which may have developed from drying shrinkage, shall not be taped or chipped out and caulked. All cracks shall be pumped and sealed with a two-part water insensitive epoxy.

P. Disinfecting and Filling:

1. Water containing 200 ppm of chlorine shall be sprayed on all walls, columns and underside of roof areas.
2. The solution from the wash down shall be allowed to stand for no more than 24 hours prior to filling the tank.
3. The chlorine shall be monitored and adjusted while filling, so that when the reservoir is full the resulting chlorine solution is approximately 2 ppm.
4. The disinfection shall be accepted if samples taken for the final bacteriological test conform to AWWA Standard C652 and are found to be satisfactory.
5. The tank should only be filled during normal working hours, at the end of each day the reservoir and ring drain should be checked for any kind of visible leakage. If only damp spots and small puddles of water are noted, the filling can continue. If major leaks are noted, they should be thoroughly investigated prior to continuing to fill the tank.

Q. Testing and Repairing Leaks:

1. Testing:
  - a. After filling the tank, the water level shall be held at the overflow for 3-days, it will be assumed for the purpose of the test that the absorption of moisture by the concrete in the tank is complete. All valves and gates to the structure shall then be closed and the change in water surface measured over a 48-hour period. The vertical distance to the water surface shall be measured to within 1/16-inch from a fixed point on the structure above the water surface. Measurements shall be recorded at 24-hour intervals.
  - b. During the test period, all exposed portions of the structure shall be examined for dampness or leaks and all visible leaks or damp spots shall be marked; such leaks or damp spots shall be later patched or corrected in a manner acceptable to the ENGINEER prior to additional leakage testing.
  - c. The tank and the drain lines from the ring drain shall then be examined for evidence of leaks.
  - d. All leaks shall be repaired to the satisfaction of ENGINEER.
  - e. Any areas that, in the opinion of ENGINEER, are exposed to contamination during the repair work shall be re-chlorinated to ENGINEER's satisfaction.
  - f. Testing shall be completed before the tank is backfilled.
2. Leak Detection Methods:
  - a. Leaks in floor construction joints may be detected with the aid of a diver.

- b. Mud, cement deposits or dye on the floor, when stirred up, would flow to the leak and may so indicate where the leaks are.
  - c. Honeycomb and cracks around waterstops may be detected through tapping with a hammer along the joint.
  - d. Any of these procedures may be insisted upon by ENGINEER when cement seeding has not stopped the leaks.
  - e. Leakage through joints, which may have resulted from bent over waterstops or honeycomb under or around waterstops may require the removal of concrete around the waterstops in suspected areas.
  - f. Chipped out concrete areas shall be properly dry packed with non-shrink grout, after coating the existing concrete surface with an approved epoxy bonding agent.
3. Acceptance:
- a. The acceptable drop in water level of covered water tanks shall not exceed 1/16-inch per 24 hours after the tank has been filled, and after accounting for evaporation. There shall be no visible running leaks or water puddles. Small damp spots may be accepted, at the discretion of ENGINEER, during the first few months of operation; however, if they have not healed, ENGINEER may order the immediate repair of such areas. Damp spots or any seepage present on the walls or other exposed areas where moisture can be picked up on a dry hand shall be considered excessive and repaired. Any cracks, voids, honeycomb or cold joints showing or causing running leaks of water, shall be epoxy injected by qualified operators until such cracks and voids have been completely sealed.
  - b. Wet areas on top of wall footings shall not be considered cause of a qualitative failure of the leakage test unless the water can be observed to be puddled or flowing.
  - c. If the leakage is excessive, and if damp spots and observed seepage is present on exposed surfaces, the tank shall be drained, all leaks and damp spots previously marked shall be patched, and the necessary repairs made, and the tank shall be retested. The CONTRACTOR'S method of repair shall be subject to the requirements of these specifications and submitted for review and approval by the ENGINEER.
    - 1) The tank shall then be refilled and again tested for leakage and this testing and repair process shall be repeated as many times as necessary until the leakage test passes. This process shall be continued until the drop in water surface in specified test period with the tank full is less than the quantity specified above and all damp spots and seepage disappears when the tank is full of water. All repairs of faulty workmanship and materials, and additional tests, shall be made by the CONTRACTOR in an acceptable manner, at no additional cost to the OWNER. Both the correction for excessive leakage and the removal of the damp or wet spots on exposed surfaces shall be required to pass the leakage test.
  - d. The purpose of this test is to determine the integrity of the finished concrete and to show that the exposed wall surfaces are visually acceptable.
  - e. The tank shall not be backfilled until and unless ENGINEER has accepted the leakage tests.
  - f. This section shall be applicable during the entire specified warranty period of the tank.

+ + END OF SECTION + +

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## **SECTION 03400**

### **PRECAST CONCRETE**

#### **PART 1 - GENERAL**

##### **1.1 DESCRIPTION**

- A. Section includes all plant-precast products, including, but not limited to, wet wells, catch basins, manholes, vaults, and wheel stops.

##### **1.2 SYSTEM DESCRIPTION**

- A. Precast products shall be designed for the indicated service, the loadings specified in the Contract Documents, and all transportation, handling, and erection loads, in accordance with requirements and recommendations of the references.
  - 1. Precast products not subjected to traffic loads shall be designed to meet and exceed the requirements of ACI 318-14.
  - 2. Precast products subjected to traffic loads shall be designed to meet and exceed the requirements of the current AASHTO LRFD Bridge Design Specifications.
  - 3. Liquid containing precast products shall be designed for the additional requirements of ACI 350-06.
- B. If precast products are proposed as substitutes for cast-in-place designed structures, such precast products shall meet the above requirements and any other requirements for which the cast-in-place structures were designed by the ENGINEER. Such products shall be designed by an engineer licensed to practice in the State where the project is performed.
- C. Items located in or adjacent to traffic areas shall be designed to resist AASHTO HL93 loading, unless otherwise indicated.
- D. Lifting inserts shall have a minimum safety factor of 4.

##### **1.3 QUALIFICATIONS**

- A. Manufacturer:
  - 1. Manufacturer shall have at least 5 years experience in the design and manufacture of precast concrete products substantially similar to those required for this project.
- B. Installer:
  - 1. Precast Items shall be installed by the Manufacturer or by an installer regularly engaged for at least 5 years in erection of precast products similar to those required on this project.

##### **1.4 SUBMITTALS**

- A. Submittal Data:
  - 1. Submit to the Engineer for review, shop drawings of the proposed details, and design calculations; all calculations and shop drawings shall be stamped and signed by a Civil or Structural Engineer registered in the State of California.
  - 2. Material specifications.

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3. All dead, live and other applicable loads used in the design.
  4. Applicable standards (from "References") met by the item(s).
  5. Setting plans locating and designating all items furnished by the manufacturer, with all major openings shown and located.
  6. Details to indicate quantities, location and type of reinforcing and prestressing steel.
  7. Sections and details showing connections, edge conditions, support conditions, and connections of the items.
  8. Description of all embeds, including stripping, lifting and erection inserts, with piece mark and location, including those cast into products or sent loose to the job site.
  9. Description and drawings of all frames and covers.
  10. Dimensions and special finishes.
- B. Mix Designs: Submit all precast mix designs for approval. Mix designs shall be prepared by an independent testing facility or qualified employee of the Precast Manufacturer.
- C. Design Modifications:
1. Submit design modifications necessary to meet performance requirements and field conditions.
  2. Variations in details or materials shall not adversely affect the appearance, durability or strength of products.
  3. Maintain general design concept without altering size of members, profiles and alignment unless otherwise approved by the Architect/Engineer.

#### 1.5 QUALITY ASSURANCE

- A. In-Plant Quality Control
1. The Manufacturer shall have an established PCI quality control program in effect prior to bidding. If requested, a copy of this program shall be submitted to the ENGINEER.
  2. Testing of materials and inspection of production techniques shall be the responsibility of the Manufacturer's Quality Control Department.
  3. Keep quality control records available for two years after final acceptance.
  4. Keep certificates of compliance available for five (5) years after final acceptance.
- B. All other testing and inspection, if any, to be provided by OWNER.

#### 1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Handle and transport products in a position consistent with their shape and design in order to avoid excessive stresses or damage.
- B. Lift or support products only at the points shown on the Shop Drawings.
- C. Installer shall be responsible for the repair of damage to items except that caused by others.
- D. After items are installed in their final positions, the CONTRACTOR shall be responsible for their protection. The CONTRACTOR shall be responsible for the repair of any damage to the items caused by someone other than the Manufacturer/Installer.

## **PART 2 - PRODUCTS**

### **2.1 CONCRETE MATERIALS**

- A. Portland Cement ASTM C150 Type I, II or III cement.
- B. Aggregates:
  - 1. Fine and coarse aggregate for mix shall conform to ASTM C33 or C330.
  - 2. Aggregates shall be clean, hard, strong, durable, inert, and free of staining and deleterious materials.
- C. Water Potable, free from deleterious material.
- D. Admixtures:
  - 1. Conforming to ASTM C260 and/or ASTM C494.
  - 2. Calcium chloride or admixtures containing chlorides shall not be used.
- E. Concrete Strength: Concrete strength shall be determined by design with a minimum 28 day design strength of 4,000 psi.

### **2.2 STEEL MATERIALS**

- A. Products:
  - 1. Structural Shapes, Bars & Plates (1.6mm and thicker): ASTM A36
  - 2. Pipe: ASTM A53 Grades A or B
  - 3. Tube Steel: ASTM A500 Grades A or B
  - 4. Reinforcing Steel: ASTM A615 Grades 300 & 420 or ASTM A706
  - 5. Prestressing Strand: ASTM A416 Grade 270, low relaxation
  - 6. Deformed Steel Bar Mats: ASTM A184
  - 7. Deformed Bar Anchors: ASTM A496
  - 8. Deformed Welded Wire Fabric: ASTM A497
  - 9. Plain Welded Wire Fabric: ASTM A185
  - 10. Welded Headed Studs: AWS D1.1 Type B
  - 11. Standard Machine Bolts: ASTM A307 Grade A or SAE J429 Grade 2
  - 12. Standard Studs/Threaded Round Stock: ASTM A307 Grade C, ASTM A572 Grade 345
  - 13. Nuts for Standard Machine Bolts and Threaded Studs: ASTM A563 Grade A Hex Nuts
  - 14. High Strength Bolts: ASTM A325 Type 1, ASTM A449 Type 1, or SAE J429 Grade 5
  - 15. Nuts for High-Strength Bolts and Threaded Studs: ASTM A563 Grade DH Heavy Hex Nuts
  - 16. Coil Rods and Bolts: ASTM A108 - SAE 1016 to 1026,  $F_u/F_y = 480/380$  MPa minimum
  - 17. Coil Nuts for Coil Rods and Bolts: Nuts passing a proof load stress of 80 ksi, based on the tensile stress area of the matching coil rods and bolts.
  - 18. Carbon Steel Castings: ASTM A27 Grade 415-205
- B. Protective Coatings:
  - 1. All connection hardware permanently exposed to weather after completion shall be protected. All connection hardware not exposed to weather after completion may be uncoated, except as otherwise explicitly required by the contract drawings. Fasteners can have either an electroplated zinc or cadmium coating.
  - 2. Alkyd Rust Inhibitive Primers (shop primers such as red iron oxide) :
    - a. Tnemec Series FD88 Azaron Primer
    - b. Ameron 5105
    - c. Weld-Thru Primer, Red, 2-0101 & Gray, 2-0102

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3. Zinc Coatings:
  - a. Hot-Dip Galvanizing: ASTM A123, or ASTM A153
  - b. Electroplated Zinc for Steel Products and Steel Hardware: ASTM B633
  - c. Zinc Rich Paints: DOD-P-21035
4. Cadmium Coatings:
  - a. Electrodeposited Coatings of Cadmium: ASTM B766

## 2.3 MISCELLANEOUS PRODUCTS

- A. Grout:
  1. Cement Grout: Portland cement, sand and water sufficient for placement and hydration.
  2. Non-Shrink Grout: Premixed, packaged non-ferrous aggregate shrink resistant.
  3. Epoxy Resin Grout: Two-component mineral-filled resin: ASTM C881.
- B. Joint Sealing Compound: The joint sealing compound shall be a permanently flexible plastic material complying in every detail to Federal Specification SS S-00210 (GSA-FSS) dated July 26, 1965. "Quickseal", or approved equal.
- C. Frames and Covers: Catch basins, manholes, and vaults shall be provided with fabricated aluminum or steel frames and covers as specified or shown on the drawings and shall be built up so that the cover is flush with the surrounding surface unless otherwise specified.

## 2.4 FABRICATION

- A. Unless otherwise noted, precast concrete structure dimensions called out on the Drawings are interior dimensions.
- B. Manufacturing procedures shall be in general compliance with PCI MNL-116.
- C. Manufacturer shall provide for those openings 10 in. or larger, round or square as shown on the drawings. Other openings shall be located and field drilled or cut by the trade requiring them after the units have been erected. Openings and/or cutting of prestressing strand shall be approved by ENGINEER and manufacturer before drilling or cutting.
- D. Forms:
  1. Forms for precast products shall be rigid and constructed of materials that will result in finished products conforming to the profiles, dimensions and tolerances indicated by this Section, the Contract Documents and the reviewed Shop Drawings.
  2. Construct forms to withstand vibration method selected.
  3. Release agents shall be applied and used according to manufacturer's instructions.
- E. Concreting:
  1. Batching of Concrete shall be in accordance with approved Mix Design(s).
  2. Convey concrete by methods which will prevent separation, segregation or loss of material.
  3. Consolidate all concrete in the form to minimize honeycombing or entrapped air.
- F. Curing: Procedures sufficient to insure specified concrete strength of all products must be employed. Stripping of a panel shall not occur until concrete strength is sufficient to prevent cracking or damage of the panel.

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- G. Manufacturing Tolerances:
1. Cross Sectional Dimensions:
    - a. Less than 24 inches:  $\pm 1/4"$
    - b. 24 to 36 inches:  $\pm 3/8"$
    - c. Over 36 inches:  $\pm 1/2"$
  2. Length:
    - a. Less than 25 ft:  $\pm 1/2"$
    - b. 25 to 50 ft:  $\pm 3/4"$
    - c. Over 50 ft:  $\pm 1"$
  3. Variation from square or designed skew (difference in length of two diagonal measurements): Max.  $\pm 3/4"$
- H. Identification: Mark each precast item to correspond to identification mark on Shop Drawings for product location, and with casting date.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Access: Clear unloading areas and access roadways to point of component placement shall be provided and maintained by the CONTRACTOR. The CONTRACTOR shall provide all required traffic controls, barricades, warning lights and/or signs to insure a safe installation.
- B. Sitework: The CONTRACTOR shall excavate and prepare the subgrade, including 2 inches of clean sand, graded level and to the proper elevation.
- C. Installer Responsibility: Prior to installation of the precast products, notify the CONTRACTOR of any discrepancies discovered which affect the work under this contract.

#### **3.2 INSTALLATION**

- A. General: Precast products shall be lifted with suitable lifting devices at points provided by the Manufacturer to prevent excessive stresses or damage to the products. Brace and secure items before unhooking.
- B. Sitework:
  1. Openings or "knockouts" shall be located as shown on the drawings and shall be sized sufficiently to permit passage of the largest dimension of pipe and/or coupling flange. Upon completion of installation, all voids or openings in the vault walls around pipes shall be filled with 4,000-psi concrete or mortar, using an approved epoxy for bonding concrete surfaces.
  2. All joints between precast sections shall be made watertight using preformed mastic material. The sealing compound shall be installed according to the manufacturer's recommendations to provide a watertight joint which remains impermeable throughout the design life of the structure. All joints shall be filled with dry-pack non-shrink grout. If plastic liner system is used, after the joint has been made and is cured, install plastic liner weld strip at all joints and seams.
  3. Frames and covers shall be built up so that the cover is flush with the surrounding surface unless otherwise specified. The CONTRACTOR is responsible for placing the cover at the proper elevation where paving is to be installed and shall make all necessary adjustments so that the cover meets these requirements.

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4. After the structure and all appurtenances are in place and approved, and after any required disinfection or testing, backfill shall be placed to the original ground line or to the limits designated on the plans.

### 3.3 FIELD QUALITY CONTROL

- A. Hydrostatic Testing:
  1. All Manholes, Wetwells, Junction Boxes, or other water bearing structures shall be hydrostatically tested prior to acceptance.
  2. Test Procedure:
    - a. Plug all inlets and outlets with temporary plugs
    - b. Fill water bearing structure with clean, potable water
    - c. Let stand for 24 hours, if desired, to allow for "soaking-in"
    - d. Fill to rim elevation
    - e. Let stand for a minimum of 2 hours
    - f. Check distance from rim to water surface
    - g. Calculate water loss. Leakage in each manhole may not exceed 0.1-gallon per hour per foot of water depth during the test.
  3. Repair all structures which do not meet the above test requirements with a method approved by the ENGINEER and re-test until passing.

### 3.4 PATCHES AND REPAIRS:

- A. Patching of products, when required, shall be performed to industry standards for structural concrete. Repairs shall be sound, permanent and flush with adjacent surface.

### 3.5 WARRANTY:

- A. All labor and materials under the Precast Manufacturers contract shall be warranted by the Precast Manufacturer for a period of one (1) year after substantial completion.

+ + END OF SECTION + +

## SECTION 03600

### GROUT

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. Section includes epoxy, non-metallic, non-shrink, and ordinary Portland cement-sand grouts.

##### **1.2 REFERENCES**

- A. American Society for Testing and Materials (ASTM)
  - 1. ASTM C33, Standard Specification for Concrete Aggregates.
  - 2. ASTM C150, Standard Specification for Portland Cement.
  - 3. ASTM C595, Standard Specification for Blended Hydraulic Cements.
  - 4. ASTM C1107, Standard Specification for Packaged Dry, Hydraulic-Cement Grout.

##### **1.3 SYSTEM DESCRIPTION**

- A. Furnish ordinary cement-sand grout for the following:
  - 1. Foundation grout.
  - 2. Construction joint grout.
  - 3. As shown in the Drawings.
- B. Furnish non-shrink, non-metallic grout for the following:
  - 1. Equipment bases, 25 hp or less.
  - 2. Base plates.
  - 3. Guardrail and railings.
  - 4. Through-bolt and form tie openings.
  - 5. As shown in the Drawings.
- C. Furnish epoxy grout for the following:
  - 1. Equipment bases, 26 hp or more and/or sole plates with vibration, thermal movement, etc.
  - 2. Blockouts for gate guides.
  - 3. Retrofit waterstop installation.
  - 4. As shown in the Drawings.

##### **1.4 SUBMITTALS**

- A. Product Data:
  - 1. Manufacturer's specifications and installation instructions for all proprietary materials.
  - 2. Proposed method for keeping existing concrete surfaces wet prior to placing grout.
  - 3. Forming method for fluid grout placements.
  - 4. Curing method for grout.
- B. Laboratory Test Reports and Certificates:
  - 1. For proprietary materials, submit copies of reports on quality control tests.
  - 2. Submit certification that materials meet specification requirements for nonproprietary materials.

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3. For ordinary cement-sand grout, copies of grout mix design and laboratory strength test reports.

## 1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery of Materials: Deliver grout materials from manufacturers in unopened containers and bearing intact manufacturer's labels.
- B. Storage of Materials: Store grout materials in a dry shelter and protected from moisture.

## **PART 2 - PRODUCTS**

### 2.1 MATERIALS

- A. High-Strength Epoxy Grout.
  1. Use 100% solids, prepackaged, solvent-free, moisture insensitive, high-strength epoxy grout.
  2. Product and Manufacturer: Provide one of the following:
    - a. E<sup>3</sup>-HP, as manufactured by The Euclid Chemical Company.
    - b. Sikadur 42 Grout Pak, as manufactured by Sika Corporation.
    - c. Five Star HP Epoxy Grout by Five Star Products, Incorporated.
    - d. Or approved equal.
- B. Non-shrink, Non-metallic Grout:
  1. Prepackaged non-staining cementitious grout which shall meet the minimum requirements of ASTM C1107 and requiring only the addition of water at the jobsite.
  2. Product and Manufacturer: Provide one of the following:
    - a. NS, as manufactured by The Euclid Chemical Company.
    - b. Five Star Grout, as manufactured by Five Star Products, Incorporated.
    - c. Sika Grout 212, as manufactured by Sika Corporation.
    - d. Or approved equal.
- C. Ordinary Cement-Sand Grout: Prepare design mix for ordinary cement grout.
  1. Cement: Portland cement, ASTM C150, Type II; or blended hydraulic cement, ASTM C595, Type 1P.
  2. Aggregates: ASTM C33 and as herein specified.
    - a. Do not use aggregates containing soluble salts or other substances such as iron sulfides, pyrite, marcasite, ochre, or other materials that can cause stains on exposed concrete surfaces.
    - b. Fine Aggregate: Clean, sharp, natural sand, free from loam, clay, lumps or other deleterious substances.
      - 1) Dune sand, bank run sand and manufactured sand are not acceptable.
    - c. Coarse Aggregate: Coarse aggregate not permitted.
  3. Admixtures: Provide admixtures produced by established reputable manufacturers and use in compliance with the manufacturer's printed instruction. Do not use admixtures that have not been incorporated and tested in the accepted mixes, unless otherwise authorized in writing by ENGINEER. Refer to Section 03300 - Cast-In-Place Concrete, for additional admixture requirements.
  4. Proportioning and Design of Mixes: Mixes are subject to the following limitations:
    - a. Specified 28-day Compressive Strength: 4,000 psi.
    - b. Minimum amount of water necessary for the mixture to flow under its own weight.
    - c. Fine Aggregate meeting ASTM C33.

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- d. Air Content Percentage:  $\pm 1.5\%$ .
- e. Minimum Cement Content in Pounds per Cubic Yard: 658.
- f. Slump at point of placement:  $5" \pm 1"$ .
- 5. Proportion mix by either laboratory trial batch or field experience methods, using materials to be employed on the Project for grout required. Comply with ACI 211.1 and provide a complete report, from an independent testing laboratory, to ENGINEER, at least 30 days prior to start of Work. Do not begin grout production until ENGINEER has approved mix.
- 6. Laboratory Trial Batches: When laboratory trial batches are used to select grout proportions, prepare test specimens and conduct strength tests as specified in ACI 301, Chapter 3 - Proportioning.
- 7. Field Experience Method: When field experience methods are used to select grout proportions, establish proportions as specified in ACI 301, Chapter 4.

### **PART 3 - EXECUTION**

#### **3.1 INSPECTION**

- A. Examine the substrate and conditions under which grout is to be placed with installer and notify ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

#### **3.2 INSTALLATION**

- A. General:
  - 1. Mix, place and cure grout as shown and in accordance with manufacturer's instructions. If manufacturer's instructions conflict with the Specifications, do not proceed until ENGINEER provides clarification.
  - 2. Manufacturers of proprietary products shall make available upon 72 hours notification the services of a qualified, full time employee to aid in assuring proper use of the product under job conditions. The cost of this service, if any, shall be borne by CONTRACTOR.
  - 3. When placing grout conform to temperature and weather limitations in Section 03300 - Cast-In-Place Concrete.
- B. Through-bolt and form-tie holes: Fill space with dry pack dense grout hammered in with steel tool and hammer. Coordinate dry pack dense grout application with bonding agent in Section 03251 - Concrete Joints.
- C. Columns, Beams and Equipment Bases: Prepare concrete surface by sandblasting, chipping, or by mechanical means to remove any soft material prior to setting base plates and machinery. After shimming columns, beams and equipment indicated to be grouted on the plans to proper grade, securely tighten anchor bolts. Properly form around the base plates allowing sufficient room around the edges for placing the grout. Adequate depth between the bottom of the base plate and the top of concrete base must be provided to assure that the void is completely filled with grout.
- D. Guardrails and Railings: After posts and rails have been properly inserted into holes or sleeves, fill the annular space between posts and cast-in-place sleeves and/or below base plates with non-shrink grout. Bevel grout at juncture with post so that moisture flows away from posts.

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- E. Construction Joints: Ordinary cement-sand grout may be used in place of mortar over the contact surface of the old concrete at the interface of horizontal construction joints as outlined in Section 03251 - Concrete Joints, and Section 03300 - Cast-In-Place Concrete, of these Specifications.
- F. Curing: Cure all grout in accordance with manufacturer's written instructions. Wet cure ordinary cement-sand grout and non-shrink non-metallic grout for a minimum of three (3) days unless directed otherwise by the ENGINEER.

+ + END OF SECTION + +

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## SECTION 03740

### CRACK REPAIR BY EPOXY INJECTION

#### **PART 1 - GENERAL**

##### **1.1 DESCRIPTION**

- A. Scope:
1. CONTRACTOR shall furnish all material, tools, equipment, appliances, transportation, labor and supervision required to repair cracks by the injection of an epoxy resin adhesive.

##### **1.2 QUALITY ASSURANCE**

- A. Qualifications for Epoxy Injection Staff:
1. Manufacturer's Site Representative:
    - a. Capable of instructing successful methods for restoring concrete structures utilizing epoxy injection process.
    - b. Understands and is capable of explaining technical aspects of correct material selection and use.
    - c. Experienced in the operation, maintenance, and troubleshooting of application equipment.
  2. Injection crew and job foreman shall provide written and verifiable evidence showing compliance with the following requirements:
    - a. Licensed and certified by epoxy manufacturer.
    - b. Minimum 3 years' experience in successful epoxy injection for at least 10,000 linear feet of successful crack injection including 2,000 linear feet of wet crack injection to stop water leakage.
  3. CONTRACTOR shall retain the services of a qualified and authorized technical representative of the materials manufacturer to provide a site visit to specifically address the parameters of the repair and provide recommendations at the beginning of the installation and to make periodic visits to ensure that the work is performed in accordance with the manufacturer's recommendations and achieves the repair objectives.

##### **1.3 SUBMITTALS**

- A. Product Data: Submit copies of manufacturer's specifications and installation instructions for all materials and accessories including:
1. Manufacturer's recommended surface preparation procedures and application instruction for epoxy adhesives.
  2. Installation instructions for repairing core holes with epoxy grout.
  3. Manufacturer's Certificate of Compliance: Certified test results for each batch of epoxy adhesive.
  4. Statements of Qualification for Epoxy Adhesive:
    - a. Manufacturer's site representative.
    - b. Injection applicator.
    - c. Injection pump operating technician.
  5. Epoxy adhesive two component ratio and injection pressure test records for concrete crack repair work.

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#### 1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Packing and Shipping: Package adhesive material in new sealed containers and label with the following information:
  - 1. Manufacturer's name.
  - 2. Product name and lot number.
  - 3. Material Safety and Data Sheet, MSDS.
  - 4. Mix ratio by volume.
- B. Store adhesive containers at ambient temperatures below 100°F and above 45°F. Condition adhesive before use as recommended by the manufacturer.

### **PART 2 - PRODUCTS**

#### 2.1 MANUFACTURERS

- A. Materials, equipment and accessories specified in this section shall be products of one of the following:
  - 1. Concreive Series, as manufactured by BASF Building Systems.
  - 2. Sikadur Series, as manufactured by Sika Corporation.
  - 3. Euco Series, as manufactured by Euclid Chemical Company.

#### 2.2 EPOXY ADHESIVE

- A. Epoxy adhesive grout shall be a 100% solids 2-part water insensitive low-viscosity epoxy resin system.
- B. Epoxy shall be suitable for grouting both dry and damp cracks.
- C. Adhesive Properties:

7-day, Tensile Strength, psi	ASTM D638	5,000 min.
Tensile Elongation @ Break, percent	ASTM D638	1.0% min.
Compressive Yield Strength, 7 days @ 73°F, psi	ASTM D695	8,000 min.
Compressive Modulus, psi	ASTM D695	1.5x10 <sup>5</sup> min.
Heat Deflection Temperature, °F	ASTM D648	120 min.
Water Absorption @ 24 hours, percent	ASTM D570	1.0% max.
Bond Strength @ 2 days, psi	ASTM C882	1,000 min.
Bond Strength @ 14 days, psi	ASTM C882	1,500 min.

#### 2.3 SURFACE SEAL

- A. The surface seal material is that material used to confine the injection adhesive in the fissure during injection and cure.
- B. The surface seal material shall have adequate strength to hold injection fittings firmly in place and to resist injection pressures adequately to prevent leakage during injection.
- C. Capable of removal after injection adhesive has cured.

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## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Clean cracks in accordance with epoxy adhesive manufacturer's instructions.
- B. Surface adjacent to cracks or other areas of application shall be cleaned of dirt, dust, grease, oil, efflorescence or other foreign matter which may be detrimental to the integrity of the bond between the epoxy and the injection surface. Acids and corrosives used for cleaning shall not be permitted.
- C. Entry ports shall be provided along the crack at intervals of not less than the thickness of the concrete at that location, unless otherwise specified by the adhesive manufacturer.
- D. Unless the crack is in submerged concrete, remove any water that can be seen by visual inspection from the crack before the injection process, and remove water that appears during the injection process.
- E. Do not inject cracks when the temperature of the concrete is below freezing and moisture conditions indicate the possibility of ice on the internal surfaces of the crack.
- F. Do not inject adhesive if the temperature of the concrete is not within the range of application temperatures recommended by the manufacturer of the adhesive.

### **3.2 INSTALLATION**

- A. Sealing: Apply surface seal in accordance with manufacturer's instructions to designated crack face prior to injection. Seal surface of crack to prevent escape of injection epoxy.
- B. Entry Ports:
  - 1. Establish openings for epoxy entry in surface seal along crack.
  - 2. Determine space between entry ports equal to thickness of concrete member to allow epoxy to penetrate the full thickness of the wall.
  - 3. Provide a means to prevent concrete dusts and fines from contaminating the crack or ports when drilling.
  - 4. Space entry ports closer together to allow adjustment of injection pressure to obtain minimum loss of epoxy to soil at locations where:
    - a. Cracks extend entirely through wall.
    - b. Backfill of walls on one side.
    - c. Difficult to excavate behind wall to seal both crack surfaces.
    - d. Core drill to verify epoxy depth where only one side of wall is exposed.
- C. Epoxy Injection:
  - 1. Condition epoxy at a minimum of 70°F, or as recommended by the manufacturer.
  - 2. Start injection into each crack at lowest elevation entry port.
  - 3. Continue injection at first port until adhesive begins to flow out of port at next highest elevation.
  - 4. Plug first port and start injection at second port until adhesive flows from next port.
  - 5. Inject entire crack with same sequence.

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D. Finishing:

1. Cure epoxy adhesive after cracks have been completely filled to allow surface seal removal without draining or runback of epoxy material from cracks.
2. Remove surface seal from cured injection adhesive.
3. Finish crack face flush with adjacent concrete.
4. Indentations or protrusions caused by placement of entry ports are not acceptable.
5. Remove surface seal material and injection adhesive runs and spills from concrete surfaces.

E. Equipment:

1. The equipment used to meter and mix the two injection adhesive components and inject the mixed adhesive into the crack shall be portable, positive displacement type pumps with interlock to provide positive ratio control of exact proportions of the two components at the nozzle. The pumps shall be electric or air powered and shall provide in-line metering and mixing.
2. The injection equipment shall have automatic pressure control capable of discharging the mixed adhesive at any pre-set pressure up to 200 psi plus or minus 5 psi and shall be equipped with a manual pressure control override.
3. The injection equipment shall have the capability of maintaining the volume ratio for the injection adhesive prescribed by the manufacturer of the adhesive within a tolerance of plus or minus 5 percent by volume at any discharge pressure up to 160 psi.
4. Do not use batch mix pumps.

### 3.3 FIELD QUALITY CONTROL

A. Injection Pressure Test:

1. The mixing head of the injection equipment shall be connected and the equipment run until clear uniformly mixed material flows into the purge pail. The Operator shall engage the equipment shut-off nozzle valve and subsequently bump the on-off switch while monitoring pressure on psi gauge until the pressure reaches 200 psi. Pressure gauge shall be monitored for one minute. If pressure is maintained between 190 – 200 psi, check valves shall be considered to be functioning properly and the injection may proceed. If pressure drops below 190 psi, CONTRACTOR shall be required to have new seals installed on the check valves and the equipment shall be subsequently retested.
2. The pressure test shall be run for each injection unit at the beginning and after meal break of every shift that the unit is used in the work of crack repair.
3. The adequacy and accuracy of the equipment shall be solely the responsibility of CONTRACTOR.

B. Metering Accuracy Ratio Test:

1. The epoxy mixture ratio shall be monitored continuously while injecting by placing a strip of masking tape on the sides of the A & B reservoirs full height. After filling reservoirs, the A & B levels shall be marked and monitored while running injection machine into purge pail for a period of one minute at 160 psi discharge pressure.
2. The ratio test shall be run for each injection unit at the beginning of every shift that the unit is used in the work of crack repair and when injection work has stopped for more than 1 hour.

C. Proof of Ratio and Pressure Test:

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1. At all times during the course of the work CONTRACTOR shall keep complete and accurate records available to ENGINEER of the pressure and ratio tests specified above.
2. In addition, ENGINEER at any time without prior notification of CONTRACTOR, may request CONTRACTOR to conduct the tests specified above in the presence of ENGINEER.

D. Daily Log

1. Maintain a written daily log for each day of injection work that includes:
  - a. Ambient temperatures at the start and end of the workday and 4 hours after the end of the workday.
  - b. Weather conditions, such as rain, snow, and wind, including changes during the shift.
  - c. Crack cleaning methods, if any, including locations.
  - d. Record of injection adhesive, including manufacturer, product and batch number, and amount used each day.
  - e. Signature and printed name of person responsible for record keeping.

E. Core Testing

1. Initial Cores:
  - a. Obtain 4-inch diameter cores for the full crack depth taken from ENGINEER selected locations.
  - b. Visual inspection for depth of penetration:
    - 1) Three cores from the first 100-feet and one core for each 100-feet thereafter.
    - 2) It is permitted to obtain 2-inch cores if they are only used to verify adhesive penetration.
  - c. Splitting tensile strength per ASTM C496:
    - 1) One core for the first 100-feet and once core for each 75-feet thereafter.
  - d. Mark each of the cores with a "T" for top or "B" for bottom for cores taken vertically, or "H" for cores taken horizontally.
  - e. Mark the respective end of the core with the letters "IS" (injection side) to indicate the side from which the injection was performed.
2. Test Requirements:
  - a. Adhesive Penetration: Minimum of 90% of the crack shall be full of epoxy adhesive.
  - b. Splitting tensile strength / Compression Test: Concrete failure before adhesive failure, or 6,500 psi with no failure of either concrete or adhesive.
3. Acceptance Criteria:
  - a. If initial cores pass the tests as specified, epoxy adhesive injection Work at the area represented by cores will be accepted.
  - b. If adhesive penetration or bond strength are not acceptable, stop injection Work until the areas represented by the testing are accepted, and changes in procedures or materials for continued injection Work have been accepted. Reinject adhesive in the locations where injection has not been acceptable. If partial injection has blocked all access to the cracks on surfaces that can be reinjected, drill injection holes into the concrete to intersect the crack in their void areas.

F. Core Hole Repair:

1. Fill core holes with epoxy grout as required by the Project Specifications. Finish surface shall blend with adjacent concrete.

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+ + END OF SECTION + +

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## SECTION 04200

### CONCRETE MASONRY UNITS

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. Section includes: All masonry work shown on the Drawings. It also includes providing openings in masonry, to accommodate the Work under other Sections, and building into the masonry all items such as sleeves, anchor bolts, inserts and all other embedded items for which placement is not specifically provided under other Sections.

##### **1.2 REFERENCES**

- A. American Concrete Institute (ACI)
  - 1. ACI 315, "Manual of Standard Practice for Detailing Reinforced Concrete Structures."
- B. American Society for Testing and Materials (ASTM)
  - 1. ASTM A36, Carbon Structural Steel, Standard Specification for.
  - 2. ASTM A82, Steel Wire, Plain, for Concrete Reinforcement, Standard Specification for.
  - 3. ASTM A153, Zinc Coating (Hot Dip) on Iron and Steel Hardware, Standard Specification for.
  - 4. ASTM A167, Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip, Standard Specification for.
  - 5. ASTM A240, Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels, Standard Specification for.
  - 6. ASTM A366, Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality, Standard Specification for.
  - 7. ASTM A569, Steel, Carbon (0.15 Maximum Percent), Hot-Rolled Sheet and Strip, Commercial Quality, Standard Specification for.
  - 8. ASTM A580, Stainless Steel Wire, Standard Specification for.
  - 9. ASTM A615, Deformed and Plain Billet-Steel Bars for Concrete Reinforcement, Standard Specification for.
  - 10. ASTM A663, Steel Bars, Carbon, Merchant Quality, Mechanical Properties, Standard Specification for.
  - 11. ASTM C5, Quicklime for Structural Purposes.
  - 12. ASTM C67, Standard Methods of Sampling and Testing Brick.
  - 13. ASTM C90, Load-bearing Concrete Masonry Units, Standard Specification for.
  - 14. ASTM C91, Masonry Cement.
  - 15. ASTM C136, Sieve or Screen Analysis of Fine and Coarse Aggregates.
  - 16. ASTM C140, Sampling and Testing Concrete Masonry Units, Standard Test Methods of.
  - 17. ASTM C144, Aggregate for Masonry Mortar.
  - 18. ASTM C150, Portland Cement.
  - 19. ASTM C180, Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
  - 20. ASTM C207, Hydrated Lime for Masonry Purposes.
  - 21. ASTM C270, Mortar for Unit Masonry.
  - 22. ASTM C331, Lightweight Aggregates for Concrete Masonry Units, Standard Specification for.
  - 23. ASTM C404, Aggregates for Masonry Grouts.

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24. ASTM C426, Linear Drying Shrinkage of Concrete Masonry Units, Standard Test Method for.
  25. ASTM C476, Grout for Masonry.
  26. ASTM C744, Prefaced Concrete and Calcium Silicate Masonry Units, Standard Specification for.
  27. ASTM C1019, Standard Test Method of Sampling and Testing Grout.
  28. ASTM D2240, Rubber Property - Durometer Hardness, Standard Test Method for.
  29. ASTM E84, Surface Burning Characteristics of Building Materials, Standard Test Method for.
  30. ASTM E119, Fire Tests of Building Construction and Materials, Standard Test Methods for.
- C. Brick Institute of America
1. "Technical Notes on Brick and Tile Construction."
  2. Technical Bulletin 1A, "Construction and Protection Recommendations for Cold Weather Masonry Construction."
- D. National Concrete Masonry Association,
1. "Guide Specifications"
  2. "Technical Bulletins."
- E. Underwriters Laboratories (UL)
1. Design Numbers U901 through U914.

### 1.3 SYSTEM DESCRIPTION

- A. Coordination:
1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the masonry Work.
  2. Masonry Work advanced without built-in flashings and other items shall be removed and rebuilt, at no additional cost to OWNER, even if discovered after masonry has been completed.
  3. Coordinate the work of other Sections to avoid delay of the masonry Work.

### 1.4 SUBMITTALS

- A. Shop Drawings:
1. Complete layout of all masonry walls showing modular planning and all special shapes to be used. Show all details for each condition encountered in the Work. Provide plans and elevations drawn at 1/4-inch scale and details drawn at 1½-inch scale. Show all items required to be built into masonry.
  2. Masonry control joint locations and details.
  3. Fabrication, bending, and placement of reinforcing bars. Show bar schedules, diagrams of bent bars, stirrup spacing, lateral ties and other arrangements and assemblies as required for fabrication and placement of reinforcing for masonry Work.
  4. Explanation of where each masonry accessory will be used in the Work, quantities purchased and intended spacings.

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- B. Samples:
  - 1. One unit of each type of concrete masonry unit specified.
  - 2. One unit or one modular length of each accessory item specified.
  - 3. Each type of colored mortar, showing the range of color that can be expected in the Work.
- C. Product Data:
  - 1. Complete selection of manufacturer's standard and custom colors.
  - 2. Mix designs for grout and mortar.
  - 3. Manufacturer's specifications and instructions for each manufactured product. Include data substantiating that materials comply with specified requirements.

## 1.5 QUALITY ASSURANCE

- A. Requirements of Regulatory Agencies:
  - 1. Comply with the applicable requirements of International Building Code, including the requirements for Special Inspection.
  - 2. Wherever a fire-resistance classification is shown or scheduled for masonry Work (4-hour, 3-hour, and similar designations), comply with applicable requirements for materials and installation established by UL and other governing authorities.
- B. Source Quality Control:
  - 1. Obtain all concrete masonry units from one manufacturer, cured by one process and of uniform texture and color or in an established uniform blend thereof. Cure units by autoclave treatment at minimum temperature of 350°F, and a minimum pressure of 125 psi.
  - 2. Do not change source or brands of materials during the course of the Work.
  - 3. No change shall be made in the proportions for mortar or grout, unless resubmitted and re-approved by the ENGINEER.
- C. Construction Tolerances:
  - 1. Variation from Plumb: For lines and surfaces of columns, walls, and expansion joints, do not exceed 1/4-inch in 10-feet, or 3/8-inch in one story height or 20-feet maximum, nor 1/2-inch in 40-feet or more.
  - 2. Variation from Level: For lines of exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines, do not exceed 1/4-inch in any bay or 20-feet maximum, nor 1/2-inch in 40-feet or more.
  - 3. Variation of Linear Building Line: For position shown and related portion of columns, walls and partitions, do not exceed 3/8-inch in any bay or 20-feet maximum, nor 1/2-inch in 40' or more.
  - 4. Variation in Cross-Sectional Dimensions: For columns and thickness of walls, do not exceed +1/2-inch-1/4-inch from dimensions shown.
- D. Preconstruction Conference: Prior to the installation of masonry Work, CONTRACTOR shall schedule a Preconstruction Conference at the project site.
  - 1. Review foreseeable methods and procedures related to the masonry Work including, but not necessarily limited to, the following:
    - a. Project requirements, including Contract Documents.
    - b. Method of sequence of masonry construction.
    - c. Special masonry details.
    - d. Required submittals, both completed and yet to be completed.
    - e. Standards of workmanship.
    - f. Quality control requirements.

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- g. Job organization and availability of materials, tradesmen, equipment and facilities needed to make progress and avoid delays.
- h. Modular planning requirements.
- i. Weather and forecasted weather conditions and procedures for coping with unfavorable conditions.
- j. Required inspection, testing and certifying procedures.
- k. Regulations concerning building code compliance.
- 2. Attendance is mandatory for the following:
  - a. CONTRACTOR'S job superintendent.
  - b. Masonry subcontractor's job superintendent.
  - c. Masonry subcontractor's foreman.
  - d. Authorized representative of concrete unit masonry supplier.
  - e. ENGINEER'S authorized representative.
- 3. Reconvene the meeting at the earliest opportunity if additional information must be developed in order to conclude the subjects under consideration and to resolve any outstanding issues.
- 4. CONTRACTOR shall record the discussions of the conference and the decisions and agreements (or disagreements) and furnish a copy of the record to each party attending.

#### 1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

##### A. Delivery of Materials:

- 1. Deliver concrete masonry units in original, unopened and undamaged packages and pallets, plainly marked with identification of materials and name of approved manufacturer. Delivery shall be by the manufacturer or manufacturer's agent.
- 2. Deliver reinforcing to the site, bundled, tagged and marked. Use metal tags indicating size, lengths and other markings shown on approved Shop Drawings.
- 3. Manufactured materials, such as cement and lime, shall be delivered and stored in their original containers plainly marked with identification of materials and manufacturer.

##### B. Storage of Materials:

- 1. Store materials off the ground, protected from dirt, construction traffic and contamination. Cover using tarpaulins or polyethylene sheets to prevent damage such as wetting, staining, and chipping.
- 2. Do not stack concrete masonry units higher than recommended by manufacturer.

##### C. Handling Materials:

- 1. Handle materials in a manner that minimizes chips, cracks, voids, discolorations or other defects that might be visible or cause staining in finished Work.

#### 1.7 JOB CONDITIONS

- A. Site Facilities: Supplemental heat sources, as may be required, should CONTRACTOR wish to continue masonry Work in cold weather if not available at the project site. The provision of all supplemental heat energy sources and equipment is the responsibility of CONTRACTOR.

##### B. Environmental Requirements:

- 1. Do not place any masonry Work when air temperature is below 28°F, on rising temperatures or below 36°F, on falling temperatures, without temporary heated



enclosures or without heating materials or other precautions necessary to prevent freezing.

2. No frozen materials shall be used, nor shall frozen masonry Work be built upon.
3. Remove and replace all masonry Work damaged by frost or freezing.

C. Protection:

1. Protect all masonry against freezing for at least 48 hours after being placed.
  - a. Mean Daily Air Temperature 40°F to 32°F: Protect masonry from rain for 48 hours after installation.
  - b. Mean Daily Temperature 32°F to 20°F: Completely cover masonry with insulating blankets for 48 hours.
  - c. Mean Daily Air Temperature 20°F and Below: Maintain masonry above 32°F for 48 hours by enclosure and supplementary heat.
2. Protect partially completed masonry against rapid heat loss and from water entering it when Work is not in progress, by covering top of walls with strong, waterproof, nonstaining membrane. Extend membrane at least 2' down both sides of walls and secure in place using wall cover clamps spaced at intervals of 4' and at each end and joint of covering.
3. Do not apply distributed floor or roof loading for at least 3 days after completing masonry columns or walls.
4. Do not apply concentrated loads for at least 7 days after completing masonry columns or walls.

D. Cold Weather Masonry Work:

1. All mortar for use in masonry Work, when the mean daily temperature is below 40°F, shall be portland cement- lime-sand mortars using high early strength portland cement.
2. Air Temperature 40°F to 32°F: Heat sand or mixing water to 70°F-160°F.
3. Air Temperature 32°F to 20°F: Heat sand and mixing water to 70°F-160°F. Provide heat on both sides of wall under construction to heat constructed masonry to 40°F. Employ wind breakers when wind is in excess of 15 mph.
4. Air Temperature below 20°F: Heat sand and mixing water to 70°F-120°F. Provide enclosure and auxiliary heat to maintain air temperature above 32°F. Heat constructed masonry to 40°F. Temperature of masonry units when laid shall not be less than 20°F.

E. Hot Weather Masonry Work:

1. Preparation – Prior to conducting masonry work:
  - a. When the ambient air temperature exceeds 100°F, or exceeds 90°F with a wind velocity greater than 8 mph:
    - 1) Maintain sand piles in a damp, loose condition.
    - 2) Provide necessary conditions and equipment to produce mortar having a temperature below 120°F.
  - b. When the ambient air temperature exceeds 115°F or exceeds 105°F with a wind velocity greater than 8 mph implement the requirements above and shade materials and mixing equipment from direct sunlight.
2. Construction – While masonry work is in progress:
  - a. When the ambient air temperature exceeds 100°F, or exceeds 90°F with a wind velocity greater than 8 mph:
    - 1) Maintain temperature of mortar and grout below 120°F.
    - 2) Flush mixer, mortar transport container, and mortar boards with cool water before they come into contact with mortar ingredients or mortar.
    - 3) Maintain mortar consistency by retempering with cool water.

- 4) Use mortar within 2 hours of initial mixing.
  - b. When the ambient temperature exceeds 115°F or exceeds 105°F with a wind velocity greater than 8 mph implement the requirements listed above and use cool mixing water for mortar and grout. Ice is permitted in the mixing water prior to use. Ice is not permitted in the mixing water when added to the other mortar or grout materials.
3. Protection – When the mean daily temperature exceeds 100°F or exceeds 90°F with a wind velocity greater than 8 mph, fog spray newly constructed masonry until damp, at least three times a day until the masonry is three days old.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL CONCRETE UNIT MASONRY**

- A. General: Unless specifically modified by other requirements specified, provide concrete masonry units in compliance with the following classifications, weights, grades, colors, textures, scores, thermal resistance values and other features specified.
- B. Hollow Load-bearing Concrete Masonry Units: Provide the following:
  1. ASTM C90 medium weight.
  2. Minimum Compressive Strength: 1,900 pounds per square inch average of three units; 1,700 pounds per square inch minimum for an individual unit. The manufacturer shall certify that the masonry units meet all requirements of ASTM C90 including the moisture content and linear shrinkage requirements for intermediate conditions.
- C. Color and Texture: Provide the following:
  1. Manufacturer's complete selection of all standard and all custom colors. Submit preliminary color selection for review by ENGINEER.
  2. Color, surface texture and aggregate uniform within the normal range established by sample submission and as approved by ENGINEER.
- D. Special Shapes: Provide the following where required:
  1. Lintels, bond beams, reinforcing units, and flush-end reinforcing units, interior and exterior corner shapes, solid jambs, sash block, coves, premolded control joint blocks, headers, and other special conditions.
  2. Split-face, scored, and other facings, and special sizes, as shown on the Drawings.
- E. Waterproofing Admixture: Manufacture all types of concrete unit masonry, used in construction of exterior walls with an integral waterproofing admixture as follows:
  1. Material: Cross-linking acrylic polymer.
  2. Proportion: In strict accordance with manufacturer's instructions.
  3. Product and Manufacturer: Provide one of the following:
    - a. DRY-BLOCK Admixture by W. R. Grace & Company Construction Products Division.
    - b. Moxie Shield 1800 by Moxie International.
    - c. Or equal.

### **2.2 MORTAR**

- A. General: Anti-freeze admixture or agents, including calcium chloride are not permitted.

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- B. Mortar for All Unit Masonry: Type S. Comply with ASTM C270, Table 2, except limit materials to those specified herein.
1. Portland cement-Lime: Provide the following proportions by volume:
    - a. Portland Cement: 1 part.
    - b. Hydrated Lime or Lime Putty: 1/4 to 1/2.
    - c. Aggregate (sand in damp, loose condition): 2¼ to 3 times the sum of cementitious materials.
    - d. Pigment: as required to match approved sample.
  2. Properties:
    - a. Average Compressive Strength, ASTM C270: 1,800 pounds per square inch.
    - b. Minimum Water Retention, ASTM C270: 75%.
    - c. Maximum Air Content, ASTM C270: 12% for Portland cement - lime mortars.

### 2.3 MASONRY GROUT

- A. Proportion coarse grout mixes subject to the following limitations:
1. Specified 28-day Compressive Strength: 2,000 psi
  2. Minimum Cementitious Content: 550 lb/cu yd
    - a. Fly ash per ASTM C618 may be used replace cement but shall not exceed 20% by weight of cement plus fly ash.
  3. Maximum Water-Cement Ratio by Weight: 0.52
  4. Slump at point of placement: 8" to 11"
- B. Proportion mixes by either laboratory trial batch or field experience methods, using materials to be employed on the Project for grout required. Comply with ACI 211.1.

### 2.4 MATERIALS

- A. Portland Cement:
1. ASTM C150: Use Type II.
  2. Nonstaining and of natural color or as required to be compatible with the approved pigment.
- B. Hydrated Lime: ASTM C207, Type S, or lime putty ASTM C5.
- C. Aggregates: ASTM C33 and as herein specified.
1. Do not use aggregates containing soluble salts or other substances such as iron sulfides, pyrite, marcasite, ochre, or other materials that can cause stains on exposed surfaces.
  2. Fine Aggregate: Clean, sharp, natural sand, free from loam, clay, lumps or other deleterious substances. For mortar, ASTM C144, except for mortar for joints less than 1/4-inch use aggregate graded with 100% passing the No. 16 sieve.
  3. Colored/ White Mortar Aggregates: Provide ground marble, granite or other sound stone, as required to match the approved sample.
  4. Coarse Aggregate: Clean, uncoated, processed aggregate containing no clay, mud, loam, or foreign matter, as follows:
    - a. Crushed stone, processed from natural rock or stone.
    - b. Washed gravel, natural or crushed. Use of slag and pit or bank run gravel is not permitted.
    - c. Coarse Aggregate Size: ASTM C33, No. 8 or 89.
- D. Admixtures:

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1. Provide admixtures produced by established reputable manufacturers and use in compliance with the manufacturer's printed instruction. Do not use admixtures that have not been incorporated and tested in the accepted mixes. Refer to Section 03300, Cast-In-Place Concrete, for additional admixture requirements.
  2. Waterproofing Admixture for Exterior Concrete Unit Masonry: Provide a cross-linking acrylic polymer integral waterproofing system, proportioned and mixed in strict accordance with manufacturer's instructions. Provide one of the following:
    - a. DRY-BLOCK Mortar Admix by W.R. Grace & Company Construction Products Division.
    - b. Moxie Shield 1800 by Moxie International.
    - c. Or equal.
- E. Colored Mortar Pigments:
1. Commercial iron oxide, manganese dioxide, ultramarine blue, chromium oxide, or carbon black, compounded for use in mortar mixes.
  2. Do not exceed pigment to cement ratios, by weight, of 1 to 35 for carbon black and 1 to 7 for other pigments.
  3. Product and Manufacturer: Provide one of the following:
    - a. Truetone Mortar Colors by Frank D. Davis Co., subsidiary of Rockwood Industries, Inc.
    - b. Sonobrite by Sonneborn Building Products Division Rexnord Chemical Products, Inc.
    - c. Or equal.
- F. Water: Clean and free from injurious amounts of oils, acids, alkalis, or organic matter.

## 2.5 REINFORCING

- A. Reinforcing Bars: ASTM A615, Grade 60 for all bars. Shop-fabricate reinforcing bars that are shown or required to be bent or hooked. Comply with ACI 315 for the fabrication of reinforcing steel for masonry Work.
- B. Wire products: Ties, and rebar positioners shall be fabricated from cold-drawn steel wire complying with ASTM A82 and hot-dipped galvanized after fabrication with 1.5 ounces per square foot of zinc coating complying with ASTM A153.
- C. Rebar Positioners: Nine gage reinforcing bar positioners which accommodate both horizontal and vertical reinforcing steel. Provide one of the following:
1. #RB Series Rebar Positioners by Hohmann & Barnard, Inc.
  2. Or equal.

## 2.6 MISCELLANEOUS ACCESSORIES

- A. Compressible Filler: Provide watertight joint filler where masonry abuts structural framework members, and as shown. Provide the following:
1. Polyurethane foam strip saturated with polybutylene waterproofing material which when installed at A compression ratio of 2:1 is impermeable to water.
  2. Resilient to -40°F with 100% movement recovery.
  3. Elongation of 140% with a tensile strength of not less than 53 psi.
  4. Product and Manufacturer: Provide one of the following:
    - a. Polyseal by Sandell Construction Solutions.
    - b. Or equal.

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- B. Premolded Control Joint Strips: Provide complete selection of solid extruded rubber strips with a Shore A durometer hardness of 80 to 90 complying with ASTM D2240, designed to fit standard sash block and maintain lateral stability in masonry wall. Provide one of the following:
  - 1. #RS Series - Rubber Control Joints by Hohmann & Barnard, Incorporated.
  - 2. Or equal.
- C. Sealants: Refer to Section 07900, Joint Sealants.

### **PART 3 - EXECUTION**

#### **3.1 INSPECTION**

- A. CONTRACTOR and his installer shall examine areas and conditions under which masonry Work is to be installed, and notify ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.
- B. Special Masonry Inspection:
  - 1. The OWNER will employ a testing laboratory to perform Special Masonry Inspections in accordance with Chapter 17 of the current Building Code.
  - 2. Masonry inspection services will be provided during the following construction activities:
    - a. During laying of units:
      - 1) During the first day of the masonry construction, inspect proportions of site prepared mortar, construction of mortar joints, location of all reinforcing and connectors, size and location of structural elements, type, size and location of anchors, protection of masonry during cold weather.
      - 2) Inspection to be continuous the first full day of masonry construction which requires special inspection.
        - a) Thereafter, a minimum of 3 hours every third day of construction until the concrete masonry work is complete.
      - 3) Inspection while laying masonry units may be made concurrently with other inspection duties provided all inspection duties are adequately performed.
      - 4) When deficiencies are found, additional inspection shall be provided as required until deficiencies have been corrected.
      - 5) If masonry crews change, an additional full day of inspection is required during the first day the new crew is on-site.
    - b. Placement of reinforcing steel:
      - 1) Verification of all reinforcing including size, grade, lap lengths, and type.
      - 2) Inspection of all reinforcing shall be continuous at Risk Category IV structures.
      - 3) Inspector to be present during the concrete pour in which any dowels connecting concrete to masonry are cast to verify proper location of dowels.
    - c. Prior to each grouting operation, verify that grout space is clean, reinforcing and connectors are properly placed, proportions of site-prepared grout are correct and mortar joints have been properly constructed.
      - 1) Inspection shall be continuous prior to and during grout placement at Risk Category IV structures.
    - d. Verify compliance with International Building Code and Specifications continuously during all grouting operations.

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- e. Provide special inspection in accordance with ACI 530 Table 3.1.3 for Risk Category IV structures including observation of masonry work for conformance to the Contract Documents:
  - 1) Provide inspection reports to the ENGINEER, Building Official and OWNER.
    - a) Notify Contractor of discrepancies for correction.
    - b) Notify ENGINEER, Building Official and OWNER, in writing, when discrepancies have been satisfactorily corrected.
  - 2) Submit final signed report stating that Work requiring special inspection was, to the best of the inspector's knowledge, in conformance to the Contract Documents and the applicable workmanship provisions of the International Building Code.

### 3.2 INSTALLATION, GENERAL

- A. Build chases and recesses as shown or required by others. Provide not less than 8-inch of masonry between chase or recess and jamb of openings, and between adjacent chases and recesses.
- B. Leave openings for equipment, piping, ducts, and other items to be installed subsequent to starting of masonry Work. After installation of said items, complete masonry Work to match Work immediately adjacent to openings.
- C. Cut masonry units using motor driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide pattern shown and to fit adjoining Work neatly. Use full size units without cutting wherever possible.

### 3.3 LAYING MASONRY WALLS

- A. General:
  - 1. Lay out walls in advance for accurate spacing of surface pattern bond with uniform joint widths and to properly locate openings, masonry control joints, returns and offsets. Avoid the use of less than half size units at corners, jambs and wherever possible at other locations.
  - 2. Lay up walls plumb and true to comply with specified tolerances, with courses level, accurately spaced and coordinated with other Work.
  - 3. Pattern Bond:
    - a. Lay all concrete masonry Work in running bond with vertical joints in each course centered on units in courses above and below unless otherwise shown.
    - b. Bond and interlock each course of each wythe at corners.
    - c. Do not use units with less than 8-inch horizontal face dimensions at corners or jambs.
- B. Mortar Bedding and Jointing:
  - 1. Lay hollow concrete masonry units with full mortar coverage on horizontal and vertical face shells. Bed webs in mortar in starting course of piers, columns and pilasters, and where adjacent to cells or cavities to be reinforced or filled with concrete or grout.
    - a. Lay walls with 3/8-inch joints.
  - 2. Cut joints flush for masonry walls that are to be concealed or to be covered by other materials, except paint, unless otherwise shown.
  - 3. Tool exposed joints when mortar is "thumbprint" hard, slightly concave, unless otherwise required to match existing joint treatment. Rake out mortar in preparation for application of caulking or sealants where required.

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4. Concave-tool exterior joints below grade.
  5. Do not use mortar that has begun to set or if more than 30 minutes have elapsed since initial mixing. Do not retemper mortar.
  6. Remove masonry units disturbed after laying; clean and reset in fresh mortar. Do not pound corners at jambs to fit stretcher units which have been set in position. If adjustments are required, remove units, clean off mortar and reset in fresh mortar.
- C. Stopping and Resuming Work: Rack back 1/2-unit masonry length in each course, and do not tooth. Clean exposed surfaces of set masonry, wet units lightly, if required, and remove loose masonry units and mortar prior to laying new masonry.
- D. Built-in Work: As the Work progresses, build in items shown, specified or required by others. Fill cores in one block width solidly with masonry grout around built-in items.
- E. Structural Reinforced Masonry:
1. Shape and dimension reinforcement as shown and are required by governing codes.
  2. Position reinforcing accurately at the spacing shown. Support and secure vertical bars against displacement with rebar positioners.
  3. For columns, piers and pilasters, provide a clear distance between vertical bars as shown, but not less than 1½-inch. Provide lateral ties.
  4. For horizontal bars, provide fully-lapped "L" shaped corner bars at corners and intersections.
  5. Provide lapped splices with reinforcing steel placed in contact with rebar positioners or tied. Provide 48 bar diameter lap length, unless otherwise shown.
- F. Grouting Structural Reinforced Masonry:
1. Place grout within 1.5 hours from introducing water in the mixture and prior to initial set. Discard grout that does not meet the specified slump, has exceeded the 1.5 hour timeframe or has reached initial set.
  2. Solid grout all walls, beams, piers and pilasters, unless noted otherwise.
  3. Provide temporary dams where required or barriers to control horizontal flow of grout at ends of wall sections. Build dams full height of grout pour. If masonry units are used, do not bond into permanent masonry wythes. Remove temporary dams after completion of grout pour.
  4. Grout pour height shall not exceed 5.33 feet for grouting cells of hollow units with dimensions equal to or greater than 2.5"x3".
  5. Grout pour height shall not exceed 1 foot for grouting cells of hollow units with dimensions less than or equal to 1.5"x3".
  6. Terminate pour 1½-inch below top of highest course in pour.
  7. Provide metal wall ties, if required, to prevent blow outs.

### 3.4 ANCHORING MASONRY WORK:

- A. Anchor masonry to structural members where masonry abuts or faces, such members to comply with the following:
1. Provide an open space, not less than 1/2-inch in width, between masonry and structural member, unless otherwise shown. Keep open space free of mortar or other rigid materials.
  2. Anchor masonry to structural members with metal ties embedded in masonry joints and attached to structure. Provide anchors with flexible tie sections, unless otherwise shown.
  3. Space anchors as shown, but not more than 8-inch on center vertically and 36-inch on center horizontally.

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4. Provide end blocks, where masonry abuts structural support, to facilitate installation of compressible filler, backer rod and sealant.
- B. Lintels and Bond Beams: Provide masonry lintels and bond beams where shown. Use specially formed "U" shaped lintel and bond beam units with reinforcing bars placed as shown, filled with grout. Temporarily support formed-in-place lintels and bond beams.

### 3.5 REPAIR, POINTING AND CLEANING

- A. Remove and replace masonry units which are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units as intended. Provide new units to match adjoining units and install in fresh mortar or grout, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge any voids or holes, except weep holes, and completely fill with mortar. Point up all joints at corners, openings and adjacent Work to provide a neat, uniform appearance, properly prepared for application of sealant compounds.
- C. Cleaning Exposed, Unglazed Masonry Surfaces:
  1. Wipe off excess mortar as the Work progresses. Dry brush at the end of each day's Work.
  2. Final Cleaning: After mortar is thoroughly set and cured, clean sample wall area of approximately 20-square feet as described below. Obtain ENGINEER'S acceptance of sample cleaning before proceeding to clean remainder of masonry Work.
    - a. Dry clean to remove large particles of mortar using wood paddles and scrapers. Use chisel or wire brush if required.
    - b. Presoak wall by saturating with water and flush off loose mortar and dirt.
    - c. Acid type cleaners shall not be permitted.
    - d. Protect other Work from cleaning operations.
- D. Protection: Protect the masonry Work from deterioration, discoloration or damage during subsequent construction operations.

+ + END OF SECTION + +

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## SECTION 05051

### ANCHORS, INSERTS, AND DOWELS

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. Section includes all post-installed anchors and inserts required to anchor parts of the Work to supporting concrete or masonry construction, and plaster. This Section also includes adhesives for anchoring reinforcing dowels into existing concrete.

##### **1.2 REFERENCES**

- A. American Society for Testing and Materials
  1. ASTM A36, Standard Specification for Structural Steel.
  2. ASTM A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
  3. ASTM A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
  4. ASTM A194, Standard Specification for Carbon and Alloy Steel Nuts for High-Pressure or High-Temperature Service, or both.
  5. ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile.
  6. ASTM A320, Standard Specification for Alloys - Steel Bolting Materials for Low-Temperature Service.
  7. ASTM A484, Standard Specification for General Requirements for Stainless and Heat-Resisting Steel Bars, Billets and Forgings.
  8. ASTM A525, Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.

##### **1.3 SYSTEM DESCRIPTION**

- A. Provide the size, type, and length of anchor shown on the drawings or, if not shown, as specified in the detailed sections of these specifications.
- B. When the size, length or load carrying capacity of an anchor bolt, expansion anchor, toggle bolt, or concrete insert is not shown or specified, provide the size, length and capacity required to carry the design load times a minimum safety factor of 4.
- C. For equipment anchors, if the design load is not specified by the manufacturer, provide anchors of diameter no less than the diameter of the hole minus 3/16 inch. When the design load is not specified by the manufacturer, provide structural calculations in accordance with Section 01610.

##### **1.4 SUBMITTALS**

- A. Product Data: Submit for approval copies of material certification, manufacturer's specifications, load tables, dimension diagrams and installation instructions for the devices.

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- B. Installer's Qualifications: When installing adhesive anchors subject to sustained tension loading or when specifically noted in the Drawings, submit for approval copies of the installer's qualifications certified by the ACI/CRSI Adhesive Anchor Installer Certification program.

## 1.5 QUALITY ASSURANCE

- A. Post-installed concrete anchors shall be ICC approved for seismic applications in cracked concrete and prequalified in accordance with ACI 355.2 or ACI 355.4.

## **PART 2 - PRODUCTS**

### 2.1 ANCHOR BOLTS

- A. Nonsubmerged Use in areas of wet use, washdown areas, or areas outside heated buildings:
  - 1. Stainless steel Type 316, unless otherwise shown.
  - 2. Diameter, Length and Bend Dimensions: As required by equipment or machinery manufacturer. Unless otherwise required, provide 3/4-inch minimum diameter by 12-inches long and other geometry as shown.
  - 3. Furnish A320 nuts and washers of same material for each bolt, unless otherwise shown.
  - 4. Provide sleeves as required or as shown for location adjustment.
- B. Submerged Use:
  - 1. Submerged use is defined as any connection 1 foot 6 inches below the normal water surface elevation in a water holding basin.
  - 2. As specified for nonsubmerged use, for equipment, machinery or other connections except as follows:
    - a. Coating of anchor bolt threads is not required.
    - b. Where threads are covered with fusion bonded coating, provide nut of proper size to fit and provide connection of equal strength to embedded bolt.
- C. For anchoring fabricated metalwork, structural steel, or other components where connections will be protected or dry:
  - 1. Galvanized Steel, 36 ksi, minimum.
  - 2. Minimum Size: 3/4-inch diameter by 12-inch long, unless otherwise shown.
  - 3. At base plates with grout pads, furnish two nuts and two washers per bolt of same material as bolt, unless otherwise shown.

### 2.2 ANCHOR BOLT SLEEVE

- A. High Density Polyethylene Plastic:
  - 1. Single unit construction with deformed sidewalls such that the concrete and grout lock in place.
  - 2. The top of the sleeve shall be self-threading to provide adjustment of the threaded anchor bolt projection.
  - 3. Material requirements shall conform to the following:
    - a. Plastic: High density polyethylene.
    - b. Density: 0.956, ASTM D1505.
    - c. Vicant Softening Point: 256°F, ASTM D1525

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d. Brittleness Temperature: -180°F, ASTM D746

B. Fabricated Steel Sleeve:

1. Material: A36 steel.
2. Dimensions, welding, and sizes as shown.

### 2.3 STAINLESS STEEL FASTENERS LUBRICANT (ANTISEIZING)

- A. Provide for stainless steel nuts and machined bolts, anchor bolts, concrete anchors, and all other threaded fasteners.
- B. Lubricant shall contain substantial amounts of molybdenum disulfide, graphite, mica, talc, or copper as manufactured by:
1. Loc Tite Co., Permatex.
  2. Or equal

### 2.4 ADHESIVE (EPOXY) ANCHORS AND DOWELS

- A. Provide adhesive anchors where specifically shown and where adhesive anchors are allowed. Unless otherwise shown, adhesive anchors are allowed for anchoring:
1. Supports for pipe, conduit, and electrical boxes, devices, and panels, on floors and walls
  2. Handrails, guardrails, sunshades, stairs,
  3. Fixtures and equipment on floors and walls, and
  4. Single pipes and conduits <2 inch in diameter to ceilings and soffits.
- B. Adhesive shall be epoxy resin. Vinylester resin anchors are NOT allowed.
- C. Product and Manufacturer: Provide one of the following:
1. Installation to Concrete:
    - a. HIT-HY 200 as manufactured by Hilti, Inc.
    - b. SET-XP as manufactured by Simpson Strong-Tie, Inc.
    - c. Or approved equal meeting ACI 355.4.
  2. Installation to solid-grouted Masonry:
    - a. HIT-HY 70 as manufactured by Hilti, Inc.
    - b. SET as manufactured by Simpson Strong-Tie, Inc.
    - c. Or approved equal.

### 2.5 EXPANSION ANCHORS

- A. Provide expansion anchors only where specifically shown and where expansion anchors are allowed. Unless otherwise shown, and except as noted below, expansion anchors are allowed for anchoring:
1. Supports for pipe, conduit, and electrical boxes, devices, and panels, to floors and walls.
  2. Handrails, guardrails, and sunshades.
  3. Fixtures and equipment which have no moving parts, to floors and walls.
- B. Expansion anchors are NOT allowed in any submerged or chemical containment areas.
- C. Leveling nuts shall not be used with expansion anchors. If leveling nuts are required, provide adhesive anchors, unless otherwise shown.

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- D. Wedge anchors: Provide one of the following:
  - 1. Installation to Concrete:
    - a. Hilti Kwik Bolt TZ by Hilti, Inc.
    - b. Strong-Bolt 2 by Simpson Strong-Tie, Inc.
    - c. Or approved equal meeting ACI 355.2.
  - 2. Installation to solid-grouted Masonry:
    - a. Hilti Kwik Bolt-3 by Hilti, Inc.
    - b. Wedge-All by Simpson Strong-Tie, Inc.
    - c. Or approved equal.

## 2.6 OTHERS

- A. Powder actuated fasteners and other types of anchors not specified herein shall not be used, unless approved by ENGINEER.

## 2.7 ACCESSORIES

- A. Provide Belleville washers, or approved equal, at anchorage connections used to transfer anchorage loads at sheet metal equipment housings.

# **PART 3 - EXECUTION**

## 3.1 INSTALLATION OF ANCHORS

- A. Obtain anchor bolts in sufficient time so as not to delay concrete or masonry work.
- B. Adhesives shall be stored and installed at the service temperature ranges recommended by the manufacturer.
- C. Locate and accurately set the anchor bolts using templates or other devices as necessary.
- D. Protect threads and shank from damage during installation of equipment and structural steel.
- E. Post-installed anchors are NOT acceptable substitutes for cast-in-place anchor bolts.
- F. Assure that embedded items are protected from damage and are not filled in with concrete.
- G. Unless otherwise shown, the minimum diameter of anchor bolts for structural steel is  $\frac{3}{4}$  inch, and for other applications,  $\frac{3}{8}$  inch.
- H. Unless otherwise shown, provide the following minimum embedment, where "d" is the nominal anchor diameter:
  - 1. Cast-in-place anchors: 12d.
  - 2. Adhesive anchors: 12d.
  - 3. Expansion anchors: 8d.
- I. Unless otherwise shown, provide a minimum edge distance equal to six times the bolt diameter for adhesive anchors, eight times the bolt diameter for expansion anchors and a bolt spacing equal to twelve times the bolt diameter.

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- J. Concrete shall have a minimum age of 21 days at the time of post-installed anchor installation.
  - 1. Concrete temperature at the time of adhesive anchor installation shall be at least 50°F.
- K. Existing reinforcing bars in the concrete structure may conflict with specific anchor locations. Unless noted on the Drawings that the bars can be cut, the contractor shall review the existing structural drawings and shall undertake to locate the position of the reinforcing bars at the locations of the concrete anchors by ferroskan, ground penetrating rebar (GPR), x-ray, chipping or other means.
- L. Drilling equipment used and installation of post-installed anchors shall be in accordance with the manufacturer's printed instructions.
- M. For the adhesive and expansion anchors, CONTRACTOR shall comply with the manufacturer's printed installation instructions on the drilled hole diameter and depth.
- N. CONTRACTOR shall properly clean out the hole utilizing a wire brush and compressed air in accordance with the manufacturer's printed installation instructions to remove all loose material from the hole, prior to installing adhesive or expansion anchors. Drilled and cleaned anchor holes shall be protected from contamination until the anchor is installed. A drilled anchor hole shall be re-cleaned assuming the hole was just drilled, if in the opinion of ENGINEER or Inspector that the hole has become contaminated after initial cleaning.
- O. Unless otherwise indicated by the manufacturer, adhesive shall be dispensed through a tube or cartridge extension, beginning at the maximum depth of the hole and withdrawn as adhesive is injected, followed by insertion and rotating the anchor to the specified depth. Where necessary, spaces around anchors at the surface shall be sealed at horizontal to vertically overhead locations to prevent loss of the adhesive during curing.
- P. Anchors to be installed in the adhesive shall be clean, oil-free, and free of loose rust, paint, or other coatings.
- Q. Installed anchors shall be securely fixed in-place to prevent displacement. Unless shown otherwise on the Drawings, anchors shall be installed perpendicular to the concrete surface.
- R. Reinforcing adhesive dowel bars or all-threaded adhesive bars shall not be bent after being adhesively embedded in hardened, sound concrete.
- S. In lieu of the use of stacked standard washers, if threads of an anchor bolt protrude beyond the attachment, the installers shall use a fabricated filler plate of equal or greater size of the washer. Hole on the filler plate shall be 1/16" (or 2 to 3 mm) greater than the bolt size. Coat as appropriate in accordance with the material and installation location requirements.

### 3.2 FIELD QUALITY CONTROL

- A. Anchors shall be installed by qualified personnel in accordance with the manufacturer's printed installation instructions. Installation of adhesive anchors shall be performed by personnel trained to install adhesive anchors.

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- B. Installation of adhesive anchors horizontally or upwardly inclined to support sustained tension loads shall be performed by personnel certified by the ACI/CRSI Adhesive Anchor Installer Certification program.
- C. OWNER shall employ a special inspector to perform field inspection services in accordance with Chapter 17 of the CBC for all post-installed anchors.
  - 1. The special inspector must be periodically on the jobsite during post-installed anchor installation.
  - 2. Adhesive anchors installed to resist sustained tension loads shall be continuously inspected during installation by an inspector specially approved for that purpose by the building official.
- D. CONTRACTOR shall correct improper workmanship, remove and replace, or correct as instructed by the ENGINEER, all anchors or bars found unacceptable or deficient, at no additional cost to the OWNER.
- E. The independent testing and inspection agency shall complete a report on each area. The report should summarize the observations made by the inspector and be submitted to ENGINEER.
- F. Provide access for the testing agency to places where Work is being produced so that required inspection and testing can be accomplished.

+ + END OF SECTION + +

**SECTION 05120**  
**STRUCTURAL STEEL**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Scope:
1. Provide all labor, materials, equipment, and incidentals as shown on the Drawings, specified and required to furnish and install structural steel, including connections, surface preparation and shop priming.
  2. Structural steel is that Work defined in AISC "Code of Standard Practice", Section 2, and as shown on the Drawings. The Work also includes:
    - a. Providing openings in and attachments to structural steel to accommodate the Work under this and other Sections and providing for the structural steel all items such as anchor bolts, studs and all items required for which provision is not specifically included under other Sections.
- B. Coordination:
1. Review installation procedures under other Sections and coordinate the Work that must be installed with or attached to the structural steel.

**1.2 SUBMITTALS**

- A. Shop Drawings: Submit for approval the following:
1. Complete details and schedules for fabrication and shop assembly of members and details, schedules, procedures and diagrams showing the sequence of erection.
    - a. Include details of cuts, connections, camber, holes, and other pertinent data. Indicate welds by standard AWS symbols, and show size, length, and type of each weld.
    - b. Provide setting drawings, templates, and directions for the installation of anchor bolts and other anchorages.
  2. Copies of manufacturer's specifications and installation instructions for products listed below. Include laboratory test reports and other data as required to show compliance with the Contract Documents.
    - a. Structural steel of each type, including certified copies of mill reports covering the chemical and physical properties.
    - b. High strength bolts of each type, including nuts and washers.
    - c. Unfinished bolts and nuts.
    - d. Shop primer and touch-up field primer paint in accordance with Section 09900, Painting.

**1.3 QUALITY ASSURANCE**

- A. Reference Standards and Codes: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:
1. ASTM A36, Specification for Carbon Structural Steel.
  2. ASTM A108, Specification for Steel Bar, Carbon and Alloy, Cold Finished.
  3. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi tensile strength.

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4. ASTM A325, Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
  5. ASTM A490, Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.
  6. AWS D1.1, Structural Welding Code.
  7. AREA, Manual of Railway Engineering.
  8. AISC, Manual of Steel Construction.
  9. AISC, Code of Standard Practice for Steel Buildings and Bridges.
  10. AISC, Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings and including the Commentary and Supplements thereto as issued.
  11. AISC, Specifications for Structural Joints Using High-Strength Bolts, RCSC Specification.
- B. Design of Members and Connections:
1. All details shown on the Drawings are typical; similar details apply to similar conditions, unless otherwise shown on the Drawings or specified. Verify dimensions at the site without causing delay in the Work.
  2. Examine conditions under which structural steel is to be provided, and notify ENGINEER, in writing, of unsatisfactory conditions existing or whenever design of members and connections may not be clearly shown on the Drawings. Do not proceed with the Work until unsatisfactory conditions or deficiencies have been corrected in a manner acceptable to ENGINEER.
- C. Source Quality Control:
1. Materials and fabrication procedures shall be subject to inspection and tests in the mill, shop, and field, conducted by a qualified inspection agency. Such inspections and tests will not relieve CONTRACTOR of responsibility for providing materials and fabrication procedures in compliance with specified requirements.
  2. Steel fabricator shall have at least 5 years experience in the fabrication of structural steel for projects substantially similar to those required for this project.
  3. Fabrication shall be performed by a structural steel fabricating plant possessing a current certificate from AISC stating that the plant satisfies the requirements for certification for Certified Building Fabricator of the AISC Quality Management Systems Certification Program. The plant shall maintain this certification for the entire time fabrication for this project is being performed.
- D. Qualifications for Welding Work:
1. Qualify welding processes and welding operators in accordance with AWS "Structural Welding Code" D1.1, Section 5, Qualification.
  2. Provide certification that all welders employed on or to be employed for the Work have satisfactorily passed AWS qualification tests within the previous 12 months. Ensure that all certifications are kept current.
  3. All welds will be subject to visual inspection. Where visually deficient welds are observed, the welds will be tested using non-destructive methods by a certified testing laboratory. If welds are found to be satisfactory, OWNER will pay for testing. Where welds are found unacceptable or deficient, pay for testing, correct improper workmanship, remove and replace, or correct as instructed, all welds found unacceptable or deficient. Responsibility belongs to CONTRACTOR to pay for all corrections and subsequent tests required to confirm the integrity of the weld.



## 1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to the site at such intervals to ensure uninterrupted progress of the Work.
  - 1. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete or masonry, in ample time to not delay that Work.
- B. Store materials to permit easy access for inspection and identification. Keep steel members off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
  - 1. Do not store materials on the structure in a manner that might cause distortion or damage to the members or the supporting structures. Repair or replace damaged materials or structures as directed.

## **PART 2 - PRODUCTS**

### 2.1 MATERIALS

- A. Wide flange sections: ASTM A992 Grade 50.
- B. Steel pipe columns: ASTM A53 Grade B.
- C. Hollow Structural Sections (HSS): ASTM A500 Grade B.
- D. Plates, Angles, Channels, and S Shapes: ASTM A36, except where other type steel is shown on the Drawings.
- E. High-Strength Threaded Fasteners: Heavy hexagonal structural bolts, heavy hexagon nuts, and hardened washers, as follows:
  - 1. Quenched and tempered medium carbon steel bolts, nuts and washers, complying with ASTM A325 or:
  - 2. Quenched and tempered alloy steel bolts, nuts and washers, complying with ASTM A490.
  - 3. ASTM F1852 high-strength bolts shall be used for twist-off / tension-controlled bolts.
  - 4. Provide ASTM F436 washers for all bolts in accordance with RCSC Specification for Structural Joints Using High-Strength Bolts.
  - 5. Provide beveled washers at connections of sloped/tapered sections.
  - 6. Unless noted otherwise, high-strength fasteners shall be used for all non-stainless steel fasteners. Pre-tension all high-strength fasteners unless noted otherwise. Pre-tension any connection with designation (SC) slip critical. Slip critical (SC) connections must be free of paint, oil, or other materials that reduce friction at contact surfaces. Galvanized or lightly rusted surfaces are acceptable.
- F. Cast-in-Place Anchor Rods:
  - 1. ASTM F1554, Grade 36 with weldability supplement S1 for threaded rods galvanized.
  - 2. Provide ASTM F436 washers at all nuts.
  - 3. Embedded anchors shall be headed with a standard square plate washer tack welded to the anchor head, unless a larger washer is shown otherwise in the Drawings.
  - 4. Only provide threads at the top of the anchor as required for connections.
- G. Common Bolts:
  - 1. ASTM A307, Grade A for headed bolts galvanized.

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- H. Stainless Steel Fasteners:
  - 1. ASTM F593 Type 304 or 316 stainless steel with matching nut and washer for non-liquid containing (dry) structures.
  - 2. ASTM F593 Type 316 stainless steel for liquid-containing structures.
- I. Electrodes for Welding: E70XX complying with AWS D1.1 Section 8.
- J. Galvanizing:
  - 1. Zinc coated hardware: ASTM A153.
  - 2. Fabrications: ASTM A123.
  - 3. Members designated as galvanized on the drawings or as directed by ENGINEER shall be galvanized after fabrication in accordance with ASTM A385. Weight of zinc coating shall not be less than 2.5 ounces per square foot of actual surface and have a coating thickness of 0.0042 inch. Coating weight will be subject to verification by ENGINEER. Thickness of coating will be measured by means of a magnetic thickness gauge.
  - 4. Each fabricated assembly shall be totally immersed in the galvanizing bath. The galvanizing procedure shall be such as to avoid distortion of the assembly. Straightening of members after galvanizing will not be permitted. Assemblies shall be held in the galvanizing bath until the temperature of the assembly is equal to the temperature of the bath. All deviations shall require approval by ENGINEER.
  - 5. Any galvanized surface which has the coating removed for any cause shall be touched up with a zinc-rich cold galvanizing compound so that the entire surface has a uniform coating of 2.5 ounces of zinc per square foot.
  - 6. Galvanized work shall be subject to inspection by ENGINEER at any time to ensure strict compliance with this specification. Any areas found to show defects or signs of improper galvanizing application will be rejected. Repairs shall be made by CONTRACTOR without additional cost to OWNER.
- K. Surface preparation and Finish:
  - 1. Steel: Where not indicated to be galvanized, steel shall be primed in the shop per Section 09900, Painting. Exposed, non-galvanized, steel shall be coated per Section 09900, Painting.

## 2.2 FABRICATIONS

- A. Shop Fabrication and Assembly:
  - 1. General:
    - a. Fabricate and assemble structural assemblies in the shop to the greatest extent possible. Fabricate items of structural steel in accordance with AISC, Manual of Steel Construction, and as shown on the Shop Drawings. Provide camber in structural members as shown on the Drawings.
    - b. Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence, which will expedite erection and minimize field handling of materials.
    - c. Where finishing is required, complete the assembly, including welding of units, before start of finishing operations. Provide finish surfaces of members exposed in the final structure free of markings, burrs, and other defects.
  - 2. Field Connections:
    - a. All field connections, unless otherwise specified below or noted, shall be made with high strength bolts, and shall be bearing type connections.
    - b. Field welding may be used only where noted or approved by ENGINEER.
  - 3. High-Strength Bolted Construction:
    - a. Install high-strength threaded fasteners in accordance with AISC "Specification for Structural Joints Using High-Strength Bolts" (RCSC).

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4. Welded Construction: Comply with AWS Code for procedures, appearance and quality of welds, and methods used in correcting welding work.
    - a. Assemble and weld built-up sections by methods which will produce true alignment of axes without warp.
  5. Shear Connectors: Install stud shear connectors in accordance with AWS D1.1 Section 4, and as recommended by the manufacturer.
- B. Bracing:
1. Bracing shall have a minimum two bolt connection, or a shop welded connection of equivalent strength.
  2. Vertical bracing and knee braces connecting to columns shall be on the centerline of the columns, unless otherwise noted.
  3. Knee braces shall be at 45 degree angle, unless shown on the Drawings or noted.
  4. All gussets shall be minimum 3/8-inch thick, unless otherwise shown on the Drawings.
- C. Columns: Column shafts shall have "finished" bearing surfaces at the base and at all splice lines.
- D. Hollow Structural Sections (HSS): HSS shall be properly sealed to protect the internal surfaces.
- E. Holes and Appurtenances for Other Work:
1. Provide holes required for securing other work to structural steel framing, and for the passage of other work through steel framing members, as shown on the Shop Drawings. If large block-outs are required and approved by the ENGINEER, the webs shall be reinforced to develop specified shears. Provide threaded nuts welded to framing, and other specialty items as shown on the Drawings to receive other work.
  2. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame cut holes or enlarge holes by burning. Drill holes in bearing plates.
  3. Refer to Paragraph 1.1.B, above, for the requirements of coordination with others.
- F. Grind smooth all rough welds and sharp edges shall be ground to approximately 1/8 inch radius.

### 2.3 WELDING

- A. Comply with AWS Code, and other requirements indicated herein, for all welding, techniques of welding employed, appearance and quality of welds, and methods used to correct defective work.
1. Qualify joint welding procedures or test in accordance with AWS qualification procedures.
- B. Test and qualify welders, welding operators and tackers in compliance with AWS Code for position and type of welding to which they will be assigned.
1. Conduct tests in presence of approved testing agency.
  2. Certification within previous 12 months will be acceptable, provided samples of the welder's work are satisfactory.
- C. Before Starting Welding:
1. Carefully plumb and align members in compliance with specified requirements.
  2. Fully tighten bolts.
  3. Comply with Section 5 of AWS Code for assembly and surface preparation.

4. Preheat base metal to temperature stated in AWS Code.
    - a. When no preheat temperature is given in AWS Code and base metal is below 50°F, preheat base metal to at least 70°F.
    - b. Maintain temperature during welding.
    - c. Preheat surface of all base metal within distance from point of welding equal to thickness of thicker part being welded or 3 inches, whichever is greater, to specified preheat temperature.
    - d. Maintain this temperature during welding.
  5. Each welder shall use identifying mark at welds.
- D. Make flange welds before making web welds.
- E. Where groove welds have back-up plates, make first three passes with 1/8 inch round electrodes.
  1. Use backup plates in accordance with AWS Code, extending minimum of 1 inch either side of joint.
- F. Flame cut edges of stiffener plates at shop or field butt weld. Do not shear.
- G. Grind flush web fillets at webs notched to receive backup plates for flange groove welds.
- H. Low Hydrogen Electrodes: Dry and store electrodes in compliance with AWS Code.
- I. Do not perform welding when ambient temperature is lower than 0°F or where surfaces are wet or exposed to rain, snow, or high wind, or when welders are exposed to inclement conditions.

### **PART 3 - EXECUTION**

#### **3.1 INSPECTION**

- A. Examine areas and conditions under which structural steel Work is to be installed, and notify ENGINEER, in writing, of conditions detrimental to proper and timely completion of Work. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

#### **3.2 ERECTION**

- A. General: Comply with the AISC Specifications and Code of Standard Practice, and as herein specified.
- B. Temporary Shoring and Bracing: Provide temporary shoring and bracing members with connections of sufficient strength to bear imposed loads. Remove temporary members and connections when permanent members are in place and final connections are made. Provide temporary guy lines to achieve proper alignment of the structures as erection proceeds.
- C. Anchor Bolts: Furnish anchor bolts and other connectors required for securing structural steel to foundations and other in-place Work.
  1. Furnish templates and other devices as necessary for presetting bolts and other anchors to accurate locations.

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- a. Refer to Section 05051, Anchors, Inserts and Epoxy Dowels, of these Specifications for anchor bolt installation requirements.
- D. Setting Bases and Bearing Plates: Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean the bottom surface of base and bearing plates.
1. Set loose and attached base plates and bearing plates for structural members on steel wedges or other adjusting devices.
  2. Tighten the anchor bolts after the supported members have been positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with the edge of the base or bearing plate prior to packing with grout.
  3. Place non-shrink grout between bearing surfaces and bases or plates as specified in Section 03600, Grout. Finish exposed surfaces, protect installed materials, and allow curing in strict compliance with the manufacturer's instructions, or as otherwise required.
  4. Leveling plates and wood wedges will not be permitted.
- E. Field Assembly: Set structural frames accurately to the lines and elevations as shown on the Drawings. Align and adjust the various members forming a part of a complete frame or structure before permanently fastening. Clean bearing surfaces and other surfaces, which will be in permanent contact before assembly. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
1. Level and plumb individual members of the structure within tolerances as specified in AISC Manual. For members requiring accurate alignment, clip angles, lintels and other members shall be provided with slotted holes for horizontal adjustment at least 3/8-inch in each direction, or more when required.
  2. Splice members only where shown on the Drawings or specified.
- F. Erection Bolts: On exposed welded construction, remove erection bolts, fill holes with plug welds and grind smooth at exposed surfaces.
- G. Comply with AISC Manual for bearing, adequacy of temporary connections, alignment, and the removal of paint on surfaces adjacent to field welds.
1. Do not enlarge unfair holes in members by burning or by the use of drift pins, except in secondary bracing members. Ream holes that must be enlarged to admit bolts.
- H. Gas Cutting: Do not use gas cutting torches for correcting fabrication errors in the structural framing. Cutting will be permitted only on secondary members, which are not under stress, as acceptable to ENGINEER. Finish gas-cut sections equal to a sheared appearance when permitted.
- I. Touchup Painting:
1. Unless otherwise specified below, comply with all requirements of touch-up painting specified in Section 09900, Painting.
  2. Immediately after erection, clean field welds, bolted connections, and all damaged and abraded areas of the shop paint. Apply paint to all exposed areas with the same material as used for shop painting. Apply by brush or spray to provide a minimum dry film thickness as specified in Section 09900, Painting.

### 3.3 FIELD QUALITY CONTROL

- A. The OWNER will employ a testing laboratory approved by the ENGINEER to perform field quality control testing to inspect and to perform tests and prepare test reports in accordance with CBC section 1705.2 and AISC 360.
  - 1. The testing agency shall conduct and interpret the tests and state in each report whether the test specimens comply with the requirements, and specifically state all deviations.
  - 2. Provide access for the testing agency to places where structural steel Work is being fabricated or produced so that required inspection and testing can be accomplished.
  - 3. The testing agency may inspect structural steel at the plant before shipment; however, ENGINEER reserves the right, at any time before Final Acceptance, to reject material not complying with specified requirements.
- B. Correct deficiencies in structural steel Work that inspection and/or laboratory test reports indicate do not comply with the Specifications. Perform additional tests, as may be required to reconfirm any non-compliance of the original Work, and as may be required to show compliance of corrected Work.

+ + END OF SECTION + +

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## SECTION 05200

### STEEL JOISTS

#### **PART 1 - GENERAL**

##### **1.1 SUBMITTALS**

- A. Shop Drawings:
  - 1. Copies of manufacturer's specifications and installation instructions for each type of joist and its accessories. Include manufacturer's certification that joists comply with AISC-SJI "Specifications."
  - 2. Detailed drawings showing layout of joist units, headers, special connections, jointing and accessories. Include the mark, number, type, location and spacing of joists and bridging. Provide location drawings for installation of anchor bolts.
  - 3. Detailed drawings showing supports, field splices, bridging attachments and nonstandard joist profiles.
  - 4. Shop Drawings shall list all applicable loads.
- B. Structural Calculations:
  - 1. The steel joist manufacturer shall submit design calculations with a cover letter bearing the seal and signature of the joist manufacturer's registered design professional licensed in California.

##### **1.2 QUALITY ASSURANCE**

- A. Fabricator Qualifications: Fabricated by a firm regularly engaged in the manufacture of the types of steel joist specified. Manufacturer to have fabricated joists for at least 2 years.
- B. Qualification of Welding Work:
  - 1. Qualify welding processes and welding operators in accordance with the AWS D1.1, Section 5 Qualification.
  - 2. All welds will be subject to visual inspection. Where visually deficient welds are observed, the welds will be tested using non-destructive methods by a certified testing laboratory. If welds are found to be satisfactory, OWNER will pay for testing. Where welds are found unacceptable or deficient, the CONTRACTOR will pay for testing. The CONTRACTOR will correct improper workmanship, remove and replace, or correct as instructed, all welds found unacceptable or deficient. The CONTRACTOR will pay for all corrections and subsequent tests required to confirm the integrity of the weld.

##### **1.3 PRODUCT DELIVERY, STORAGE AND HANDLING**

- A. Deliver, store and handle steel joists as recommended in AISC-SJI "Specifications." Handle and store joists in a manner to avoid deforming members and to avoid excessive stresses.

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## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Steel: Comply with AISC-SJI "Specifications".
- B. Unfinished Threaded Fasteners: ASTM A307, Grade A, regular hexagon type, low carbon steel.
- C. High-Strength Threaded Fasteners: ASTM A325 or A490 heavy hexagon structural bolts with nuts and hardened washers.
- D. Surface Preparation and Shop Priming: All steel joists shall be primed in the shop. Surface preparation and shop priming are included herein, but are specified in Section 09900 - Painting.

### **2.2 FABRICATION**

- A. General: Fabricate steel joists in accordance with AISC-SJI "Specification."
- B. Bottom Chord: Joists with bottom chords consisting of round bars will not be acceptable.
- C. Holes in Chord Members:
  - 1. Provide holes in chord members where shown for securing other Work to the steel joists.
- D. Extended Ends:
  - 1. Provide extended ends on joists where shown, complying with the manufacturer's standards and requirements of applicable AISC-SJI "Specifications" and load tables.
- E. Bridging:
  - 1. Provide horizontal or diagonal type bridging for open web joists, complying with AISC-SJI "Specifications".
- F. End Anchorage: Provide end anchorages to secure joists to adjacent construction, complying with AISC-SJI "Specifications", unless otherwise shown.

## **PART 3 - EXECUTION**

### **3.1 INSPECTION**

- A. The CONTRACTOR and their installer shall examine the substrate and the conditions under which Work is to be performed and notify ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

### **3.2 ERECTION**

- A. Place and secure steel joists in accordance with AISC-SJI "Specifications," approved Shop Drawings, and as specified.
- B. Anchors: Furnish anchor bolts and other devices to be built into the concrete and masonry construction. Furnish templates for the accurate location of anchors in other

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Work. Furnish unfinished threaded fasteners for anchor bolts, unless otherwise indicated.

C. Placing Joists:

1. Do not start placement of steel joists until supporting Work is in place and secured. Place joists on supporting Work, adjust and align in accurate locations and spacing before permanently fastening.
2. Provide temporary bridging, connections, and anchors to ensure lateral stability during construction.

D. Bridging: Install bridging simultaneously with joist erection.

E. Fastening Joists:

1. Field weld joists to supporting steel framework in accordance with AISC-SJI "Specifications" for the type of joists used. Coordinate welding sequence and procedure with the placing of joists.
2. Bolt joists to supporting steel framework in accordance with AISC-SJI "Specifications" for the type of joists used.
  - a. Provide unfinished threaded fasteners for bolted connections, unless otherwise indicated.
  - b. Provide unfinished threaded fasteners for bolted connections, except where high-strength bolts or welded connections are shown.
  - c. Provide high-strength threaded fasteners for bolted connections of steel joists to steel columns, and at other locations where shown, installed in accordance with AISC, Specifications for Structural Joints Using ASTM A 325 or A 490 Bolts.

F. Touch-Up Painting: After joist installation, paint all field bolt heads and nuts, and welded areas, abraded or rusty surfaces on joists and steel supporting members. Wire brush surfaces and clean with solvent before painting. Use the same type of paint as used for shop painting.

+ + END OF SECTION + +

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**SECTION 05300**  
**METAL ROOF DECKING**

**PART 1 - GENERAL**

**1.1 SUBMITTALS**

- A. Shop Drawings:
  - 1. Complete erection drawings showing layout and dimensions, including type and gauge of decking sections, adaptations around openings and other special conditions, method of welding or anchoring sections to supporting structural steel, procedure for attaching end closure plates and butt joint cover plates, support of openings and miscellaneous flashing.
  - 2. Manufacturer's product literature and relevant approvals for decking, welding, mechanical fasteners, and sidelap connectors.

**1.2 QUALITY ASSURANCE**

- A. Field Measurements: Take field measurements prior to preparation of Shop Drawings and fabrication to ensure proper fitting of the Work.
- B. Fabrication and erection shall be in accordance with the current edition of the Steel Deck Institute "Code of Standard Practice". Steel decking shall be delivered, stored, handled and installed in such a manner that it will not be damaged or deformed.
- C. Qualification of Welding Work:
  - 1. Qualify welding processes and welding operators in accordance with AWS D1.1, Section 5 - Qualification.
  - 2. Decking welded in place is subject to inspection and testing. Expense of removing and replacing any portion of decking for testing purposes will be borne by the Owner if welds are found to be satisfactory; otherwise the CONTRACTOR shall pay all costs involved. Remove Work found to be defective and provide new acceptable Work.

**1.3 PRODUCT DELIVERY, STORAGE AND HANDLING**

- A. Transport, store and erect metal decking and accessories in a manner that will prevent corrosion, deformation or other damage. Store decking clear of the ground with one end elevated to promote drainage. Protect metal deck from water and the elements with a water resistant material.

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

- A. Deck sections and attachments shall be as shown on the Drawings. Decking having cross-sectional properties, which differ from the indicated, may be used provided that the structural properties of the proposed decking are equal to or greater than, the structural properties of the decking indicated.

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- B. Decking, where indicated, shall have sheet lengths that cover three or more spans wherever practicable.
- C. Galvanized Steel Sheet Decking: ASTM A653. The steel shall receive a protective metal coating of zinc conforming to ASTM A653, with a minimum of 0.6-ounce zinc per square foot, G-90. The decking shall be 18-gauge, unless otherwise shown on the Drawings.
  - 1. Product and Manufacturer: Provide one of the following:
    - a. Vulcraft.
    - b. Verco Manufacturing.
    - c. ASC Steel Deck.
    - d. Or approved equal.
- D. Accessories shall be formed of the same material as used for the steel deck.
- E. Miscellaneous Steel Shapes: ASTM A36.
- F. Mechanical Fasteners (power actuated):
  - 1. Product and Manufacturer: Provide one of the following:
    - a. Hilti, Inc.
    - b. Or approved equal.
- G. Sidelap Connectors:
  - 1. Product and Manufacturer: Provide one of the following:
    - a. Hilti, Inc.
    - b. Elco Textron.
    - c. Or approved equal.
- H. Galvanizing Repair Paint: Any galvanized surface which has the coating removed for any cause shall be touched up with a zinc-rich cold galvanizing compound so that the entire repair surface has a uniform coating of 1.0 ounces of zinc per square foot.

## **2.2 FABRICATION**

- A. Manufacture deck units to lengths as indicated on the shop drawings. Panel end conditions are to be end-lapped 2-inches minimum. Sidelaps are to be nestable or interlocking when using screw-type fasteners.

## **PART 3 - EXECUTION**

### **3.1 INSPECTION**

- A. The CONTRACTOR shall examine conditions under which decking is to be installed and notify Engineer, in writing, of any unsatisfactory condition existing or whenever design of decking and connection may not be clearly indicated. Do not proceed with the Work until unsatisfactory conditions or deficiencies have been corrected in a manner acceptable to Engineer.

### **3.2 WORKMANSHIP**

- A. Decking shall be installed in accordance with the manufacturer's requirements and approved erection layout drawing.

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- B. Steel decking shall be provided complete, including all cutting, shaping, fitting, drilling, welding, ridge plates, valley plates, reinforcing plates for all openings in the deck and miscellaneous pieces necessary for proper installation and weathertight construction.
- C. The steel deck units shall be placed on the supporting framework, aligned, and adjusted to final position before being permanently fastened.
- D. If the supporting beams are not properly aligned or sufficiently level to permit proper bearing of steel units, The CONTRACTOR shall take corrective action to ensure properly aligned Work.
- E. Special care shall be exercised not to damage or overload the decking during installation. The maximum uniform distributed load shall not exceed 20 psf. The decking shall not be used for storage or as a working platform until the sheets have been welded into position.
- F. The decking sheet shall be formed at the longitudinal sides in such a manner that they will overlap and interlock. All interlocking seams shall be welded as specified on the Drawings, with 1 ½-inch long side seam welds.
- G. End laps shall be a minimum of 2-inches and shall occur over bearings only.
- H. The steel decking shall provide a continuous uniform slope, with practically flush top surfaces, and shall be installed in straight and continuous rows, as far as practicable, with ribs at right angles to the supporting members.
- I. All sheets shall be 36-inch wide. Narrower closure strips shall be welded to adjacent full sheet with 1 ½-inch long seam welds at 12-inch on center.
- J. Flashing: Provide zinc coated continuous flashing for deck units at openings and at deck perimeters, if necessary.
- K. Connection Plates: Provide 14-gauge galvanized bent plate sections as shown or required over perimeter and interior framing to allow specified welding to parallel supports.
- L. After erection, all damaged surfaces shall be primed with a zinc dust type primer paint.
- M. After erection, all surfaces shall be cleaned and left free of all grime and dirt.

### 3.3 ATTACHMENT

- A. Steel deck units shall be fastened to steel framework as shown on the Drawings. Welds shall be free of sharp points or edges. All welds shall be cleaned immediately, by chipping or wire brushing, and shall be coated with a zinc dust type primer paint.
- B. Welding shall conform to the applicable requirements of the AISC "Light Gauge Steel Design" and all welding shall be done by qualified welders. Welder qualifications shall be in accordance with AWS Specification B3.0, "Standard Qualification Procedures."
- C. Decking sheets fastened to framing with proprietary mechanical connections or screws shall be installed in accordance with the manufacturer's recommendations and ICC report.

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+ + END OF SECTION + +

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**SECTION 05500**  
**MISCELLANEOUS METALS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Work necessary to furnish and install, complete, fabricated metalwork and castings as shown or as required to secure various parts together and provide a complete installation.

**1.2 SUBMITTALS**

- A. Shop Drawings: Submit Shop Drawings for the fabrication and erection of the miscellaneous metal Work. Include plans, elevations and details of sections and connections. Clearly show all field connections. Show anchorage and accessory items.
- B. Product Data: Submit copies of manufacturer's specifications, load tables, dimensions, diagrams, anchor details, and installation instructions for manufactured products.
- C. Samples: Submit representative samples of manufactured products.

**1.3 QUALITY ASSURANCE**

- A. Field Measurements: Take field measurements prior to preparation of Shop Drawings and fabrication to ensure proper fitting of the Work.
- B. Shop Assembly: Preassemble items in the shop to the greatest extent possible, so as to minimize field splicing and assembly of units at the project site. Disassemble units to the extent necessary for shipping limitations. Clearly mark units for reassembly and coordinated installation.
- C. Qualifications: Qualify welding operators in accordance with requirements of current AWS Standard Performance Qualification Procedures in the applicable structural welding code.
  - 1. Qualification Tests: Performed by a recognized testing laboratory.
- D. Certification: Certify welders of structural and reinforcing steel for all positions of welding in accordance with such procedure.

**PART 2 - PRODUCTS**

**2.1 GENERAL**

- A. Like Items of Materials: Provide end products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, replacement, and manufacturer's service.
- B. Lifting Lugs: Provide on equipment and equipment components weighing over 100 pounds.
- C. Furnish miscellaneous items:

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1. Miscellaneous metalwork and castings as shown, or as required to secure various parts together and provide a complete installation.
2. Items specified herein are not intended to be all-inclusive. Provide metalwork and castings shown, specified, or which can reasonably be inferred as necessary to complete the project.

## 2.2 MATERIALS

- A. Carbon steel structural shapes:
  1. Wide flange sections: ASTM A992 Grade 50.
  2. Steel pipe columns: ASTM A53 Grade B.
  3. Hollow Structural Sections (HSS): ASTM A500 Grade B.
  4. Plates, Angles, Channels, and S Shapes: ASTM A36.
- B. Stainless Steel:
  1. Plates and Sheets: ASTM A240, Type 304L or 316
  2. Structural shapes: ASTM A276 or A479, Type 304L or 316.
  3. Fasteners and fittings: ASTM A320, Type 316
    - a. Where stainless steel bolts are in contact with dissimilar metals provide insulating sleeves and phenolic washers to electrically isolate the bolts and nuts.
- C. Aluminum, Structural Shapes and Plates: Alloy 6061-T6, meeting Aluminum Assoc. Specification for Aluminum Structures
- D. Cast Iron: A48, Class 30
- E. Light Gauge Steel Framing:
  1. Manufactured by SSMA ICC ESR-3064P, or equivalent, to meet the requirements of AISI S100.
  2. ASTM A570 or A446 with a minimum yield strength of 33 ksi for 18 gauge and 20 gauge, 50 ksi for 14 gauge and 16 gauge.
  3. Framing members shall have the section properties as listed on the Drawings.
- F. High-Strength Threaded Fasteners: Heavy hexagonal structural bolts, heavy hexagon nuts, and hardened washers, as follows:
  1. Quenched and tempered medium carbon steel bolts, nuts and washers, complying with ASTM A325 or:
  2. Quenched and tempered alloy steel bolts, nuts and washers, complying with ASTM A490.
  3. Provide two ASTM F436 washers for all bolts.
  4. Provide beveled washers at connections of sloped/tapered sections.
  5. Unless noted otherwise, high-strength fasteners shall be used for all non-stainless steel fasteners.
- G. Cast-in-Place Anchor Rods:
  1. ASTM F1554, Grade 36 with weldability supplement S1, galvanized, unless shown otherwise.
  2. Provide ASTM F436 washers at all nuts unless shown otherwise.
  3. Provide anchor bolt sleeves as required or as shown for location adjustment.
  4. Provide stainless steel anchors where shown on the Drawings or listed in another specific specification section.
- H. Galvanizing:
  1. Zinc coated hardware: ASTM A153.

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2. Fabrications: ASTM A123.

I. Surface preparation and Finish:

1. Steel: Where not indicated to be galvanized, steel shall be primed in the shop. Comply with Section 09900, Painting.

2.3 ANCHOR BOLT SLEEVE

A. High Density Polyethylene Plastic:

1. Single unit construction with deformed sidewalls such that the concrete and grout lock in place.
2. The top of the sleeve shall be self-threading to provide adjustment of the threaded anchor bolt projection.
3. Material requirements shall conform to the following:
  - a. Plastic: High density polyethylene.
  - b. Density: 0.956, ASTM D1505.
  - c. Vicat Softening Point: 256°F, ASTM D1525
  - d. Brittleness Temperature: -180°F, ASTM D746

B. Fabricated Steel Sleeve:

1. Material: A36 steel.
2. Dimensions, welding, and sizes as shown.

2.4 FABRICATIONS

A. Miscellaneous Framings and Supports:

1. Fabricate units to the sizes, shapes, and profiles shown, or if not shown, of the required dimensions to receive the adjacent gratings, plates, tanks, doors, or other work to be retained by the framing.
2. Except as otherwise shown, fabricate from structural shapes, plates, and bars of compatible material, 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 other items to be anchored to the work.
3. Equip units with integrally welded anchors for casting into concrete or integrating into masonry. Furnish inserts for casting in, if units must be installed after concrete or grout is placed. Anchor spacing shall be 24" on-center, unless otherwise shown.
4. Galvanize where shown.

B. Miscellaneous Fabricated Metals:

1. The following additional items are listed as a guide. Some items on list may not be required, and list may not be all-inclusive. Submittal data for materials and products must be approved before they are incorporated in the work.
  - a. Float Switch Supports
  - b. Lifting Eyes.
  - c. Pipe Supports.
  - d. Steel Bases and Anchors.

C. Stainless Steel Fabrication: Following welding fabrication all stainless steel assemblies shall be cleaned, descaled and passivated in accordance with ASTM A380.

D. Anchors, Fasteners, and Fittings: Provide zinc-coated carbon steel for steel fabrications, and stainless steel for aluminum and stainless steel fabrications, unless shown otherwise.

E. Pipe Sleeves

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1. Provide as follows:
  - a. Hot-dip galvanized, Schedule 40 steel pipe sleeves where shown for piping passing through concrete or masonry.
  - b. Holes drilled with rotary drill may be provided in lieu of sleeves in existing walls.
  - c. Provide a center flange for water stoppage on sleeves in exterior or water-bearing walls.
  - d. Provide a rubber caulking sealant or a modular mechanical unit to form a watertight seal in the annular space between pipes and sleeves.

### **PART 3 - EXECUTION**

#### **3.1 FABRICATION**

- A. General:
  1. Exposed Surfaces Finish: Smooth, sharp, well-defined lines.
  2. Provide necessary rabbets, lugs, and brackets so work can be assembled in neat, substantial manner.
  3. Conceal fastenings where practical.
  4. Drill metalwork and countersink holes as required for attaching hardware or other materials.
  5. Fabricate materials as specified.
  6. Weld connections, except where bolting is directed.
  7. Methods of fabrication not otherwise specified or shown shall be adequate for stress and as approved.
  8. Grind exposed edges of welds smooth on walkways, guardrails, handrails, stairways, channel door frames, steel column bases and where shown.
  9. Round sharp edges to 1/8-inch minimum radius. Grind burrs, jagged edges, and surface defects smooth.
- B. Aluminum:
  1. Fabricate as shown, and in accordance with the Aluminum Association Standards and manufacturer's recommendations as approved.
  2. Grind smooth sheared edges exposed in finished work.

#### **3.2 WELDING**

- A. General
  1. Meet codes for Arc and Gas Welding in Building Construction of the AWS and AISC for techniques of welding employed, appearance, quality of welds made, and the methods of correcting defective work.
  2. Welding Surfaces: Free from loose scale, rust, grease, paint, and other foreign material, except mill scale which will withstand vigorous wire brushing may remain.
  3. A light film of linseed oil may likewise be disregarded.
  4. Do not weld when temperature of base metal is lower than zero degrees F.
  5. Finished members shall be true to line and free from twists.
  6. Prepare welds and adjacent areas such that there is:
    - a. No undercutting or reverse ridges on the weld bead.
    - b. No weld spatter on or adjacent to the weld or any other area to be painted.
    - c. No sharp peaks or ridges along the weld bead.
  7. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.
- B. Welding Operators: As specified in PART 1, Article 1.3 QUALITY ASSURANCE.

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### 3.3 INSTALLATION

- A. Set units accurately in location, alignment, and elevation, level, plumb, true, and square, measured from established lines and levels. Brace or anchor temporarily in formwork where units are to be built into concrete, masonry, or similar construction.
- B. Anchor securely as shown or as required for the intended use, using concealed anchors wherever possible.
- C. Fit exposed edges accurately together to form tight, hairline joints. Do not weld, cut, or abrade the surfaces of galvanized or anodized units which are intended for bolted or screwed connections.
- D. Field Welding: Where field welding is necessary, grind joints smooth and touch-up the shop paint. Comply with the applicable provisions of AWS D1.1 for the procedures of manual shielded metal-arc welding, the appearance and quality of welds made, and the methods used in correcting welding.
- E. Field Coat all miscellaneous ferrous and steel metals per Specification Section 09900 - Painting, System 300.
- F. Where aluminum is in contact with dissimilar metals, or embedded in masonry or concrete, protect surfaces as specified in Section 09900 - Painting, System 305.

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## SECTION 05610

### ALUMINUM HANDRAILS AND RAILINGS

#### **PART 1 - GENERAL**

##### **1.1 SCOPE**

- A. This section covers the supply and installation of welded or non-welded mechanical construction aluminum handrails and guardrails.

##### **1.2 SUBMITTALS**

- A. Shop Drawings: Submit Shop Drawings for the fabrication and erection of the handrails and guardrails. Include plans, elevations and details of sections and connections. Clearly show all field connections. Show anchorage and accessory items.
- B. Product Data: Submit copies of manufacturer's specifications, dimensions, anchor details, and installation instructions for manufactured products.

##### **1.3 QUALITY ASSURANCE**

- A. Reference Standards:
  - 1. Aluminum Associate (AA)
    - a. Aluminum Standards and Data
    - b. Specifications for Aluminum Structures
- B. Design Criteria:
  - 1. Fabricate units to support a live load of 20 pounds per linear foot and a non-concurrent load of 200 pounds at the top of the railing, in any direction.
  - 2. Expansion/Contraction:
    - a. Provide linear expansion joints at a maximum spacing of 20'-0" designed for 1/4" expansion and 1/4" contraction.
    - b. Provide expansion joints in handrail and railing systems where systems cross expansion joints in structure.
- C. Allowable Tolerances:
  - 1. Limit variation of cast-in-place inserts, sleeves and field-drilled anchor and fastener holes to the following:
    - a. Spacing:  $\pm 3/8$ -inch.
    - b. Alignment:  $\pm 1/4$ -inch.
    - c. Plumbness:  $\pm 1/8$ -inch.
  - 2. Minimum Handrails and Railings Systems Plumb Criteria:
    - a. Limit variation of completed handrail and railing system alignment to 1/4-inch in 12' - 0" with posts set plumb to within 1/16-inch in 3 foot - 0 inches.
    - b. Align rails so variations from level for horizontal members and from parallel with rake of stairs and ramps for sloping members do not exceed 1/4-inch in 12' - 0 inches.
- D. Obtain all handrails and railings systems components and accessories from the same manufacturer.

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#### 1.4 DELIVERY, STORAGE AND HANDLING

- A. Protect aluminum work from abuse, staining, or damage during shipment, storage, erection and installation.
- B. Store in a manner to prevent warping of materials.

### **PART 2 - PRODUCTS**

#### 2.1 GENERAL

- A. Fabricate aluminum to conform to AA standards.
- B. Handrails and railings may be either of welded construction, or non-welded mechanical construction.

#### 2.2 MANUFACTURERS AND PRODUCTS

- A. Golden Railings, Inc.; TCF Bolted System.
- B. Superior Aluminum Products; Series 800 Pipe Railing.
- C. Or Equal.

#### 2.3 MATERIALS

- A. Rails and Posts:
  - 1. Conform to ASTM B221.
  - 2. 1-1/2" nominal diameter, minimum
  - 3. Provide Schedule 40 pipe minimum for rails and Schedule 80 pipe minimum for posts, unless conditions of detail and fabrication require heavier pipe weights to comply with performance criteria specified.
  - 4. All rail, posts and components shall be Aluminum Alloy 6005-T5 or 6063-T6
  - 5. Clear satin anodized finish, 0.7 mil minimum (AA-M10-C22-A41).
- B. Fittings and Accessories:
  - 1. Either weld rail and post components, or provide mechanical fittings to join rail and post components using bolted connections.
  - 2. Provide floor flanges where indicated
  - 3. Provide wall brackets with 3-inch minimum clearance between handrail and finished wall surface and as indicated for ladder rails.
  - 4. Fasteners and anchors shall be Type 304 stainless steel and of type as required by substrate
- C. Toeboard (Kick Plate):
  - 1. Extruded, beveled aluminum 4-inch height, aluminum alloy 6063-T6.
  - 2. Furnish required stainless steel clamps and fasteners for complete installation.
  - 3. Manufacturer/Product:
    - a. Crane Veyor Corp., Toeboard No. C43880 with splice plates and corner connectors.
    - b. Or Equal.

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- D. Weep Holes:
1. Fabricate joints, which will be exposed to the weather so as to exclude water.
  2. Provide 15/64-inch diameter weep holes at the lowest possible point on all handrail and railing systems posts.
  3. Provide pressure relief holes at closed ends of handrail and railing systems.

### **PART 3 - EXECUTION**

#### **3.1 GENERAL**

- A. Conform to applicable AA standards.
- B. At locations where welds will be made (if applicable), the anodizing shall be ground off to ensure a proper weld is made. The weld shall then be ground smooth and burn marks removed. Completed welds shall be painted to match the anodizing of the pipe.
- C. Bituminous Coating:
1. Protect aluminum in contact with other metals, grout and concrete by a heavy brush coat of alkali-resistant bituminous coating or a non-porous tape or gasket.
  2. Coating is not required for aluminum in contact with stainless steel bolts.
  3. Apply bituminous coating at 15-mil minimum dry film thickness.
  4. Manufacturer/Product:
    - a. Carboline – Bitumastic No. 50
    - b. Tnemec – Series 46-465
    - c. Or Equal.

#### **3.2 INSTALLATION**

- A. Space posts at a maximum of 6'-0" on center, except when a different spacing is indicated on the Drawings.
- B. Install toe boards (kick plates) and anchor to each post with clamps and bolts. Allow 1/4-inch space between bottom of toe board and top of floor surface.
- C. Install handrail to walls with brackets spaced not greater than 5'-0" on center, except where otherwise indicated.
1. For connecting to concrete walls, use anchors as indicated.
  2. For connecting to hollow masonry walls, use toggle bolts having square heads.
- D. Cleaning: Clean all aluminum surfaces, after installation, free of smudges, stains, or other deleterious substances.
- E. Protect aluminum, after cleaning, with clear methacrylate lacquer coating.

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## **SECTION 05620**

### **GRATING AND CHECKERED PLATE**

#### **PART 1 - GENERAL**

##### **1.1 SCOPE**

- A. Furnish all materials, labor and equipment required to provide all gratings and floor plates in accordance with the Contract Documents.

##### **1.2 SUBMITTALS**

- A. Shop Drawings: Submit Shop Drawings for the fabrication and erection of all gratings and checkered plate specified herein. Include plans, elevations and details of sections and connections.
- B. Setting drawings and templates for location and installation of anchorage devices.

#### **PART 2 - PRODUCTS**

##### **2.1 GENERAL**

- A. Grating, including support frames, fastenings and all necessary appurtenances for a complete installation shall be furnished as indicated on the Drawings.
- B. All exposed bearing ends of grating shall be enclosed in a perimeter band of the same dimensions and material as the main bars, including ends at all cutouts.
- C. Grating shall be fabricated into easily removable sections and shall be fastened at each corner and as required with fasteners provided by the grating manufacturer. No fasteners shall be permitted to project above the walking surface.
- D. Grating and Checkered Plate shall be designed for a loading of 150 psf, with a maximum deflection of  $L/360$ , unless otherwise required by the Drawings.
- E. Minimum grating depth shall be as shown on the drawings. Space bearing bars at 1-3/16 inch center to center. Band all edges with minimum 3/16 inch thick banding bar.
- F. Openings in Grating:
  - 1. Cut gratings for penetrations as indicated and as required for installing and operating equipment. Layout grating units to allow grating removal without disturbing items penetrating grating.
  - 2. At openings, notches, and cuts in grating, provide banding of same material and size as bearing bars, unless otherwise indicated. Weld band to each bearing bar.
- G. Notching of bearing bars at supports to maintain elevations will not be permitted.

##### **2.2 ALUMINUM GRATING**

- A. I-bar type consisting of extruded bearing bars positioned and locked by cross bars.

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- B. Material:
  - 1. All supports, cross members, etc. shall be aluminum.
  - 2. Bearing Bars: Alloy 6061-T6 or Alloy 6063-T6, conforming to ASTM B221
  - 3. Cross Bars or Bent Connecting Bars: Alloy conforming to either ASTM B221 or ASTM B210.
- C. Plank clips for grating hold-downs or other required attachments shall be aluminum or Type 304 stainless steel.
- D. Bolts shall be stainless steel Type 316. Where stainless steel bolts are in contact with dissimilar metals provide insulating sleeves and phenolic washers to electrically isolate the bolts and nuts.
- E. Manufacturer/Product:
  - 1. Grating Pacific, "I-Bar 19-SG-4"
  - 2. Borden Grating, "Squeeze Locked Grating"
  - 3. Ohio Grating, "I-Bar 19-SG-4"
  - 4. Or Equal.

### 2.3 HEAVY DUTY GALVANIZED STEEL GRATING

- A. Welded rectangular design (spaced approximately 1-3/16 x 4 inches on center) designed to support heavy rolling and static loads.
- B. Grating Size and Design:
  - 1. Main bearing bars thickness and depth as indicated on the Drawings.
  - 2. Cross bars to be 5/16" twisted steel and resistance welded at right angles to the main bars, unless noted otherwise on the Drawings.
  - 3. Band all open ends.
  - 4. Hot dip galvanize after fabrication.
- C. Material:
  - 1. Galvanized steel: ASTM A36, hot dipped galvanized per ASTM A123 after fabrication
- D. Manufacturer/Product:
  - 1. Grating Pacific W-19-4
  - 2. Ohio Grating 19-W-4
  - 3. Or Equal.

### 2.4 CHECKERED PLATE

- A. Minimum thickness: As shown on the drawings
- B. Material:
  - 1. Plate to conform to ASTM B209 with anodized finish.
  - 2. Stainless steel support angles: Type 316 unless otherwise shown.
- C. Raised Pattern Floor Plate: Provide pattern standard with the manufacturer to provide non-slip surface.
- D. Plates shall be stiffened by angles welded to the underside as shown on the drawings.
- E. Lifting Handles:

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1. Each checkered plate shall be provided with four lifting handles, as shown on the drawings.
- F. Maximum weight of each checkered plate shall be 150 pounds.

### **PART 3 - EXECUTION**

#### **3.1 FABRICATION**

- A. All measurements and dimensions shall be based on field conditions and shall be verified by the CONTRACTOR prior to fabrication. Such verification shall include coordination with adjacent work.
- B. All fabricated work shall be shop-fitted together as much as practicable, and delivered to the field, complete and ready for installation. All miscellaneous items such as stiffeners, fillets, connections, brackets and other details necessary for a complete installation shall be provided.
- C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.
- D. Finished members shall conform to the lines, angles and curves shown on the Drawings and shall be free from distortions of any kind.
- E. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.
- F. All shop connections shall be welded unless otherwise indicated on the Drawings or specified herein. All fastenings shall be concealed where practicable.

#### **3.2 INSTALLATION**

- A. Assembly and installation of fabricated system components shall be performed in strict accordance with manufacturer's recommendations.
- B. All gratings shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set a proper elevations and positions.

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**SECTION 07200**  
**ROOF INSULATION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies requirements for building insulation for roofs and associated accessories to result in complete assemblies.

**1.2 SUBMITTALS**

- A. Shop Drawings:
  - 1. Manufacturer's specifications and installation instructions for type of insulation required. Include data substantiating that the materials comply with specified requirements.
  - 2. Complete layout of all roof insulation showing sizes, placement and number of courses.
  - 3. Manufacturer's specifications and installation instructions showing the sizes and layout of the mechanical fasteners.

**1.3 DELIVERY, HANDLING, AND STORAGE**

- A. Package and protect during shipment.
- B. Inspect for damage, dampness, and wet storage stains upon delivery to the Work site.
- C. Remove and replace damaged or permanently stained materials that cannot be restored to like-new condition.
- D. Carefully handle to avoid damage to surfaces, edges, and ends.
- E. Do not open packages until ready for use.
- F. Store materials in dry, weathertight, ventilated areas until immediately prior to installation.

**1.4 COORDINATION WITH OTHER ROOFING SYSTEM COMPONENTS**

- A. Roof insulation shall be part of a coordinated, complete roof system which includes the roofing system and all other roofing system components.
- B. Roof insulation manufacturer shall certify that the roof insulation provided is completely compatible with the roofing system specified and all other roofing system components.

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## **PART 2 - PRODUCTS**

### **2.1 EXTRUDED POLYSTYRENE RIGID ROOF INSULATION**

- A. Composed of extruded polystyrene (XPS) and water-resistant binders formed into rigid, non-combustible boards specifically designed for roofing applications with installation directly on structural steel decks beneath a sheet membrane or a standing seam metal roof.
- B. Size: 48-inches by 96-inches.
- C. Thickness:
  - 1. Base Layer: Thickness as shown in the Drawings.
  - 2. Tapered Top Layer: Varies to provide drainage.
- D. Provide the following physical properties:
  - 1. Thermal Resistance, R-Value, ASTM C518: 5.0 hr\* $\text{ft}^2$ \*°F/BTU/in.
  - 2. Water Vapor Permeance, ASTM E96: 1.5 maximum perm.
  - 3. Compressive Strength, ASTM D1621: 25 psi.
- E. Provide tapered and non-tapered boards as required to produce a minimum slope to drain of 1/4-inch per foot.
- F. Provide custom pre-cut factory-formed corners, crickets, hips and valleys.
- G. Product and Manufacturer: Provide one of the following:
  - 1. STYROFOAM Brand DECKMATE Plus, by Dow Building Solutions.
  - 2. THERMAPINK 25 by Owens-Corning Fiberglass Corporation.
  - 3. Or equal.

### **2.2 ROOF INSULATION COVER BOARD**

- A. Fiberglass-mat faced roof cover boards.
- B. Provide the following physical properties:
  - 1. Size: 48-inches by 96-inches, 1/2-inch thick
  - 2. Weight: 1.95 psf
  - 3. Water Adsorption, ASTM C1177: < 10%
  - 4. Compressive Strength, ASTM C472: 900 psi
- C. Product and Manufacturer: Provide one of the following:
  - 1. DensDeck Prime by Georgia-Pacific
  - 2. SecurRock by USG
  - 3. Or approved equal

### **2.3 MISCELLANEOUS MATERIALS:**

- A. Mechanical Fasteners: Screw-type 6-gauge minimum self-drilling galvanized steel with sufficient length and quantity to securely anchor system into place and to withstand all super-imposed loads. Provide 1 1/2" diameter disc washers.
- B. Joint Tape: 6-inch wide glass fiber tape.

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## **PART 3 - EXECUTION**

### **3.1 SEQUENCING**

- A. Proceed with and complete the Work only when materials, equipment and tradesmen required for the installation of the roofing membrane over the roof insulation are at the site and are ready to follow with this Work immediately (same day) behind the roof insulation Work.
- B. Do not install any more roof insulation each day than can be covered with complete elastic sheet roofing system by the end of that working day.

### **3.2 INSPECTION**

- A. CONTRACTOR and his installer shall examine the substrate and the conditions under which the insulation Work is to be performed, and notify ENGINEER, in writing, of any unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

### **3.3 INSTALLATION**

- A. General:
  - 1. Tapered glass fiber board roof insulation system shall be designed and totally precut at the factory.
  - 2. Comply with manufacturer's instructions for the particular conditions of installation in each case. If printed instructions are not available or do not apply to the project conditions, consult the manufacturer's technical representative for specific recommendations before proceeding with the Work.
  - 3. Where skylight or other roof openings are required, provide crickets shaped from tapered glass fiber board to direct roof drainage around opening and too roof drain.
  - 4. Extend roof insulations full thickness, as shown and specified, over entire surface to be insulated.
  - 5. Cut and fit roof insulation Work tightly around obstructions, and fill voids with insulation. Keep back 1/4-inch for all vertical flashings.
- B. Laying Roof Insulation Units:
  - 1. Apply rigid glass fiber board roof insulation to the thickness shown in the Drawings. Provide tapered rigid board roof insulation at crickets and sloped areas shown to provide 1/4-inch per foot positive slope to drains.
  - 2. Mechanically fasten insulation boards to substrate at the UL required spacing.
  - 3. Stagger end joints and stagger joints between courses where two or more courses are used.
  - 4. Lay insulation boards with edge in moderate contact without forcing.

### **3.4 PERFORMANCE**

- A. Roof insulation Work shall withstand the uplift forces of wind, as defined by the Roofing System Guarantee. Refer to the roofing system specification. Failures of the roof insulation Work, or within the insulation, shall be considered failures of materials or workmanship under the Roofing System Guarantee.

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**SECTION 07211  
BUILDING INSULATION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Scope:
1. CONTRACTOR shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install all building insulation.
  2. Extent of each type of building insulation is shown.
  3. Types of products required include the following:
    - a. Glass fiber batt insulation.
    - b. Miscellaneous materials and accessories.
- B. Coordination:
1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the building insulations.
  2. Notify other contractors in advance of the installation of the building insulations to provide other contractors with sufficient time for the installation of items included in their contracts that must be installed before the building insulations.

**1.2 QUALITY ASSURANCE**

- A. Manufacturer/Installer Qualifications:
1. Engage single installers for each type of building insulation who are skilled, trained and have a record of successful experience in the application of each product and who have a successful record of performing work in accordance with the recommendations and requirements of the manufacturer or who can submit evidence in writing of being acceptable to the manufacturer for production of guaranteed construction and who agree to employ only tradesmen with specific skill and successful experience in each type of Work.
- B. Source Quality Control:
1. Obtain building insulations, requiring a hydrochlorofluorocarbon blowing agent, from manufacturers who manufacture specified insulation using a blowing agent acceptable for use until the year 2020 complying with the requirements of the Copenhagen Amendments to the Montreal Protocol in all ways.
- C. Performance Criteria:
1. Thermal Conductivity: The thicknesses shown are for the thermal conductivity, k-value at 75 F, specified for each material.
  2. Provide adjusted thicknesses, based on thicknesses shown or specified for building insulations, as required to comply with required thermal resistances for use of material having a different thermal conductivity.

- D. Requirements of Regulatory Agencies: Comply with fire-resistance and flammability ratings as shown and specified; and comply with code interpretations by governing authorities.
- E. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:
1. ASTM C 165, Measuring Compressive Properties of Thermal Insulations, Test Method for.
  2. ASTM C 177, Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus, Standard Test Methods for.
  3. ASTM C 203, Breaking Load and Flexural Properties of Block-Type Thermal Insulation, Test Method for.
  4. ASTM C 236, Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box, Standard Test Method for.
  5. ASTM C 272, Water Absorption of Core Materials for Structural Sandwich Constructions, Standard Test Method for.
  6. ASTM C 303, Dimensions and Density of Preformed Block-Type Thermal Insulation, Standard Test Method for.
  7. ASTM C 518, Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of Heat Flow Meter Apparatus, Standard Test Method for.
  8. ASTM C 520, Density of Granular Loose Fill Insulations, Standard Test Method for.
  9. ASTM C 531, Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Monolithic Surfacing, and Polymer Concrete, Standard Test Method for.
  10. ASTM C 549, Perlite Loose Fill Insulation, Standard Specification for.
  11. ASTM C 553, Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications, Specification for.
  12. ASTM C 578, Rigid, Cellular Polystyrene Thermal Insulation, Standard Specification for.
  13. ASTM C 612, Mineral Fiber Block and Board Thermal Insulation, Specification for.
  14. ASTM C 665, Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing, Standard Specification for.
  15. ASTM C 764, Mineral Fiber Loose-Fill Thermal Insulation, Specification for.
  16. ASTM D 696, Coefficient of Linear Thermal Expansion of Plastics between -30 Degrees C and 30 Degrees C, Standard Test Method for.
  17. ASTM D 1621, Compressive Properties of Rigid Cellular Plastics, Standard Test Method for.
  18. ASTM D 1622, Apparent Density of Rigid Cellular Plastics, Standard Test Method for.
  19. ASTM D 2126, Response of Rigid Cellular Plastics to Thermal and Humid Aging, Standard Test Method for.
  20. ASTM D 2842, Water Absorption of Rigid Cellular Plastics, Standard Test Method for.
  21. ASTM E 84, Surface Burning Characteristics of Building Materials, Standard Test Method for.
  22. ASTM E 96, Water Vapor Transmission of Materials in Sheet Form, Standard Test Method for.

23. ASTM E 119, Standard Methods of Fire Tests of Building Construction and Materials.
24. Underwriters Laboratories, Incorporated, UL 1479, Fire Tests of Through-Penetration Firestops.

F. Codes: Comply with the applicable requirements of the 2016 California Building Code for types of building insulation work specified.

### 1.3 PRODUCT DELIVERY STORAGE AND HANDLING

A. Delivery of Materials:

1. Deliver building insulation products in manufacturer's original, unopened, factory-sealed containers, bearing manufacturer's name and labels, accurately representing container contents as shown on approved Shop Drawings.
2. Damaged materials shall be permanently removed from Site by CONTRACTOR.
3. Do not deliver insulation materials to the Site before the time of installation.
4. Deliver materials in sufficient quantities to allow uninterrupted continuity of the Work.

B. Storage of Materials:

1. Store materials in original, undamaged containers with manufacturer's labels and seals intact.
2. Store all materials in a dry, enclosed area, off the ground and away from all possible contact with water, ice or snow.
3. Prevent damage to materials during storage, primarily by minimizing the amount of time they are stored on-Site before being incorporated into construction systems. Store only sufficient quantity of building **insulation** materials on-Site as necessary for the continuous advancement of the Work without causing delay.

C. Handling of Materials:

1. Handle materials carefully in order to avoid damage and breakage or compressing of boards to less than their specified thickness, or other damage.
2. Do not open containers, or expose materials to detrimental conditions or physical damage. Materials which are so exposed shall be removed from the Site and shall not be incorporated into the Work. If incorporated into the Work they shall be removed at no additional expense to OWNER.
3. Handle materials in a manner which prevents inclusion of foreign materials.
4. Do not open packages or containers until all necessary preparatory Work is complete and installation will begin immediately.

### 1.4 JOB CONDITIONS

A. Protection:

1. Do not allow building insulation materials to become wet or soiled, or covered with ice or snow. Provide continuous protection of materials against damage, wetting and moisture absorption primarily by storing materials under cover and above ground and away from all other construction traffic.
2. Protect foam plastic building insulation from exposure to sunlight.
3. Do not allow building insulations to come into contact with welding operations or other fire or ignition sources.

4. Do not overload the building structure or damage in-place construction system with the weight of stored materials or use of equipment.
  5. Protect materials against damage by construction activities.
- B. Scheduling:
1. Proceed with building insulation Work only when preceding Work is ready to receive the Work of this Section.
  2. Proceed with the building insulation and associated Work only after curbs, blocking, substrate board, nailer strips, vents, drains and other projections through the substrates have been installed, and when the substrate construction and framing of openings is complete.
  3. Proceed with and complete the Work only when materials, equipment and tradesmen required for the installation of the building insulation and backfilling operations are at the Site and are ready to follow with the Work in a manner which will not leave the Work vulnerable to damage or deterioration.
  4. Do not advance the installation of building insulation materials beyond that which is necessary for proper sequencing of the Work. Do not advance Work when there is no proper and secure protection from damaging weather and construction activities.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Glass Fiber Insulations: Provide the following types:
1. General: Provide insulations formed from glass fibers and resinous binders fabricated into flexible blankets, semi-rigid and rigid sheets complying with ASTM C665, ASTM C553, and ASTM C612.
  2. Unfaced Batt Insulation: Provide unfaced thermal batt insulation complying with ASTM C665, Type I.
    - a. Physical Properties.
      - 1) R-value, ASTM C518: Reference Drawings. If not specified on the Drawings, provide the maximum R-value corresponding to the framing member thickness.
      - 2) Density, provide standard density unless high-density is required to achieve the specified R-value.
    - b. Thickness: Match the framing thickness shown on the Drawings.
    - c. Width: 16-inches, or as required based on framing member spacing.
    - d. Product and Manufacturer: Provide one of the following:
      - 1) Thermal Batt Insulation by Owens-Corning Fiberglas Corporation.
      - 2) Thermal Batt Insulation by CertainTeed.
      - 3) Thermal Batt Insulation by Johns Manville.
      - 4) Or equal.
- B. Miscellaneous Materials and Accessories: Provide the following:
1. Mechanical Anchors: Type and size shown or, if not shown, as recommended by the insulation manufacturer for the type of application shown and condition of substrate.
  2. Adhesive Tapes: Complete selection of insulation manufacturer's recommended taping materials.

## **PART 3 - EXECUTION**

### **3.1 INSPECTION**

- A. CONTRACTOR and his installer shall examine the substrate and the conditions under which the building insulation Work is to be performed, and notify ENGINEER in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

### **3.2 SUBSTRATE PREPARATION**

- A. Verify that surfaces to receive building insulation are clean of all debris, dirt and other contamination before installation begins in any area.

### **3.3 INSTALLATION**

- A. General:
  - 1. Comply with manufacturer's instructions for the particular conditions of installation in each case. If printed instructions are not available or do not apply to Site conditions, submit to ENGINEER specific recommendations from manufacturer for approval before proceeding with the Work.
  - 2. Extend all insulations full thickness over entire surface to be insulated. Cut and fit tightly around obstructions, and fill voids with insulation.
  - 3. Apply the number of layers of insulation specified, each of the required thickness, or the required thickness to provide the thermal value indicated, unless otherwise shown or required, to make up the total thickness.
- B. Batt-Type Insulation:
  - 1. Install batt insulation above ceilings and between studs and rafters as shown. Extend insulation full width, length and height in all areas shown.
  - 2. Fit tightly around obstructions to form a uniform insulated barrier.

### **3.4 PROTECTION**

- A. All components of the Work shall be protected from detrimental weather conditions and until construction operations including, but not limited to, backfilling, framing and sheathing, aluminum siding and concrete unit masonry Work, is completed and acceptable to ENGINEER.
- B. Work which cannot for reasons acceptable to ENGINEER be covered with complete construction system before onset of weather detrimental to the Work, shall be completely covered and protected in such a manner as to deflect precipitation from the installation without damaging adjacent Work.
- C. Protect building insulations from all damage and abuse from all other contractors and installers involved on the Site until final acceptance by OWNER.

### **3.5 FIELD QUALITY CONTROL**

- A. Submit results of all testing to ENGINEER along with recommendations for remedial Work. Do not delay job progress. Coordinate the submission of tests

and remedial Work in a manner which does not impact the acceptability of substrate and which permits expeditious completion of finishing Work.

### 3.6 ADJUSTMENT AND CLEANING

- A. System components which are dislodged, damaged, expanded, broken, penetrated, or crushed by subsequent installation operations or damaged by detrimental weather shall be immediately replaced with undamaged material in compliance with the Specifications and properly protected as specified.
- B. Only the original installer shall repair or replace deteriorated or defective Work.

### 3.7 INSPECTION AND ACCEPTANCE

- A. Do not allow construction traffic which is not associated with the installation of building insulation in the area of Work. Protect the area from access by other installers and contractors until the Work of this Section has been incorporated into finished construction systems.
- B. Building insulations which have become wet, damaged, or deteriorated shall be promptly removed from the Site and replaced with materials meeting the requirements of this Specification.

+ + END OF SECTION + +

## SECTION 07320

### STANDING SEAM METAL ROOF

#### **PART 1 - GENERAL**

##### **1.1 DESCRIPTION**

- A. Scope: This Section applies to design, manufacture and installation of standing seam metal roof paneling, soffit panels and associated materials.

##### **1.2 QUALITY ASSURANCE**

A. References

1. American Society for Testing and Materials (ASTM)
  - a. ASTM A653: Steel Sheet, Zinc-Coated by the Hot Dip Process
  - b. ASTM A792: Steel Sheet, Aluminum-Zinc Alloy Coated by the Hot Dip Process
  - c. ASTM B209: Aluminum and Aluminum Alloy Sheet and Plate
2. Underwriters Laboratory
  - a. UL Building Materials Directory
3. Sheet Metal and Air Condition Contractors National Association, Inc. (SMACNA)
  - a. SMACNA Architectural Sheet Metal Manual, 1993 Edition
4. American Iron and Steel Institute (AISI)
  - a. AISI Cold Formed Steel Design Manual
5. Aluminum Association
  - a. Aluminum Design Manual
6. Metal Construction Association (MCA)
  - a. Preformed Metal Wall Guidelines
7. Code References:
  - a. ASCE 7, Minimum Loads for Buildings and Other Structures
  - b. IBC, International Building Code

B. Experience:

1. Manufacturer shall have a minimum of ten (10) years experience in manufacturing standing seam metal roofing.
2. Panel installer shall have a minimum of two (2) years experience in the installation of standing seam metal roofing and shall show evidence of successful completion of at least three (3) projects of similar size, scope, and complexity.

##### **1.3 SUBMITTALS**

- A. Shop Drawings: Submit Shop Drawings showing roof plan with layout of panels, clips, clip attachment, underlayment and sections of each flashing/trim condition for approval prior to fabrication. Drawings shall contain material type, metal thickness and finish. Drawings shall distinguish between factory and field fabrication.
- B. Product Data: Submit manufacturer's specifications, standard profile sheet, product data brochure and finish warranty.

- C. Samples:
  - 1. Submit sample 12" long x full panel width showing proposed metal gauge, seam profile and specified finish.
  - 2. Submit manufacturer's standard colors for OWNER's selection. If design or bid documents specify a color, submit color specified.
- D. Test Reports: Submit the test reports prepared by Underwriters Laboratory indicating wind uplift rating of the proposed roof system. The manufacturer must be listed by name in the UL Directory.
- E. Certification: Submit manufacturer's certification that materials and finishes meet specification requirements.

#### 1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Panels and flashings shall be protected and properly packaged to protect against transportation damage in transit to the jobsite.
- B. Upon delivery, exercise care in unloading, stacking, moving, storing and erecting panels and flashings to prevent twisting, bending, scratching or denting.
- C. Store panels and flashings in a safe, dry environment under a waterproof covering to prevent water damage. Allow adequate ventilation to prevent condensation. Panels and flashings with strippable film shall not be stored in direct sunlight.
- D. Upon installation immediately remove strippable film from panels and flashings. Protect panels and flashings from foot traffic and from all other trades.

#### 1.5 WARRANTY

- A. Standing seam metal roof manufacturer shall provide a twenty (20) year warranty on the paint finish covering chalking, cracking, checking, chipping, blistering, peeling, flaking, and fading.
- B. Applicator shall furnish written warranty for a two (2) year period from date of substantial completion of building covering repairs required to maintain roof and flashings in watertight condition.

### **PART 2 - PRODUCTS**

#### 2.1 SERVICE CONDITIONS AND PERFORMANCE

- A. System shall be designed to withstand service conditions described in 01610 – General Equipment Requirements and be in compliance with all applicable codes and regulations.



## 2.2 STANDING SEAM METAL ROOFING

### A. Roof Panels:

1. Performance Requirements: Provide factory formed, prefinished, concealed clip structural standing seam metal roof system that has been pretested and certified by manufacturer to comply with specified requirements under installed conditions.
2. Roof system shall meet the wind uplift test requirements in accordance with UL 580 Class 90 when the panels are attached to a substructure meeting the assembly requirements of UL 580.
3. Structural Requirements: Engineer panels for structural properties in accordance with the latest edition of American Iron and Steel Institute's *Cold Formed Steel Design Manual* using "effective width" concept and Aluminum Association's *Aluminum Design Manual*.
4. Panels shall be constructed from 24 gauge, Grade 50 (50 ksi yield strength) structural steel with AZ50 (0.50 oz./ft.<sup>2</sup>) aluminum-zinc alloy coating, both conforming to ASTM A792.
5. Each panel shall be formed with a 1-1/2" to 2-1/2" seam height.
6. Panel width will be between 12- and 18-inches from seam to seam. Between seams, each panel shall have two or more equally spaced ridges, or stiffeners running parallel with seams.
7. Each panel shall be designed to be screwed to the roof substrate, then have the adjacent panel mechanically seamed with a field-operated, electric- seaming machine provided by the manufacturer in such a way that all screws are concealed.
8. Roof panels shall use a standard UL 90 one-piece roof clip allowing for thermal movement of the panel system.
9. Panels shall be designed for use on roofs with pitch as shallow as 2-inch per foot
10. The panel system shall be a true standing seam shape requiring no trapezoidal foam closures, plugs, or fillers at eaves.
11. Texture: panels shall be smooth or have striations to eliminate oil canning potential.

### B. Underlayment:

1. Ice and Water Shield Waterproofing Membrane: 40 mil self-adhered roofing underlayment meeting ASTM E96.

### C. Flashing, Roof Jacks, and Trim

1. All flashing, roof jacks, and trim shall be of the same material, gauge, finish, and color as the roof panels and fabricated in accordance with standard SMACNA procedure and details.
2. Provide transition rib covers where roofing changes pitch or Z-closure made from the same material.
3. Provide rake and eave trim at the roof perimeter.
4. Provide roof jacks at all roof penetrations.
5. Fabricate gutters and downspouts in the same gauge, material, finish and color as the roof panels.
6. Flashings shall be designed and installed to allow thermal expansion of the roofing system.

D. Closures:

1. Ridge and hip closures shall be protected and supported by a formed metal closure manufactured from the same material, color and finish as the panels.
2. Metal closures shall be factory fabricated and field-cut as needed.

E. Finish:

1. Metal Preparation: all metal shall have the surfaces carefully prepared for painting on a continuous process coil coating line by alkali cleaning, hot water rinsing, application of chemical conversion coating, cold water rinsing, sealing with an acid rinse, and thorough drying.
2. Prime Coating: a base coat of epoxy paint, specifically formulated to interact with the top-coat, shall be applied to the prepared surfaces by roll coating to a dry film thickness of  $0.20 \pm 0.05$  mils. This prime coat shall be oven cured prior to application of finish coat.
3. Exterior Coating: a Kynar® 500/Hylar® 5000 finish coating shall be applied over the primer by roll coating to a dry film thickness of  $0.80 \pm 0.05$  mils for a total dry film thickness of  $1.00 \pm 0.10$ . This finish coating shall be oven-cured.
4. Interior Finish Coating: a washcoat shall be applied on the reverse side over the primer by roll coating to a dry film thickness of  $0.30 \pm 0.05$  mils for a total dry film thickness of  $0.50 \pm 0.10$  mils. The washcoat shall be oven-cured.
5. Color: Color shall be as noted on Drawings, or as selected by OWNER.

F. Fasteners:

1. Clips to Substrate: screws shall be #10 diameter, self-tapping type, zinc-plated steel, with Phillips style pancake head.
2. Flashings to Panels: exposed screws shall be zinc plated with a #14 x 1" combination steel and neoprene washer, color to match panel.

G. Sealants:

1. Shall not contain oil, asbestos or asphalt.
2. Field applied panel end sealant shall be mastic tape sealant.
3. Exposed sealant shall be one-part polyurethane joint sealant, color to coordinate with roof panels.

H. Product and Manufacturer:

1. ATAS International: Field-Lok
2. Fabral: Stand'N Seam
3. MBCI: SuperLok
4. Or approved equal.

## 2.3 METAL SOFFIT PANELS

- A. General: Provide factory-formed metal soffit panels designed to be field-assembled by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fastening in side laps; included accessories for a complete, weathertight installation.

- B. Flush Profile: Perforated panels formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced at 4-inch nominal on center between panel edges with flush joint between panels.
  - 1. Material: 22-gauge minimum metal thickness.
  - 2. Finish: Fluoropolymer.
  - 3. Color: As selected from manufacturer's standard color range.
  - 4. Sidelap Sealant: Factory apply sealant, except where no sealant is required. Field-applied sealant is not acceptable.
  - 5. Trims and Flashings: Material, metal thickness, and finish to match panels. Provide profile closures at the ends of panels as required.
  - 6. Fasteners: Concealed fasteners per manufacturer's recommendation.
  - 7. Panel Coverage: 12 inches.  
Panel Height: 1 inch.
- C. Manufacturer and Product:
  - 1. AEP Span: Prestige Series
  - 2. McElroy Metal: Marquee-Lok
  - 3. MBCI: Artisan Series
  - 4. Or approved equal.

## **2.4 FABRICATION**

- A. Field dimensions shall be taken prior to fabrication to verify jobsite conditions.
- B. Roof panels shall be formed in continuous lengths. End-laps will not be allowed.
- C. Panels shall be roll formed on a stationary industrial type rolling mill. Portable roll formers, rented or owned by the installer, are not acceptable.
- D. Fabricate flashings from the same material as the roof system.
- E. Follow tolerances in MCA's Preformed Metal Wall Guidelines.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Examine roof deck for conditions that would prevent proper application of roofing. Immediately notify Contractor and Engineer of defects, and do not proceed with roofing operation until defects are corrected.
- B. Verify that surfaces to receive roofing are smooth, sound, clean and dry.

- C. Layout Pattern:
  - 1. Lay out to place seams equidistant from corners and aligned with seams on other side of hip or ridge.
  - 2. Coordinate Work of this section with flashing, trim, and other construction to provide a permanently leakproof, secure, and noncorroding installation.

### 3.2 INSTALLATION

- A. Conform to manufacturers written instructions, the standard set forth in the SMACNA architectural sheet metal manuals and the approved shop drawings detailed for the project.
- B. Roof Underlayment:
  - 1. Provide a double layer of underlayment.
  - 2. Provide 18" wide starter strip of underlayment at the eaves, followed by a 36" wide strip of underlayment which completely overlaps the 18" wide starter strip.
  - 3. Continue with consecutive 36" wide strips of underlayment, overlapping 19" at each course, shingle-style.
  - 4. Total of a double layer of underlayment plus 2" overlap at the horizontal seams is required.
  - 5. Overlap vertical seams 6" and minimize their occurrence.
  - 6. Provide ice and water shield membrane at all valley and eave conditions as well as any area at less than a 3:12 slope.
- C. Standing Seam Roof Panel Installation:
  - 1. Install panels straight with the seams parallel, conforming to the design as indicated.
  - 2. Install panel system so it is watertight, without waves, warps, buckles or distortions, and allow for thermal movement considerations.
  - 3. Abrasive devices shall not be used to cut on or near the roof panel system.
  - 4. Apply sealant tape or caulking as necessary at flashing and panel joints to prevent water penetration.
  - 5. Remove any strippable film immediately upon exposure to direct sunlight.
- D. Metal Soffit Panel Installation:
  - 1. Install panels straight over the full width of soffit.
  - 2. Install perpendicular to support framing.
  - 3. Flash and seal panels with weather closures where metal soffit panels meet walls and at perimeter of openings and joints.
  - 4. Align soffit panel joints with roof or wall panel joints where occurs.
  - 5. Install trims, closures, flashings, and sealants in accordance with the manufacturer's recommended details.

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### 3.3 CLEANING

- A. Dispose of any excess materials and debris from jobsite.
- B. Remove filings, grease, stains, marks, or excess sealants from roof panel system to prevent staining.
- C. Protect work from damage from other trades until final acceptance.
- D. Replace metal roof or soffit panels that have been damaged or have deteriorated beyond successful repair.

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## **SECTION 07600**

### **METAL FLASHING, GUTTERS, DOWNSPOUTS AND OTHER ROOFING SPECIALTIES**

#### **PART 1 - GENERAL**

##### **1.1 SUBMITTALS**

- A. Shop Drawings: Provide documentation showing the gutter, gutter guard, and downspout profiles, dimensions and material properties. Show joints, types and location of fasteners, and special shapes.

##### **1.2 DELIVERY, HANDLING, AND STORAGE**

- A. Package and protect during shipment.
- B. Inspect for damage, dampness, and wet storage stains upon delivery to the Work site.
- C. Remove and replace damaged or permanently stained materials that cannot be restored to like-new condition.
- D. Carefully handle to avoid damage to surfaces, edges, and ends.
- E. Do not open packages until ready for use.
- F. Store materials in dry, weathertight, ventilated areas until immediately prior to installation.

#### **PART 2 - PRODUCTS**

##### **2.1 METAL**

- A. Galvanized Sheet Steel: ASTM A653, G90, commercial quality copper bearing steel, thickness 24 gauge, unless otherwise shown.

##### **2.2 ANCILLARY MATERIALS**

- A. Solder: ASTM B32, alloy composition Sn 50.
- B. Soldering Flux: ASTM B32, Type RA.
- C. Sealer Tape: Polyisobutylene sealer tape as specified in Section 07900, JOINT SEALANTS.
- D. Isolation Paint: As specified in Section 09900, PAINTING AND PROTECTIVE COATINGS, System No. 27.
- E. Isolation Tape: Butyl or polyisobutylene, internally reinforced, or 20-mil thick minimum polyester.
- F. Plastic Roof Cement: ASTM D4586, Type II.

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- G. Fasteners:
  - 1. For Galvanized Steelwork: Steel, galvanized per ASTM A153 or stainless steel fasteners.
  - 2. Nails: Roofing nailhead, 10-gauge spiral or ring shank, lengths as required to penetrate wood at least 3/4-inch.
- H. Gutter Guard (Cover): Provide low profile perforated metal gutter guards compatible with the gutter style supplied. Gutter guards shall be riveted or screwed to the lip of the gutter.

### 2.3 FABRICATION OF FLASHING

- A. Field measure prior to fabrication.
- B. Fabricate in accordance with SMACNA Architectural Sheet Metal Manual.
- C. Accurately form flashings to shapes shown and detailed, with angles and lines in true alignment.
- D. Form angles true to line and surfaces free of waves and buckles.
- E. Form bends to 1/16-inch inside radius.
- F. Hem exposed edges.
- G. Reinforcements and Supports: Provide same material as flashing unless other material is shown. Steel, where shown or required, shall be galvanized or stainless.
- H. Rigid Joints and Seams: Make mechanically strong. Solder galvanized and stainless steel metal joints. Do not use solder to transmit stress.
- I. At exposed ends of counterflashing furnish weathertight closures.
- J. Neutralize soldering flux.
- K. Solvent clean sheet metal. Surfaces to be in contact with roofing or otherwise concealed shall be coated with isolation paint.

### 2.4 FABRICATION OF DOWNSPOUTS AND GUTTERS

- A. Fabricate in accordance with SMACNA Architectural Sheet Metal Manual.
- B. Form downspouts and gutters in maximum lengths as practicable to sizes and shapes indicated on Drawings or to field-fit the locations shown on the drawings.
- C. Telescope end joints 1-1/2 inches and lock longitudinal joints of downspouts.
- D. Furnish elbows at bottom where downspouts empty onto splash blocks.



## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Flashing:
1. Coordinate flashing Work with roofing Work for weathertight and watertight assembly.
  2. Isolate metal from wood and concrete and from dissimilar metal with isolation tape or two coats of isolation paint.
  3. Use only stainless steel fasteners to connect isolated dissimilar metals.
  4. Set flanges of flashings and roof accessories on continuous sealer tape or in plastic roof cement on top of deck. Nail flanges through sealer tape and at 3-inch maximum spacing. Touch up isolation paint on flanges.
  5. Joints, Fastenings, Reinforcements, and Supports: Sized and located as required to preclude distortion or displacement due to thermal expansion and contraction.
  6. Provide continuous holddown clips at counterflashing and edge drips.
  7. Conceal fastenings wherever possible.
  8. Set flashing and sheet metal to straight, true lines with exposed faces aligned in proper plane without bulges or waves.
- B. Downspouts and Gutters: Anchor downspouts to wall with straps of same material as downspouts. Install gutters, scuppers, and conductor heads as indicated on Drawings.

### **3.2 FINISH**

- A. Exposed Surfaces of Flashing and Sheet Metalwork: Free of dents, scratches, abrasions, or other visible defects, and clean and ready for painting where applicable.

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## **SECTION 07900**

### **JOINT SEALANTS**

#### **PART 1 - GENERAL**

##### **1.1 SUBMITTALS**

- A. Product Data: Surface preparation and installation instructions. Indicate where each product is proposed to be used. Provide sealant certified to NSF/ANSI Standard 61 where sealant is in direct contact with potable water.
- B. Samples: Material proposed for use showing color range available.
- C. Quality Control Submittals:
  - 1. Applicator Qualification: Documentation showing minimum of 5 years' experience installing sealants in projects of similar scope.
  - 2. Certificates of Compliance: Proposed materials meet Specification requirements.

##### **1.2 ENVIRONMENTAL REQUIREMENTS**

- A. Ambient Temperature: Between 40 and 80 degrees F (4 and 27 degrees C) when sealant is applied. Consult manufacturer when sealant cannot be applied within these temperature ranges.

#### **PART 2 - PRODUCTS**

##### **2.1 SEALANT MATERIALS**

- A. Sealant Characteristics:
  - 1. Uniform, homogeneous.
  - 2. Free from lumps, skins, and coarse particles when mixed.
  - 3. Nonstaining, nonbleeding.
  - 4. Hardness of 15 minimum and 50 maximum, measured by ASTM C661 method.
  - 5. Immersible may be substituted for nonimmersible.
- B. Sealant Color: To match adjacent surfaces or as selected by ENGINEER.
- C. One-Part Polyurethane, Immersible:
  - 1. Polyurethane base, single-component, moisture curing; ASTM C920, Type S, Grade NS or P, Class 25.
  - 2. Capable of being continuously immersed in water.
  - 3. Designed to be used where the maximum depth of sealant will not exceed 1/2 inch.
  - 4. Provide sealant certified to NSF/ANSI Standard 61 where sealant is in direct contact with potable water.
  - 5. Manufacturers and Products for Nonsag:
    - a. Sika Construction: Sikaflex-1a.
    - b. Tremco: Vulkem 116.
    - c. Or approved equal.
  - 6. Manufacturers and Products for Self-Leveling:
    - a. Sika Construction: Sikaflex-1C SL.

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- b. Tremco: Vulkem 45 SSL.
- c. Or approved equal.

## **2.2 BACKUP MATERIAL**

- A. Nongassing, extruded, closed-cell round polyethylene foam rod, compatible with sealant used, and as recommended by sealant manufacturer.
- B. Size: As shown or as recommended by sealant material manufacturer. Provide for joints greater than 1/2-inch deep. Backup material should be sized to maintain 2:1 width to depth ratio to the greatest extent possible.
- C. Manufacturers and Products:
  - 1. Dow Corning; Ethafoam SB.
  - 2. Sonneborn; Sonofoam.
  - 3. Or approved equal.

## **2.3 ANCILLARY MATERIALS**

- A. Bond Breaker: Pressure sensitive tape as recommended by sealant manufacturer to suit application. Provide bond breaker tape in the bottom of joints to prevent 3-sided joint sealant adhesion when backup material is not used.
- B. Joint Cleaner: Noncorrosive and nonstaining type, recommended by sealant manufacturer; compatible with joint forming materials.
- C. Primer: Nonstaining type recommended by sealant manufacturer to suit application

# **PART 3 - EXECUTION**

## **3.1 GENERAL**

- A. Use of more than one material for the same joint is not allowed unless approved by the sealant manufacturer.
- B. Install joint sealants in accordance with ASTM C1193.
- C. Horizontal and Sloping Joints of 1 Percent Maximum Slope: Use self-leveling (Grade P) joint sealant.
- D. Steeper Sloped Joints, Vertical Joints, and Overhead Joints: Use nonsag (Grade NS) joint sealant.

## **3.2 PREPARATION**

- A. Verify that joint dimensions, and physical and environmental conditions, are acceptable to receive sealant.
- B. Surfaces to be sealed shall be clean, dry, sound, and free of dust, loose mortar, oil, and other foreign materials.
  - 1. Mask adjacent surfaces where necessary to maintain neat edge.
  - 2. Starting of work will be construed as acceptance of subsurfaces.

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3. Apply primer to dry surfaces as recommended by sealant manufacturer.
- C. Verify that joint shaping materials and release tapes are compatible with sealant.
- D. Examine joint dimensions and size materials to achieve required width/depth ratios.
- E. Carefully follow manufacturer's instructions for mixing multi-component products.

### 3.3 INSTALLATION

- A. Use joint filler to achieve required joint depths, to allow sealants to perform intended function.
  1. Install backup material as recommended by sealant manufacturer.
  2. Where possible, provide full length sections without splices; minimize number of splices.
  3. Tape sealant may be used as joint filler if approved by sealant manufacturer.
- B. Use bond breaker where recommended by sealant manufacturer and in the bottom of joints to prevent 3-sided joint sealant adhesion.
- C. Seal joints around window, door and louver frames, expansion joints, and elsewhere as indicated.
- D. Joint Sealant Materials: Follow manufacturer's recommendation and instructions, filling joint completely from back to top, without voids.
- E. Joints: Tool slightly concave after sealant is installed.
  1. When tooling white or light color sealant, use a water wet tool.
  2. Finish joints free of air pockets, foreign embedded matter, ridges, and sags.
- F. Tape Sealant: Compress to 50 percent of expanded thickness and install in accordance with manufacturer's instructions.

### 3.4 CLEANING

- A. Clean surfaces next to the sealed joints of smears or other soiling resultant of sealing application.
- B. Replace damaged surfaces resulting from joint sealing or cleaning activities.

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## **SECTION 08100**

### **METAL DOORS**

#### **PART 1 - GENERAL**

##### **1.1 DESCRIPTION**

- A. Scope: Provide and install metal doors per this section and Door Schedule included in the Drawings.

##### **1.2 SUBMITTALS**

- A. Shop Drawings: Applicable information for each type of door and frame, including:
  - 1. Frame conditions, complete anchorage details, dimensions, glazing, fire ratings, etc.
  - 2. Reference door numbers used on Drawings and in Door Schedule on shop drawings.

##### **1.3 DELIVERY, STORAGE, AND HANDLING**

- A. Identify each door with number used on Drawings and in Door Schedule.
- B. Store doors upright, in protected dry area and provide for air circulation around each door. Store doors at least 4-inches off of the floor to prevent water damage and wear of door bottom on floor. Do not cover doors in plastic tarps or other storage provisions which promote water damage and rust. If door packaging becomes wet, remove it immediately.

#### **PART 2 - PRODUCTS**

##### **2.1 HOLLOW STEEL DOORS**

- A. General:
  - 1. Doors and Frames shall conform to SDI 100, except as modified herein.
  - 2. Doors and Frame cutouts, anchors and reinforcement shall conform to SDI 107 and ANSI A115 to receive hardware as specified elsewhere.
- B. Materials:
  - 1. Doors, frames and frame components shall be manufactured from commercial quality carbon steel conforming to ASTM designation A366, with an A60 zinc-iron alloy coating conforming to ASTM designation A653.
- C. Hollow Metal Doors:
  - 1. Flush Panel Doors: 16-gauge, Grade III, Model 1, with honeycomb or polyurethane core.
  - 2. Trim for doors with glass cutouts shall be 18-gauge galvanized steel. If the trim is installed using screws, screws shall be only visible from the non-secure side of the door. Trim shall be flush or shall protrude no more than 1/16" from the door face, and shall be the same on both sides of the door.
  - 3. All doors shall have flush end closure at top of doors to eliminate moisture penetration. Door tops shall not have holes or openings.

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4. All doors shall include a self-adjusting, concealed door sweep installed in the bottom channel. The bottom seal shall not include springs.
  5. Glass Lites
    - a. Provide door with a narrow lite (N) located along the lock edge of the door with exposed glass dimensions of approximately 4" x 25" where indicated in the Door Schedule.
    - b. Provide door with a half glass (G) where indicated in the Door Schedule.
    - c. Glazing:
      - 1) All glass shall be 1/4" thick fully tempered safety glass, manufactured by a horizontal process.
      - 2) The tempered glass shall meet, at the time of installation, quality and strength requirements of ASTM C-1036 and ASTM C-1048 and the safety criteria of CPSC 16 CFR 1201 and ANSI Z97.1-1984.
      - 3) Glass shall be appropriate for service in environmental conditions from -10 degrees Fahrenheit air temperature to 130 degrees Fahrenheit air temperature.
      - 4) Glass shall be labeled as follows: Each pane of safety glass shall be identified by a label specifying the labeler, whether the manufacturer or installer, the type and thickness of glass, and the safety glazing standard with which it complies. Label shall be acid etched, sand blasted, ceramic fired or an embossed mark or otherwise written so that it cannot be removed without destroying the glass.
  6. Door swing shall be as shown on Drawings.
- D. Metal Frames:
1. Products of hollow metal door manufacturer, constructed to coordinate with hollow metal door.
  2. Frames for Doors 14-Gauge: Welded type, of cross-section shown.
  3. Finished size, shape, and profile of frame members as shown.
  4. Concealed fasteners or welding are preferred to through-the-face fasteners.
  5. Identification: Stamp opening number, as shown on Drawings and in Door Schedule, on center hinge reinforcement of each frame.
- E. Finish:
1. Doors and frames shall be cleaned and phosphate treated.
  2. Doors and frames shall be galvanized with A60 or G60 zinc coating in accordance with ASTM A525 (Wipe Coat galvanized coating is not acceptable).
  3. Doors and frames shall be finished with a baked-on rust-inhibiting primer in accordance with ANSI A250.3. Doors shall be field finished in accordance with Section 09900.
- F. Manufacturers and Models:
1. Steelcraft L series with F series frame
  2. Curries 727 series with M type frame
  3. Or equal.
- G. Door Schedule:
1. See Drawings.

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## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Clean and prepare rough opening to accept metal frame. Identify and report any deficiencies in rough opening to Engineer prior to installing metal frame.

### **3.2 INSTALLATION**

- A. Metal Frames:
  - 1. Set all frames in accordance with SDI 105.
  - 2. Set welded frames in position prior to beginning partition work.
  - 3. Brace frames until permanent anchors are set.
  - 4. Set anchors for frames as work progresses.
  - 5. Install anchors at hinge and strike levels.
  - 6. Use temporary setting spreaders at all locations.
  - 7. Use intermediate spreaders to assure proper door clearances and header braces for grouted frames.
  - 8. Install frames in prepared openings in concrete and masonry walls using countersunk bolts and expansion shields.
- B. Hollow Metal Doors:
  - 1. Install hollow metal doors in frames using hardware specified in Section 08700 Door Hardware.
  - 2. Clearances at edge of doors
    - a. Between door and frame at head and jambs: 1/8 inch.
    - b. At meeting edges pairs of doors and at mullions: 1/8 inch.
    - c. At transom panels, without transom bars: 1/8 inch.
    - d. At sills without thresholds: 5/8 inch maximum above finish floor.
    - e. At sills with thresholds: 1/8 inch above threshold.

### **3.3 ADJUSTMENT AND CLEANING**

- A. Remove dirt and excess sealants, mortar or glazing compounds from exposed surfaces.
- B. Adjust moving parts for smooth operation. Use shims if necessary to allow for proper closing.
- C. Fill all dents, holes, etc. with metal filler and sand smooth and flush with adjacent surfaces - Reprime/paint to match finish.

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## **SECTION 08300**

### **METAL COILING OVERHEAD DOORS**

#### **PART 1 - GENERAL**

##### **1.1 DESCRIPTION**

- A. Scope: Provide and install interior face-mounted, insulated rolling service door assemblies, completely weather sealed and provided with all necessary accessories and components for a complete installation.

##### **1.2 SUBMITTALS**

- A. Shop Drawings: Construction and installation details.
- B. Quality Control: Installer's factory authorization.

##### **1.3 QUALITY ASSURANCE**

- A. Qualifications: Experienced, factory authorized installer.

#### **PART 2 - PRODUCTS**

##### **2.1 METAL COILING OVERHEAD DOOR**

- A. Features:
  - 1. Dimensions: Provide Metal Coiling Overhead doors to fit the openings with the dimensions shown on the drawings.
  - 2. Door Curtain Slats: Interlocking roll-formed flat profile type slats as follows:
    - a. The front slat shall be fabricated of 18-gauge galvanized steel.
    - b. The back slat shall be 24-gauge galvanized steel.
  - 3. Provide insulated slats.
    - a. The slat cavity shall be filled with CFC-free formed-in-place polyurethane insulation.
  - 4. Endlocks shall be attached to each end of alternate slats to prevent lateral movement.
  - 5. Windload Design: 20 PSF.
  - 6. Weatherseals: Vinyl bottom seal, exterior guide and internal hood seals.
  - 7. Bottom Bar: Two galvanized steel angles, minimum thickness 1/8" bolted back to back to reinforce curtain in the guides.
  - 8. Guides:
    - a. Provide three galvanized structural steel angles with minimum thickness of 3/16".
    - b. Guides shall be weatherstripped with a vinyl weather seal at each jamb, on the exterior curtain side and interior curtain side.
  - 9. Brackets: Galvanized steel to support counterbalance, curtain and hood.
  - 10. Counterbalance:
    - a. Helical torsion spring type.
    - b. Designed for 100,000 cycle life design.
    - c. Housed in a steel tube or pipe barrel, supporting the curtain with deflection limited to 0.03" per foot of span.

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- d. Adjustable by means of an adjusting tension wheel.
  - 11. Hood:
    - a. Galvanized steel
    - b. 24 gauge
    - c. Intermediate supports as required.
    - d. Provide with internal hood baffle weatherseal.
  - 12. Color: Powder coating finish in color as selected by ENGINEER from manufacturer's standard colors.
  - 13. Operation: Manual chain hoist (continuous chain, crank operation).
  - 14. Locking: Interior bottom bar slide boltlock and chain keeper locks.
- B. Manufacturers and Products:
- 1. Overhead Door Corp.; 625 Series Stormtite rolling door.
  - 2. The Cookson Co.; Type ESD20.
  - 3. Or equal.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Examine the substrates and conditions under which the Work is to be installed and notify ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until any unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

#### **3.2 INSTALLATION**

- A. Strictly comply with manufacturers installation instructions and recommendations. Coordinate installation with adjacent work to ensure proper clearances.

#### **3.3 TESTING AND ADJUSTING**

- A. Upon completion of installation including the work by other trades, test and adjust doors to operate easily, free from warp, twist or distortion.
- B. Test the door in presence of ENGINEER to demonstrate proper operation.

#### **3.4 ADJUSTING AND CLEANING**

- A. Adjust doors and operators for smooth, easy operation.
- B. Repair any damage to paint or finishes.
- C. Leave door assemblies clean and remove all debris from work area.

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**SECTION 08305**  
**ACCESS HATCHES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Scope: Provide all materials, equipment, and accessories to furnish and install the following access hatches:
  - 1. Flush floor hatches
  - 2. Roof hatches

**1.2 QUALITY ASSURANCE**

- A. Warranty: Provide a 1-yr warranty on all hatches from date of installation. Warranty shall cover defects in workmanship, design, and materials. If any component should fail during the warranty period, it shall be corrected and the unit restored to service at no expense to the OWNER.

**1.3 DESIGN REQUIREMENTS**

- A. In other locations and where designated as "Standard" hatches shall be designed for a live load of 300 pounds per square foot.

**1.4 SUBMITTALS**

- A. Shop Drawings:
  - 1. Detailed drawings showing component and assembly dimensions, location of connections, weights of all equipment, installation details, and accessory details.
- B. Product Data:
  - 1. Descriptive literature, specifications, and engineering data.
  - 2. Materials of construction for all components and accessories.

**1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING**

- A. All equipment and accessories shall be properly protected during shipment such that no damage or deterioration shall occur between shipment and installation.
  - 1. Finished surfaces shall be protected by wooden blanks.
  - 2. Finished ferrous metal surfaces not painted shall be protected from corrosion.
  - 3. Each box and package shall be clearly marked with the contents and total weight.
- B. Manufacturer shall provide any special storage and handling instructions.

**PART 2 - PRODUCTS**

**2.1 MANUFACTURERS**

- A. General: Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted.

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1. Aluminum hatches:
  - a. The Bilco Co.
  - b. Babcock-Davis, Inc.
  - c. Or Equal.

## 2.2 MATERIALS

- A. Unless otherwise noted, all access hatches shall be constructed of aluminum.
- B. Aluminum hatches shall be provided with aluminum frames and stainless-steel hardware.
- C. Steel hatches and frames shall be galvanized and provided with galvanized or cadmium-plated hardware.

## 2.3 FLUSH FLOOR HATCHES

- A. General
  1. Doors shall be pre-assembled from the manufacturer.
  2. Covers shall open 90 degrees and be equipped with a hold open arm which automatically locks the cover in the open position.
  3. Covers shall be fitted with the required number and size of compression spring operators. Springs shall have an electrocoated acrylic finish. Spring tubes shall be constructed of a reinforced nylon 6/6-based engineered composite material.
  4. A removable exterior turn/lift handle with a spring loaded ball detent shall be provided to open the cover and the latch release shall be protected by a flush, gasketed, removable screw plug.
  5. Hardware:
    - a. Hinges shall pivot so that the cover does not protrude into the channel frame.
    - b. A Type 316 stainless steel snap lock with fixed handle shall be mounted to the underside of the cover.
  6. Entire door and all hardware components shall be highly corrosion resistant.
  7. Doors shall be sealed with an EPDM gasket for odor control purposes.
- B. **H-100:** Single leaf flush floor hatch for walking areas (up to 42-inch by 42-inch)
  1. Furnish and install where indicated on drawings flush floor access hatch. The hatch shall be single leaf.
  2. Service: Floor hatch for use in areas of foot traffic.
  3. Features:
    - a. Material:
      - 1) Cover: ¼-in aluminum diamond pattern plate
      - 2) Frame: ¼-in extruded aluminum
    - b. The cover shall be reinforced to support a minimum live load of 300 lb/ft<sup>2</sup> with a maximum deflection of 1/150<sup>th</sup> of the span.
    - c. Hinges:
      - 1) Aluminum cover: Provide heavy forged aluminum hinges with a minimum ¼-in diameter Type 316 stainless steel pin.
- C. **H-101:** Double leaf flush floor hatch for walking areas (over 42-inch by 42-inch)
  1. Furnish and install where indicated on drawings flush floor access hatch. The hatch shall be double leaf.
  2. Service: Floor hatch for use in areas of foot traffic.
  3. Features:
    - a. Material:

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- 1) Cover: ¼-in aluminum diamond pattern plate
- 2) Frame: ¼-in extruded aluminum
- b. The cover shall be reinforced to support a minimum live load of 300 lb/ft<sup>2</sup> with a maximum deflection of 1/150<sup>th</sup> of the span.
- c. Hinges:
  - 1) Aluminum cover: Provide heavy forged aluminum hinges with a minimum ¼-in diameter Type 316 stainless steel pin.

## 2.4 ROOF HATCHES

### A. General

1. All roof hatches shall be preassembled from the manufacturer.
2. Entire hatch shall be weathertight with fully welded corner joints on cover and curb.
3. Cover:
  - a. Material: 11 gauge aluminum with a 3-inch beaded flange with formed reinforcing members.
  - b. Cover shall be reinforced to support a minimum live load of 40 psf with a maximum deflection of 1/150<sup>th</sup> of the span or 20 psf wind uplift.
  - c. Cover shall have a heavy extruded EPDM rubber gasket that is bonded to the cover interior to assure a continuous seal when compressed on the top surface of the curb.
  - d. Cover insulation shall be fiberglass of 1-inch thickness, fully covered and protected by an 18 gauge aluminum liner.
4. Curb:
  - a. Material: 11 gauge aluminum
  - b. The curb shall be 12 inches in height.
  - c. The curb shall be formed with a 3-1/2-inch flange with 7/16-inch holes provided for securing to the roof deck.
  - d. The curb shall be equipped with an integral metal capflashing of 11 gauge aluminum, fully welded at the corners.
  - e. Curb insulation shall be rigid, high-density fiberboard of 1-inch thickness on outside of curb.
5. Lifting Mechanisms:
  - a. Manufacturer shall provide compression spring operators enclosed in telescopic tubes to provide smooth, easy, and controlled cover operation.
  - b. The upper tube shall be the outer tube to prevent accumulation of moisture, grit, and debris inside the lower tube assembly.
  - c. The lower tube shall interlock with a flanged support shoe welded to the curb assembly.
6. Winch Operated Rigging:
  - a. Manufacturer shall provide winch operated rigging to allow the roof hatches to be manually opened from ground floor level.
  - b. Rigging shall include all winches, cables and pulleys per roof hatch.
  - c. Contractor shall install rigging and provide all necessary hardware and stand-off brackets to allow the winches to be readily accessible without interference of adjacent mechanical, structural or electrical items.
  - d. Layout of rigging shall be approved by ENGINEER prior to installation.
7. Hardware:
  - a. Heavy pintle hinges shall be provided.
  - b. Cover shall be equipped with a spring latch with interior and exterior turn handles.
  - c. Roof hatch shall be equipped with interior and exterior padlock hasps.
  - d. The latch strike shall be a stamped component bolted to the curb assembly.

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- e. Cover shall automatically lock in the open position with a rigid hold open arm equipped with a 1-inch diameter red vinyl grip handle to permit easy release for closing.
  - f. Compression spring tubes shall be an anti-corrosive composite material and all other hardware shall be zinc plated and chromate sealed. Springs shall have an electrocoated acrylic finish for corrosion resistance.
  - g. Cover hardware shall be bolted into heavy gauge channel reinforcing welded to the underside of the cover and concealed within the insulation space.
8. Factory finish shall be mill finish aluminum.
- B. **H-201:** Single leaf roof hatch for small equipment access
- 1. Furnish and install where indicated on plans a metal roof hatch.
  - 2. Dimensions: width of 60 inches and length of 60 inches (hinge side).
  - 3. The roof hatch shall be single leaf.
  - 4. Furnish winch operated rigging for each roof hatch.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. General: Install in accordance with the manufacturer's recommendations and approved shop drawings. Install level and square with other construction, without warp or rack.
- B. Unless otherwise shown, hatches shall be cast integrally with concrete decks, and shall not be grouted in later.
- C. Coordinate precise location with equipment to be accessed thereby.
- D. Aluminum surfaces shall be protected with two heavy coats of asphaltic or zinc chromate paint, where they are in contact with concrete or masonry.

+ + END OF SECTION + +



**SECTION 08700**  
**DOOR HARDWARE**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Scope: Provide all materials, equipment, and accessories to furnish and install door hardware.

**1.2 SUBMITTALS**

- A. Shop Drawings:
1. Product Data: Manufacturers' literature for each item of finish hardware required herein, clearly marked.
  2. Finish Hardware Schedule: Furnish complete and detailed schedule, show product items, numbers, and finishes for all hardware for each separate opening.
  3. Special Tools: Provide listing and description of usage.

**1.3 QUALITY ASSURANCE**

- A. Qualifications of Supplier: A recognized supplier of architectural finish hardware, with warehousing facilities, who has been furnishing hardware in the vicinity of the Project for not less than 5 years, and who is, or who employs, an architectural hardware consultant.

**1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Provide secure storage for all finish hardware until installation is made.
- B. Before delivery, clearly identify and tag each item of hardware with respect to specified description and location of installation.

**1.5 SPECIAL TOOLS**

- A. Provide two sets of special tools for installation and maintenance of hardware.

**PART 2 - PRODUCTS**

**2.1 DOOR HARDWARE**

- A. Provide all door hardware from a single manufacturer in order to have consistency in appearance, function and maintenance procedures.
- B. Fasteners:
1. All fasteners shall be type 304 stainless steel.
- C. Butt Hinges:
1. Conforming to ANSI A156.1-88.
  2. Quantity per Door Leaf (Minimum):

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DOOR HEIGHT	MINIMUM NUMBER OF HINGES PER LEAF
Up to 5'-0"	2 ea
5'-0" to 7'-7"	3 ea
7'-7" to 10'-0"	4 ea
10'-0" to 12'-6"	5 ea
Over 12'-6"	One for every 30" of door height, rounding up

3. Hinge Size: Except as otherwise specified or as required to comply with UL and NFPA, provide hinges of the following sizes:
  - a. Up to 36" wide: 4½" heavy weight.
  - b. Over 36" to 48" wide: 5" heavy weight.
  - c. Over 48" wide: 6" heavy weight.
4. Types of Hinges: Full-mortise type, ball-bearing hinges swaged for mortise applications, inner leaf beveled, square cornered.
5. Width: Minimum for clearance of trim and 180-degree swing.
6. Exterior Hinges: Non-removable pin.
7. Joint Tolerance: 0.012-inch maximum, gauged in CLOSED position.
8. Material: type 304 stainless steel.
  - a. Finish: Satin stainless steel No. 630.
9. Hinge Manufacturers and Models:
  - a. Stanley FBB191-32D
  - b. McKinney TB2314
  - c. Or Equal.

D. Exit Devices:

1. Provide exit devices on all exit doors listed in the Door Schedule complying with ANSI A156.3.
2. Furnish cylinders on all exterior doors.
3. Provide card key access with key backup on each door, Johnson Controls to match existing City of Roseville Systems.
4. Exit Device Manufacturer and Model:
  - a. To be determined as part of Design-Assist process to match OWNER's existing facilities.

E. Coordinator:

1. Provide coordinator at all double doors.
2. Coordinator Manufacturers and Models:
  - a. Ives COR7G.
  - b. Or Equal.

F. Closers:

1. Provide closers on all exterior doors or as indicated in the Door Schedule which comply with ANSI A156.4.
2. Size closers in accordance with manufacturer's standards. Mount regular arm closers on pull side of doors. Mount parallel arm closers on push side of doors. On pair of doors provide closer on active leaf only, unless noted otherwise.
3. Closer Manufacturers and Models:
  - a. LCN 4110 Series
  - b. Sargent 351 Series
  - c. Or Equal.

G. Thresholds:

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1. Provide threshold at each door as indicated in the Door Schedule or shown on the drawings: One-piece full width of opening; extend beyond jamb where indicated.
  2. Provide with stainless steel machine screws in threaded expansion anchors at concrete.
  3. Finish: Mill finish aluminum, unless indicated otherwise.
  4. Threshold Manufacturers and Models:
    - a. Pemko 274X4AFG
    - b. Reese Enterprises, Inc. S407A
    - c. Or Equal.
- H. Weatherstrip:
1. Provide complete weatherstrip system at exterior doors, including rubber or vinyl at jambs and head, door sweep, rain drip, astragal seal for 2-leaf doors, and all other weatherstripping necessary to provide a weather-sealed door system which does not allow air or moisture movement through the gap between the door and frame.
- I. Stops and Holders:
1. Provide stops and holders for all doors with closers in accordance with ANSI A156.16.
  2. Finish: Satin chromium-plated No. 626.
  3. Stop/Holder Manufacturers and Models:
    - a. Ives WS445
    - b. Hager Companies 256
    - c. Or Equal.

## 2.2 KEYING

- A. Coordinate Keying System with OWNER. Provide master-keying and local-keying to match OWNER's keying system prior to Final Completion.
- B. Provide removable construction core system for use during construction.

## **PART 3 - EXECUTION**

### 3.1 INSTALLATION

- A. In accordance with manufacturer's written instructions.
- B. Make Work neat and secure, develop full strength of components, and provide proper function.
- C. Prevent marring, scratching, or otherwise damaging adjacent finishes during hardware installation.
- D. Latchbolts: Install to engage in strikes automatically, whether activated by closers or manually. In no case shall additional manual pressure be required to engage latchbolt in strike.
- E. Wall Mounted Hardware: Install over solid structural backing or solid blocking in hollow walls.
- F. Thresholds:
  1. Cope ends neatly to profile of jamb.

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- 2. Set in sealant and seal ends to jambs.
- G. Hardware: Adjust for easy, noise-free operation.
- H. Replace damaged hardware items.

### 3.2 MOUNTING DIMENSIONS

- A. Standard Door Hardware Locations: As recommended and published by the Door and Hardware Institute, except as noted or detailed otherwise.
- B. Door Silencers: Install 3 inches from top and bottom of jamb and 1 inch above strike at single doors, and 3 inches from edges of doors in head for pairs of doors.

### 3.3 MANUFACTURER'S SERVICES

- A. Deliver permanent lock cores to the site.
- B. Remove temporary construction cores and insert permanent cores.
- C. Inspect each lock set to ensure permanent cores are operating satisfactorily.
- D. Deliver to OWNER change and control keys for the permanent system.
- E. Return temporary construction cores to the manufacturer.

### 3.4 PROTECTION

- A. Cover and protect exposed surfaces of hardware during installation and until Substantial Completion.
- B. Fit, dismantle, and reinstall finish hardware as required for finish painting work.
- C. Protect and prevent staining of hardware during construction in accordance with manufacturer's recommendations.
- D. Remove protective measures and permanent lock cylinders installed prior to final cleaning.

+ + END OF SECTION + +

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**SECTION 09250**  
**GYPSUM WALLBOARD**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Scope: Furnish all materials, labor, equipment and incidentals required to install gypsum wallboard.

**1.2 QUALITY ASSURANCE**

- A. General: Regardless of the minimum specifications herein, utilize materials and applications recommended by the manufacturer.
- B. Applicator's Qualifications: Use only workers regularly employed in this type of work who can show experience in the application of similar materials and the specific systems specified.

**1.3 SUBMITTALS**

- A. Shop Drawings:
  - 1. Manufacturer's list of items and materials proposed for use, with descriptive literature for each system used.

**1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING**

- A. Delivery of Materials:
  - 1. Deliver materials to the project site with manufacturer's labels intact and legible.
  - 2. Deliver fire rated materials bearing testing agency label and required fire classification numbers.
- B. Storage and Handling of Materials:
  - 1. Store materials inside under cover, stack flat, off floor.
  - 2. Stack gypsum wallboard so that long lengths are not over short lengths.
  - 3. Store adhesives and finishing compounds in dry areas, and protect against freezing at all times.

**1.5 ENVIRONMENTAL REQUIREMENTS**

- A. Temperature:
  - 1. In areas receiving gypsum wallboard installation, maintain temperature range between 55 and 70 degrees F for 24 hours before, during, and after gypsum wallboard and joint treatment application.
  - 2. In areas receiving veneer plaster, where outside air temperature is less than 50 degrees F, maintain interior temperature range between 50 degrees F and 80 degrees F for a period of 1 week before, during, and 1 week after application of veneer plaster, base, and joint treatment.
- B. Ventilation:
  - 1. Provide ventilation during and following adhesives and joint treatment applications.

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2. Use temporary air circulators in enclosed areas lacking natural ventilation.
3. Keep air circulation at a minimum level during veneer plastering to avoid excessive drying.
4. Under slow drying conditions, allow additional drying time between coats of joint treatment.
5. Protect installed materials from drafts of ambient air during hot, dry weather.

## **PART 2 - PRODUCTS**

### **2.1 GYPSUM WALLBOARD**

- A. Regular Board: ASTM C36, Type X, 5/8 inch thick with tapered edges.

### **2.2 FASTENERS FOR GYPSUM WALLBOARD**

- A. Screws: ASTM C1002, self-drilling, self-tapping, bugle head, for use with power-driven tool.
  1. Type S, 1-inch long for gypsum wallboard to sheet metal.

### **2.3 JOINT TREATMENT**

- A. Joint Tape for General Interior Applications: ASTM C475, perforated paper tape.
- B. Joint Compound for General Interior Applications: ASTM C475, all-purpose, ready-mixed compound.

### **2.4 ANCILLARY MATERIALS**

- A. Adhesives: As recommended by gypsum wallboard manufacturer for intended use.

### **2.5 TRIM ACCESSORIES**

- A. Zinc-Coated Metal, ASTM C1047:
  1. Corner Bead: 1-1/4 inch by 1-1/4 inch:
    - a. United States Gypsum; Dur-A-Bead.
    - b. Award Metals; standard corner beads.
    - c. Clark Dietrich; standard corner beads.
  2. Edge Trim:
    - a. United States Gypsum; L-Trim and J-Trim.
    - b. Award Metals; L-Bead and J-Bead.
    - c. Clark Dietrich; L-Trim and J-Trim.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Inspect surfaces to receive gypsum wallboard and related materials before beginning work and report to ENGINEER any defects in such work which will adversely affect the quality of work specified herein.

### 3.2 PREPARATION

- A. General: Provide, install, and maintain necessary scaffolding, staging, trestles, planking, and temporary heating, lighting, and ventilation as necessary for the duration of the gypsum wallboard work.
- B. Protection: Protect work of other trades.
- C. Coordination:
  - 1. Coordinate work with that of other trades. Check specifications and drawings of other trades to determine parts of work requiring coordination.
  - 2. Cut and repair gypsum wallboard systems for installation of omitted work.
- D. Surface Preparation: Repair defective surfaces prior to starting work. Prepare as specified for application of specific materials.

### 3.3 APPLICATION OF GYPSUM WALLBOARD

- A. Inspection and Preparation:
  - 1. Check framing for accurate spacing and alignment.
  - 2. Verify that spacing of installed framing does not exceed maximum allowable for thickness of gypsum wallboard to be used.
  - 3. Verify that frames are set for thickness of gypsum wallboard to be used.
  - 4. Do not proceed with installation of gypsum wallboard until deficiencies are corrected and surfaces to receive gypsum wallboard are acceptable.
  - 5. Protrusions from framing, twisted framing members, or unaligned members must be repaired before installation of gypsum wallboard is started.
- B. General:
  - 1. Meet requirements of ASTM C840 and GA-216.
  - 2. Joints: Use gypsum wallboard of maximum lengths to minimize end joints. Stagger end joints when they occur. Locate end joints as far as possible from center of wall or ceiling. Abut gypsum wallboard without forcing. Neatly fit ends and edges of gypsum wallboard. Do not place butt ends against tapered edges.
  - 3. Support ends and edges of gypsum wallboard panels on framing or furring members except for face layer of double layer and where ends are back blocked and floated.
  - 4. Use metal edge trim where gypsum wallboard abuts another material and where shown or noted on Drawings.
  - 5. Use gypsum fiberglass-mat faced gypsum backing board in toilet and shower walls, behind ceramic tile, and elsewhere as indicated on Drawings.
  - 6. Follow manufacturer's recommendation of good practice.
- C. Over Framing:
  - 1. Apply gypsum wallboard first to ceiling and then to walls for single layer horizontal application.
  - 2. Use vertical application for fire-rated walls.
  - 3. Fasten gypsum wallboard securely to framing using double nailing, screw, or adhesive method.

### 3.4 JOINT SYSTEM

- A. Interior Gypsum Wallboard: Conform to ASTM C840.

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- B. Required: On exposed gypsum wallboard, under ceramic tile and wall covering, and behind casework.
- C. Prefill: Fill V-grooves formed by abutting rounded edges of gypsum wallboard with prefill joint compound. Fill V-joint flush and remove excess compound beyond groove. Leave clear depression to receive tape. Permit prefill joint compound to harden prior to application of tape.
- D. Taping and Finishing Joints:
  - 1. Taping or Embedding Coat: Apply compound in thin, uniform layer to joints and angles to be reinforced. Apply reinforcing tape immediately. Center tape over joint and seat tape into compound. Leave approximately 1/64-inch to 1/32-inch compound under tape to provide bond. Apply skim coat immediately following tape embedment but not to function as fill or second coat. Fold tape and embed in angles to provide true angle. Dry embedding coat prior to application of fill coat.
  - 2. Filling Coat: Apply joint compound over embedding coat. Fill taper flush with surface. Apply fill coat to cover tape. Feather out fill coat beyond tape and previous joint compound line. For joints with no taper, feather out at least 4 inches on either side of tape. Do not apply fill coat on interior angles. Allow fill coat to dry prior to application of finish coat.
  - 3. Finishing coat: Spread joint compound evenly over and beyond fill coat on joints. Feather to smooth uniform finish. Apply finish coat to tapes angles to cover tape and taping compound. Sand final application of compound to provide surface ready for decoration.
  - 4. Filling and Finishing Depressions:
    - a. Apply joint compound as first coat to fastener depressions. Apply at least two additional coats of compound after first coat is dry. Leave filled and finished depressions level with plane of surface.
- E. Finishing Beads and Trim:
  - 1. First Fill Coat: Apply joint compound to bead and trim. Feather out from ground to plane of the surface. Dry compound prior to application of second fill coat.
  - 2. Second Fill Coat: Apply joint compound in same manner as first fill coat. Extend beyond first coat onto face of gypsum wallboard. Dry compound prior to application of finish coat.
  - 3. Finish Coat: Apply joint compound to bead and trim. Extend beyond second fill coat. Feather finish coat from ground to plane of surface. Sand finish coat to provide flat surface ready for decoration.

### 3.5 FINAL FINISHES

- A. Levels of Finish: Conform to GA-214.
- B. Level 5:
  - 1. Taping, filling, and finishing coats plus two separate coats applied over joints, angles, fastener heads, and trim accessories.
  - 2. Sand between coats and after last coat.
  - 3. Add a thin, smooth, uniform skim coat of joint compound, or product specially formulated for this purpose, over entire surface.
  - 4. Produce surfaces free of tool marks and ridges, ready for painting.
  - 5. Use on surfaces not indicated otherwise, those indicated to receive gloss, semi-gloss, and nontextured flat paints, and where indicated.

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### 3.6 ADJUST AND CLEAN

- A. Clean: Remove droppings or texture overspray from walls, windows, and floor, leaving room clean for following trades.

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## SECTION 09900

### PAINTING

#### **PART 1 - GENERAL**

##### **1.1 DESCRIPTION**

- A. Scope: Provide and install coatings on all exposed surfaces as indicated herein, in other Specification Sections, and on the Drawings.

##### **1.2 QUALITY ASSURANCE**

- A. Experience: Both Coatings Manufacturer and Coatings Installer shall have a minimum 5 years' experience in production and application, respectively, of specified products. Coatings Installer shall be approved and endorsed, in writing, by Coatings Manufacturer.
- B. Regulations: Meet federal, state, and local requirements which apply to the work, including, but not limited to those regulations limiting the emission of volatile organic compounds.
- C. Coatings Manufacturer Recommendations: Coatings Installer shall follow all recommendations of the Coatings Manufacturer regarding storage, handling, surface preparation, application of coatings, recoat times, environmental conditions during storage, preparation and application of coatings, and all other Coatings Manufacturer recommendations.
- D. Warranty: Both Coatings Manufacturer and Coatings Installer shall provide a 1-year complete replacement warranty for all coatings. Manufacturer shall provide 5-year warranty for long-term performance of coatings in addition to 1-year warranty.

##### **1.3 SUBMITTALS**

- A. Shop Drawings: Coatings Manufacturer shall submit for approval the following:
  - 1. Copies of Manufacturer's technical information and application instructions for each material proposed for use. Specify exactly which product is being proposed for each coating type (as specified below). This may be accomplished through a reference table along with information on the various products, or by a separate, tabbed section with information on products being submitted for each system in a separate tab of a binder. Submittal of general Manufacturer's literature without detailing which product is proposed for each paint system will be unacceptable.
  - 2. Copies of Manufacturer's complete color charts for each coating system.
  - 3. Letter from the Coatings Manufacturer approving and endorsing Coatings Installer.
  - 4. Letter from Coatings Manufacturer stating that volatile organic compounds (VOCs) meet all Federal, State and Local requirements.
  - 5. Furnish copies of the final, approved submittal to the Coatings Installer so that it is clear which product is to be used for which each system.
- B. Reference Samples:
  - 1. Provide reference samples of paint colors and textures as required by the ENGINEER. Reference samples will show the color and texture of the final paint to be applied and shall be approved by the ENGINEER prior to painting. Reference samples should be

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applied to similar substrates to the final surfaces to be painted. If ENGINEER chooses to forego reference samples, CONTRACTOR must receive the allowance to forego reference samples before painting begins or all painted surfaces will be re-painted at the ENGINEER's discretion and at no additional cost to the OWNER.

#### 1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Protection: Protect all pre-coated items from coating damage during shipping.
- B. Store products in accordance with Manufacturer's directions.
- C. Store products in a neat, orderly fashion. Protect products from damage. Protect storage area from damage from stored products.

### **PART 2 - PRODUCTS**

#### 2.1 PRODUCT AND MANUFACTURER:

- A. Provide coating types as listed in the following table. The systems referenced in the table are those provided by TNEMEC and Sherwin-Williams. If manufacturers other than TNEMEC or Sherwin Williams are desired, the CONTRACTOR shall submit equivalent paint systems.

COATING TYPE	DESCRIPTION	Sherwin Williams Series	TNEMEC SERIES
Clear Polyamine Epoxy	Clear Polyamine Epoxy, high solids, moisture resistant, designed as a one-coat wood sealer.	GP3477	Series 201, Epoxoprime
Acrylic Filler	Waterborne Cementitious Acrylic designed for application on porous surfaces such as rough-faced concrete masonry units	CementPlex 875	Series 130, Envirofill
Acrylic Latex	Single component, finish as required	ProMar 200	N/A
Industrial Acrylic	Single component, high density acrylic finish for interior, exterior surfaces	Shercryn HPA	Series 1029
Latex Primer/ Sealer	Waterborne vinyl acrylic primer/sealer for interior gypsum wallboard/plaster. Capable of providing uniform seal and suitable for use with specified finish coats.	ProMar 200 Primer	Series 115
Polyamine Epoxy Sealer	Waterborne Polyamine Epoxy, penetrating, flexible and low-odor primer designed for sealing porous substrates.	Multi-Purpose Acrylic Primer	Series 151, Elasto-Grip FC
Acrylate	Modified Waterborne Acrylate designed for application on porous surfaces such as rough-faced concrete masonry units or wood surfaces. Flexible and breathable, moisture and UV resistant. Matte Finish	Loxon XP	Series 156, Enviro-crete
Polyamidoamine	Polyamidoamine Epoxy designed for	Sher-glass	Series N69, V69

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Epoxy	use on steel or other ferrous metals not in contact with potable water but submerged or immersed in wastewater or non-potable water.	FF	or L69 (type per local VOC regulations), Hi-Build Epoxoline II
	Polyamidoamine Epoxy designed for use on steel or other ferrous metals in contact with potable water.	Macropoxy 5500	Series N140, L140 or V140 (type per local VOC regulations), Pota-Pox Plus
Polyurethane	Aliphatic Acrylic Polyurethane designed for exterior weathering, abrasion and corrosion resistance	HS Polyurethane 250 or Waterbased Acrolon	Series 1095, Endura-Shield
Silane Water Repellent Sealant	Silane/Siloxane penetrating water repellent blend designed for application on above-grade concrete, stucco, block, masonry and stone surfaces	Loxon 7% Siloxane	Series 636, Dur A Pell 20
Wood Sealer / Stain	Single component, 250 g/l wood stain in clear or standard colors	Minwax 250	
Wood Varnish Finish	Single component polyurethane varnish	Minwax	

- B. All coatings used shall comply with Federal, State and local VOC limits based on application location.

## 2.2 COLOR

- A. Color Pigments: Pure, nonfading, lead-free applicable types to suit the substrates and service indicated.
- B. Provide colors as described in the drawings or specifications, or as selected by ENGINEER from standard color palette. For piping system colors, reference City of Roseville Process Control Standards.
- C. Where existing colors are to be matched or satisfactory color is not available from standard color palette, provide custom-mixed colors.
- D. Provide samples of each color on the substrate to be coated for approval by the ENGINEER prior to beginning coating application.

## **PART 3 - EXECUTION**

### 3.1 SURFACE PREPARATION

- A. Coatings Installer shall prepare all surfaces to be painted in strict accordance with Coatings Manufacturer's recommendations.
- B. Coatings Manufacturer representative shall observe Coatings Installer's methods of preparing surfaces and approve of the work prior to Coatings Installer beginning coating

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installation. If, after a period of time, Coatings Manufacturer is satisfied with Coatings Installers methods, Coatings Manufacturer can allow Coatings Installer to proceed without inspection following surface preparation. Coatings Manufacturer and installer will still both be held equally accountable for any coatings failure.

C. Wood surface preparation

1. Coatings Installer shall clean and prepare all wood surfaces in accordance with the Coating Manufacturer's recommendations. Patching may be required where approved by the Engineer. All joints in wood members including trim, siding, soffits, and joints between wood and dissimilar materials shall be filled with joint sealant prior to coating.

### 3.2 PROTECTION

- A. Protect all adjacent surfaces from overspray, dripping or other transfer of coatings not intended for those surfaces. Use masking, tape, drop cloths, plastic and other protective materials as appropriate.
1. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, stainless steel surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted.
  2. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process. Mask openings in motors, fan housings, etc. to prevent coatings from falling inside.
  3. Correct all damages by cleaning, repairing or replacing, and repainting, as acceptable to ENGINEER.
- B. Completely remove all masking, tape, drop cloths, plastic and other protective materials within 48 hours of completion of application of finish coat. Take special care to remove masking and plastic which cover tank vent openings, HVAC registers, vents, motor vents, and other areas where airflow is critical to proper operation.

### 3.3 APPLICATION

- A. Paint all exposed surfaces not specifically excluded in 3.3.C, below. Provide and install Coatings in accordance with the following Table, unless otherwise specified in other Sections:

COATING SYSTEM NO.	SURFACE TO BE COATED	PRIMER COATING	NO OF PRIMER COATS	PRIME COAT THICKNESS (EACH COAT)	FINISH COATING	NO OF FINISH COATS	FINISH COAT THICKNESS (EACH COAT)
100	Concrete Masonry Units (Interior)	Acrylic Filler	1	70 SF/Gal Application Rate	Acrylate	2	135 SF/Gal Application Rate
101	Concrete Masonry Units (Exterior)	Silane Waterproofing Sealant	1	250 SF / Gal Application Rate	None		
102	Concrete Roof Slab (Exterior)	Silane Waterproofing Sealant	1	250 SF/Gal Application Rate	None		

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COATING SYSTEM NO.	SURFACE TO BE COATED	PRIMER COATING	NO OF PRIMER COATS	PRIME COAT THICKNESS (EACH COAT)	FINISH COATING	NO OF FINISH COATS	FINISH COAT THICKNESS (EACH COAT)
200	Wood (Interior and Exterior)	Polyamine Epoxy	1	250 SF/Gal Application Rate	Acrylate	2	135 SF/Gal Application Rate
201	Wood (Interior, where noted)	Wood Sealer	1	250 SF/Gal Application Rate	Wood Finish	1	350 SF/Gal Application Rate
202	Gypsum Board (Interior)	Latex Primer/Sealer	1	350 SF/Gal Application Rate	Acrylic Latex (Semigloss)	2	400 SF/Gal Application Rate
300	Exposed Ferrous Pipe Systems and Exposed Steel Items	Polyamidoamine Epoxy	2	4-6 MDFT	Polyurethane	2	2-3 MDFT
301	Exposed, Non-metallic Pipe Systems	Latex Primer/Sealer	1	3-5 MDFT	Acrylic Latex (Semigloss)	2	3-5 MDFT
302	Immersed Ferrous Pipe Systems and Steel Items	Polyamidoamine Epoxy*	1	6-10 MDFT	Polyamidoamine Epoxy*	1	6-10 MDFT
303	Immersed Non-metallic Pipe Systems	Latex Primer/Sealer*	1	4-6 MDFT	Acrylic Latex (Semigloss)*	1	4-6 MDFT
304	Buried Ferrous and Steel Items	Polyamidoamine Epoxy	1	8-10 MDFT	Polyamidoamine Epoxy	1	8-10 MDFT
305	Aluminum Surfaces in Contact with Concrete	Polyamidoamine Epoxy	1	4-6 MDFT	None		
	Steel Tank	Per 09871, Coating of Steel Water Storage Tank					
	Pumps	Touch up factory applied coatings, per Pump Specifications					

\* Where in contact with potable water, coating shall be NSF-61 certified.

B. Items Delivered with Factory Applied Primer:

1. For items delivered with a factory applied primer and requiring painting under this Section, the factory applied primer may be used in lieu of field applied primer only under the following conditions:
  - a. The ENGINEER approves the use of the factory applied primer in lieu of field applied primer.
  - b. The factory applied primer is certified by the Coatings Manufacturer as compatible with the field applied finish coat.

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- c. The Coatings Manufacturer's recommended recoat time for the factory applied primer has not been exceeded.
  2. If all of the above conditions are not met, the Coatings Installer shall re-prepare all surfaces to be painted in strict accordance with Coatings Manufacturer's recommendations and primer applied, in accordance with this Section.
- C. Table Definitions:
1. SF/Gal: Square foot of coverage per gallon of coating used.
  2. MDFT: mil dry film thickness
  3. mil: 1/1000 of an inch paint thickness
  4. Ferrous Pipe: Includes Ductile Iron, Cast Iron, Steel, and Galvanized Steel piping
  5. Steel Items: Includes steel and galvanized steel items such as structural steel, doors, window frames, overhead coiling doors, bollard posts, steel gates, steel fences, and all other steel and galvanized steel items.
  6. Non-Metallic Pipe: Polyvinyl Chloride, Chlorinated Polyvinyl Chloride, Fiberglass Reinforced Plastic, High Density Polyethylene
  7. Exposed: Located above grade, exposed to the atmosphere not submerged. Includes surfaces inside and outside of buildings.
  8. Submerged: In an area which normally is under water or other liquid or is intermittently under water or other liquid.
  9. Buried: Located below grade, surrounded by backfill.
- D. Surfaces Not Requiring Painting:
1. Unless otherwise stated or shown below or in other sections, the following areas or items will not require painting or coating:
    - a. Concrete surfaces.
    - b. Reinforcing steel.
    - c. Copper, bronze, brass, Monel, aluminum, chromium plate, and stainless-steel surfaces, except where:
      - 1) Required for electrical insulation between dissimilar metals.
      - 2) Aluminum and stainless steel are embedded in concrete or masonry, or aluminum is in contact with concrete or masonry.
      - 3) Color coding of equipment and piping is required.
    - d. Existing piping, fittings and pipe supports.
    - e. Pipe unions or portions of piping systems where painting would make disassembly difficult or impossible.
    - f. Prefinished electrical, mechanical and architectural items such as motor control centers, switchboards, switchgear, panelboards, transformers, disconnect switches, HVAC equipment enclosures, ductwork, acoustical tile, cabinets, louvers, and wall panels.
    - g. Electrical conduits.
    - h. Cathodic protection anodes.
    - i. Insulated piping and insulated piping with jacket will require prime coat only.
    - j. Fiberglass reinforced plastic (FRP) surfaces with an integral ultra-violet resistant colored gel coat do not require painting, provided the color is as selected.
    - k. Glass, plexiglass or other transparent or translucent material intended to allow passage of light.
    - l. Civil/site materials such as asphalt, gravel, rock, chain-link fence, and plantings.

### 3.4 RECOAT TIMES:

- A. Coatings Installer shall observe all requirements of the Coatings Manufacturer regarding recoat times.

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### 3.5 PAINT LOG

- A. Coatings Installer shall keep a paint log
  - 1. Specific details of the contents and format paint log shall be determined by the Coatings Installer and approved by the ENGINEER.
  - 2. At a minimum, paint log shall record, on a daily basis for any day when coating work is performed:
    - a. Weather conditions, including 3-day forecast
    - b. Which surfaces were prepared for coating
    - c. Approval of surface preparation by the Coatings Manufacturer representative
    - d. Which surfaces or systems were coated that day
    - e. Who the installer was (specific names of persons on crew)
    - f. Which coating type was used
    - g. Which coat was installed
    - h. What the application rate or MDFT was (as approved by ENGINEER)
  - 3. Paint log shall be kept on-site. Paint log shall be signed on a daily basis, for any day when coating work is performed, by the supervisor of the coatings installer field crew and by the ENGINEER.
  - 4. Any painted surface which was not recorded in the paint log shall be stripped, re-prepared, and recoated at the ENGINEER's discretion.

### 3.6 WARRANTY INSPECTION

- A. Warranty inspection shall be conducted during the eleventh month following completion of the Work. All defective Work shall be repaired by the CONTRACTOR in accordance with this Specification and to the satisfaction of the ENGINEER and at the CONTRACTOR'S expense.
- B. Any location where paint has peeled, bubbled, or cracked and any location where rusting is evident shall be considered to be a failure of the system. The CONTRACTOR shall make repair at all points where failures are observed by removing the deteriorated paint, cleaning the surface, and recoating or repainting with the same system. If the area of failure exceeds 25 percent of the total coated or painted surface, the entire coating or paint system may be required to be removed and repainted in accordance with this specification as determined by the ENGINEER.
- C. All costs for CONTRACTOR'S inspection, Manufacturer's inspection and all costs for repair shall be borne by the CONTRACTOR.

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## SECTION 10340

### ARCHITECTURAL SUNSHADES AND CANOPIES

#### **PART 1 - GENERAL**

##### **1.1 DESCRIPTION**

- A. Scope: Work in this section includes furnishing and installation of roll-formed aluminum overhead hanger rod style canopies as shown on the Drawings.

##### **1.2 QUALITY ASSURANCE**

- A. Qualifications:
1. Designer: Professional Civil or Structural Engineer registered in the same state as the Project.
  2. Erector: Approved by the manufacturer.
- B. Warranty: Furnish manufacturer's extended guarantee or warranty, with OWNER named as beneficiary, in writing. Warranty shall provide for correction, or at the option of OWNER, removal and replacement of Work specified in this Section found defective during a minimum period of 5 years after date of Substantial Completion. Finish will not chalk, crack, check, blister, peel, flake, chip or lose adhesion for 5 years.

##### **1.3 SUBMITTALS**

- A. Shop Drawings:
1. Drawings stamped by manufacturer's Designer:
    - a. Drawings shall be specifically prepared for this Project.
    - b. Show structural component locations and positions, dimensions, and details of construction and assembly.
  2. Structural Calculations stamped by manufacturer's Designer:
    - a. Complete analysis and design of structural components and connections in accordance with the design requirements indicated.
  3. Samples: Minimum 2-inch by 3-inch metal components requiring color selection.
- B. Product Data:
1. Manufacturer's literature and technical data.

##### **1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING**

- A. Protect components and accessories from corrosion, deformation and other damage during delivery, storage and handling.
- B. Store on wood blocking or pallets, flat and off ground, to keep clean and to prevent damage or permanent distortion. Support bundles so there is no danger of tipping, sliding, rolling, shifting, or material damage. Cover with tarpaulins or other suitable weathertight ventilated covering.

## **PART 2 - PRODUCTS**

### **2.1 PRODUCT AND MANUFACTURER**

- A. Products manufactured or supplied by the following, and meeting these Specifications, may be used on this Project:
  - 1. Mapes Architectural Canopies
    - a. Sunshade: SuperShade.
    - b. Canopy: Lumishade
  - 2. Or equal.

### **2.2 SERVICE CONDITIONS AND DESIGN CRITERIA**

- A. Dead Load:
  - 1. As calculated.
- B. Live Load:
  - 1. 0 psf.
- C. Snow Load:
  - 1. 30 psf.
- D. Wind Load:
  - 1. Basic Wind Speed: 85 mph
  - 2. Exposure Category: C.
  - 3. Importance Factor: 1.15
- E. Seismic:
  - 1. Seismic Design Category: D.
  - 2. Importance Factor: 1.0.
  - 3. Site Class: D.
  - 4. Design Spectral Acceleration Parameters:
    - a.  $S_{DS} = 0.613$ .
    - b.  $S_{D1} = 0.348$ .

### **2.3 COMPONENTS**

- A. Materials:
  - 1. Decking at sunshades shall consist of louvered blades (.110 inch extruded aluminum).
  - 2. Decking at canopies shall consist of 2-1/2 inches interlocking, roll formed .032-inch decking.
  - 3. Intermediate framing members shall be extruded aluminum, alloy 6063-T6, in profile and thickness as required by manufacturer.
  - 4. Hanger rods to be powder coated finish to match the canopy.
  - 5. Fascia shall be standard 8-inch extruded, minimum .125 aluminum, flat face (Mapes style 'J').
- B. Finishes:
  - 1. Finish: Two-Coat Kynar Finish.
  - 2. Color: Selected by OWNER.

## 2.4 FABRICATION

- A. All sunshades and canopies shall be factory preassembled to the greatest extent possible.
- B. All connections shall be mechanically assembled utilizing 3/16-inch fasteners with a minimum shear stress of 350 pounds. Pre-welded or factory-welded connections are not acceptable.
- C. Concealed drainage at canopies: Water shall drain from covered surfaces into intermediate trough and be directed to downspouts.

## **PART 3 - EXECUTION**

### 3.1 INSPECTION

- A. Confirm that surrounding area is ready for the canopy installation.
- B. Installer shall field confirm dimensions and elevations to be as shown on shop drawings provided by the manufacturer and the Drawings.
- C. Erection shall be performed by an approved installer and scheduled after all concrete, masonry and roofing in the area is completed.

### 3.2 INSTALLATION

- A. Installation shall be in strict accordance with manufacturer's shop drawings and written instructions. Particular attention should be given to protecting the finish during handling and erection.

### 3.3 REPAIR AND CLEANING

- A. Immediately following erection, remove unused material, screws, fasteners, and other debris from completed installation. Use caution in removing metal cuttings from surface of prefinished metal panels.
- B. Replace damaged, dented, buckled, or discolored metal panels.

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## **SECTION 10400**

### **IDENTIFICATION DEVICES**

#### **PART 1 - GENERAL**

##### **1.1 CONFORMANCE WITH CITY OF ROSEVILLE PROCESS CONTROL STANDARDS**

- A. Refer to City of Roseville Process Control Standards (CORPCS) for pipe, equipment, valve, conduit, wire, and other system tag naming and labeling requirements for identification requirements for these systems.
- B. The following products and installation requirements are included in the Specifications as minimum requirements and for cost estimating purposes for bidding purposes, and for items that may not be addressed in the CORPCS. Where a conflict exists between the CORPCS and this section, the CORPCS has precedence and shall be followed.
- C. Efforts were made to label all major equipment and valves. However, not all equipment and valves may be shown with tag numbers on the Drawings, such as small diameter valves included in standard details or included as part of equipment packages. Refer to CORPCS for tag numbering requirements and convention for equipment and valves not shown with tag numbers (including equipment and valves not shown on the Drawings that are shown on Shop Drawings) and propose tag numbers coordinated with established sequences for ENGINEER approval.

##### **1.2 DESCRIPTION**

- A. Scope: Furnish and install signs, placards, and labels for safety equipment, hazards, and equipment and piping identification.

##### **1.3 SUBMITTALS**

- A. Shop Drawings:
  - 1. Provide manufacturer's literature showing available letter sizes and styles, standard and custom colors, and standard mounting details.
  - 2. Provide drawings showing layouts, actual letter sizes and styles, colors, and project-specific mounting details.

#### **PART 2 - PRODUCTS**

##### **2.1 FIRE EXTINGUISHER LOCATION SIGNS**

- A. Material:
  - 1. Subsurface silkscreened graphics on a transparent acrylic sheet, 0.08" thick with Helvetica Medium alphabet and matching arrows type face.
  - 2. Provide 2" high upper-case letters and 1" high lower-case letters.
- B. Fire Extinguisher Identification Sign:
  - 1. Provide 15"x 15" with 1" radiused corners, unframed.
  - 2. Provide one for each surface mounted fire extinguisher.
  - 3. Background color shall be red with white lettering.

4. Signs shall incorporate a white directional arrow as located by ENGINEER.

C. Product and Manufacturer: Provide one of the following:

1. ASI/SPE MH (Four Corners) Plaque by ASI Sign Systems, Incorporated.
2. Or equal.

## 2.2 FIRE PROTECTION PLACARDS

A. Fire Protection Placards:

1. Provide diamond-shaped placards: 15" square of 0.125" rigid polyethylene.
2. The placard shall meet NFPA 704.

B. Product and Manufacturer: Provide one of the following:

1. W.H. Brady Company
2. Seton Name Plate Company
3. Or Equal

C. Provide fire protection placards in accordance with the following schedule:

LOCATION AND NUMBER OF SIGNS	MATERIAL	HEALTH	FLAMMABILITY	REACTIVITY	SYMBOL
Provide one sign at chemical pump and storage location	Sodium Hypochlorite	3	0	1	COR

## 2.3 MISCELLANEOUS SAFETY SIGNAGE

A. Safety signs shall comply with the following standards:

1. Occupational Safety and Health Administration (OSHA), Standards for General Industry, Subparts 1910.200 Hazard Communication (July, 1986).
2. National Fire Protection Association (NFPA) Standard No. 704 - Label System.
3. Uniform Fire Code, Latest Edition.
4. Uniform Fire Code Standard 79-3.

B. Safety signs shall be of height and width required by layout and shall be formed from semi-rigid butyrate, polyethylene or fiberglass. Lettering shall be 3-inches high and 1/2-inch in stroke.

C. Provide the following safety signs:

LOCATION AND NUMBER OF SIGNS	TEXT	BACKGROUND COLOR	LETTERING COLOR
Provide one at each eyewash safety shower location	SAFETY SHOWER/ EYEWASH	Green	White
Provide one at each above-grade motorized equipment location	CAUTION: EQUIPMENT STARTS AUTOMATICALLY	Yellow	Black
Provide one sign at each MCC and high-voltage switchboard location	DANGER: HIGH VOLTAGE	White	Black



## 2.4 EXIT SIGNS

- A. Material: Plastic, 1/8-inch minimum thickness.
- B. Lettering: 6 inches high, 3/4-inch stroke, white letters on red background.

## 2.5 IDENTIFICATION LABELS

- A. Pipe Labels and Flow Direction Arrows:
  - 1. Label, Lettering Color, Size and Placement: In accordance with ANSI A13.1, and as listed below.
  - 2. Label Colors:

<b>Fluid Service</b>	<b>Background Color</b>	<b>Letter Color</b>
Fire quenching fluids	Safety red	White
Toxic and corrosive fluids	Safety orange	Black
Flammable fluids	Safety yellow	Black
Combustible fluids	Safety brown	White
Potable, cooling, boiler feed, and other water	Safety green	White
Compressed air	Safety blue	White

- 3. Label Size:

<b>Outside Diameter of Pipe Covering, inches</b>	<b>Length of Color Field, inches</b>	<b>Size of Letters, inches</b>
3/4 to 1-1/4	8	1/2
1-1/2 to 2	8	3/4
2-1/2 to 6	12	1-1/4
8 to 10	24	2-1/2
Over 10	32	3-1/2

- 4. Label Placement:
  - a. Labels shall be positioned on the pipes so they can be easily read. Proper label placement is on the lower side of the pipe if the employee has to look up to the pipe, on the upper side of the pipe if the employee has to look down towards the pipe, or directly facing the employee if on the same level as the pipe. Labels should be located near valves, branches, where a change in direction occurs, on entry/re-entry points through walls or floors, and on straight segments with spacing between labels that allows for easy identification.
- 5. Material: Manufacture from or encase in outdoor grade plastic or vinyl that will resist damage or fading from washdown, sunlight, mildly corrosive atmosphere, dirt, grease, and abrasion.
- 6. Message: See Piping Schedule.
- 7. Labels:
  - a. Snap-Around Type: Size for finished outside diameter of pipe and insulation.
  - b. For 6 Inches and Over Diameter Pipe: May furnish strap-on type fastened without use of tools with plastic or stainless-steel straps.
  - c. Firmly grip pipe so labels remain fixed in vertical pipe runs.
- 8. Manufacturers and Products:
  - a. T & B/Westline, Rariton, NJ, Model WSS Snap-Around.
  - b. Seton Name Plate Corp., New Haven, CT, Setmark Series.

- c. Or equal.
- B. Equipment Labels:
  - 1. Applies to equipment with assigned tag numbers wherever specified.
  - 2. Lettering: Black bold face, 3/4-inch minimum high.
  - 3. Background: OSHA safety yellow.
  - 4. Materials: Either of the following:
    - a. Aluminum or stainless-steel base with a baked-on finish that is suitable for use on wet, oily, exposed, abrasive, and corrosive areas.
    - b. Fiberglass with fiberglass-encased lettering.
  - 5. Furnish 1-inch margin on each end of label for mounting. On fiberglass labels furnish grommets at each end for mounting.
  - 6. Size:
    - a. As appropriate for lettering provided.
    - b. Provide same-size labels for equipment series which are adjacent.
  - 7. Message: Equipment names and tag numbers as used in Sections where equipment is specified and/or on Drawings.
  - 8. Manufacturers and Products:
    - a. T & B/Westline Co., Rariton, NJ; Type KQ.
    - b. Seton Name Plate Corp., New Haven, CT; Style EB.
    - c. Or equal.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION OF SIGNS**

- A. Install Fire Extinguisher location signs at all fire extinguisher locations, approximately 12" above fire extinguisher mounting bracket.
- B. Install Exit Signs mounted to each door which leads to the outside of the building, on the panic bar side of the door, mounted to the door approximately 5'-6" above finished floor.
- C. Install all other signs at locations as shown on the drawings. Signs should be installed approximately 5'-6" off of finished floor, attached to doors where appropriate. Where two signs are indicated in the same location, signs should be mounted side-by-side, where possible.
- D. Install all signs plumb and level. They shall be attached with four stainless steel screws or anchor bolts as required for substrate. Provide theft/tamper-resistant fasteners on all signs.

#### **3.2 INSTALLATION OF PIPE IDENTIFICATION LABELS**

- A. Provide pipe identification label with flow arrows on all exposed piping systems as follows:
  - 1. At all connections to equipment, valves, tees or wall penetrations.
  - 2. At intervals along piping not greater than 18 feet on center with at least one label applied to each exposed horizontal and vertical run of pipe.
- B. Install pipe identification labels after all painting has been completed.

### 3.3 INSTALLATION OF EQUIPMENT IDENTIFICATION LABELS

- A. Install equipment identification labels on all equipment which has been given an equipment number in the Drawings or Specifications. Provide identification label which includes equipment name and tag number.
- B. Where no damage will be caused to equipment, mount equipment identification label directly to equipment. Otherwise, mount equipment identification labels to concrete equipment base or wall space. Install equipment identification label such that it is clear which piece of equipment is being labeled.
- C. Anchor to equipment or base for easy removal and replacement with ordinary hand tools.

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**SECTION 10520**  
**SAFETY EQUIPMENT**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Scope:
  - 1. The following safety equipment is to be provided and installed by CONTRACTOR so that it may be integrated into OWNER's safety program for operation of the facility into which it is installed.
  - 2. The following safety equipment does not represent a complete package of safety equipment required to operate the facility. Refer to OWNER's safety program for all required safety equipment and procedures.

**1.2 SUBMITTALS**

- A. Shop Drawings: Provide manufacturer's product data for each item including sizes, ratings, UL listings, OSHA certifications or other certifications, and mounting/installation information.
- B. Warranty: Provide manufacturer's 5-year warranty on all products provided.

**1.3 PRODUCT DELIVERY, STORAGE, AND HANDLING**

- A. Protect all equipment provided from all damage until such time as it is turned over to the OWNER.
- B. Safety equipment provided under this specification shall not be used by the CONTRACTOR in the construction of the facility. Safety equipment shall be turned over to the OWNER in new condition.

**PART 2 - PRODUCTS**

**2.1 FIRE EXTINGUISHERS**

- A. Provide at all locations labeled "FEXT" on Drawings.
- B. Provide Fire Extinguishers which Conform to NFPA-10 and as follows:
  - 1. Tri-class dry chemical extinguishing agent.
  - 2. Pressurized, red enameled steel shell cylinder.
  - 3. Activated by top squeeze handle.
  - 4. Agent propelled through hose or opening at top of unit.
  - 5. For use on A, B, and C class fires.
  - 6. Minimum UL Rating: 4A:60B:C, 10-pound capacity.
- C. Mounting Hardware:
  - 1. Furnish heavy-duty brackets with clip-together strap for wall mounting.
  - 2. Use all stainless steel fasteners for attaching brackets to wall.

- D. Manufacturers:
  - 1. Walter Kidde
  - 2. Master Protection Enterprises
  - 3. Or Equal

## 2.2 FALL PROTECTION EQUIPMENT

- A. Hatch Safety Net:
  - 1. Standards:
    - a. Comply with all applicable OSHA, UL, ANSI and other applicable standards.
      - 1) Including, but not limited to, OSHA 1926.502(c), safety net systems
  - 2. General Purpose:
    - a. Designed to allow visual inspection and wash down of confined space through net while preventing falls into open hatches. Designed to be easily removed for confined space entry once entrant is properly harnessed and utilizing proper retrieval system.
  - 3. Features:
    - a. Materials:
      - 1) Metallic parts shall be Aluminum and/or stainless steel
      - 2) Netting shall be UV-resistant, highly visible synthetic netting (polyester, or equal) in safety orange or safety yellow.
      - 3) Netting shall be stitched with UV-resistant PTFE thread.
    - b. Netting shall have approximately 4-inch openings to allow for visual inspection and wash-down through netting.
  - 4. Manufacturer and Product:
    - a. U.S. Netting, Hatch Net 121
    - b. U.S.F. Fabrication, Hatch Safety Net
    - c. Or equal
- B. Fall Protection Grating:
  - 1. Standards:
    - a. Comply with all applicable OSHA, UL, ANSI and other applicable standards including, but not limited to, OSHA 29 CFR 1910.23.
  - 2. General Purpose:
    - a. Designed to allow visual inspection and wash down of confined space through grating while preventing falls into open hatches.
    - b. Designed as a factory installed option to be easily opened for confined space entry once entrant is properly harnessed and utilizing proper retrieval system.
  - 3. Features:
    - a. Materials:
      - 1) Metallic parts shall be Aluminum and/or stainless steel.
      - 2) Fiberglass grating panel.
    - b. Fiberglass grating panel shall be equipped with lift assistance and automatic hold-open arm for ease of operation and user safety.
    - c. Fiberglass grating panel shall operate independently of the access cover.
    - d. Fall protection grating shall be rated for 300 psf.
  - 4. Manufacturer and Product:
    - a. The Bilco Co
    - b. Or equal
- C. Portable Davit Arm Retrieval System:
  - 1. Standards:
    - a. Comply with all applicable OSHA, UL, ANSI and other applicable standards.

2. General Purpose:
  - a. Designed to retrieve an entrant into a confined space using a standard personnel harness system.
3. Features:
  - a. 60-inch high center post with winch mounting assembly
  - b. Allows for either 18" or 24" reach on offset arm
  - c. Weight rating of 350 lbs
  - d. Safety factor of 10: 1
4. Accessories:
  - a. Winch
    - 1) Designed to attach to a person that is entering or exiting from a confined space.
    - 2) Built with an internal braking system to prevent the accidental pay out of line, as well as a back-up locking pawl system to prevent "free-wheeling" of the winch.
    - 3) Cable extension (payout) should occur ONLY when the handle is turned counterclockwise AND a force of AT LEAST 10 lbs. (4.5 kg.) is applied to the line.
    - 4) The winch frame back plate attaches to a mounting plate which can then be mated to the Portable Davit Arm Retrieval System. Coordinate winch and Portable David Arm Retrieval System.
    - 5) Weight rated to 350 lbs.
    - 6) 10: 1 safety factor
    - 7) 5.5: 1 gear ratio single speed drive
    - 8) Retrieval rate of 23 feet per minute
    - 9) Continuous braking drive prevents free wheeling
    - 10) Double pawls on friction brake provide back-up safety
    - 11) Low wear, high temperature brake pads
    - 12) Anti-friction drive bearings
    - 13) Three permanent wraps of cable on the drum
    - 14) Level wind springs to prevent loosening of cable lays
    - 15) Slip clutch drive to prevent back-winding of cable drum
    - 16) Galvanic zinc coating of all metal parts
    - 17) Double action locking swivel snap hook
    - 18) Provide with 70 feet of stainless-steel cable
5. Flush Floor Mounted Davit Sleeve:
  - a. Provide flush floor mounted davit sleeve by same manufacturer as davit crane.
    - 1) Sleeve shall be designed specifically for davit crane and shall allow for full functionality and load rating of crane
    - 2) Sleeve and anchor bolts shall be stainless steel
    - 3) Sleeve to be designed for installation in concrete after concrete placement by core drilling a hole in the concrete and bolting sleeve to concrete floor using stainless steel chemical anchors, per manufacturer's instructions.
    - 4) Provide stainless steel debris cap with sleeve.
6. Manufacturer and Product:
  - a. Davit Crane: T.A. Pelsue Company, Model PNUH1824, or equal
  - b. Winch: T.A. Pelsue Company, Model PLPS806MR-70, or equal
  - c. Davit Sleeve: T.A. Pelsue Company, Model PNUS102B-SS, or equal
  - d. Debris Cap: T.A. Pelsue Company, Model PNUS106-SS, or equal

## 2.3 LIFE PRESERVERS

- A. General: Life preservers shall be Coast Guard and SOLAS approved and designed and manufactured in accordance with 46 CFR 160.
- B. Features:
  - 1. Materials: Designed for outdoor storage and use in a corrosive environment. Made from high impact linear low-density polyethylene
  - 2. Size: 30-inch diameter
  - 3. Color: Orange
  - 4. Buoyancy: Must be such that the life preserver can support a minimum of 22-pounds for up to 48 hours in fresh Water
  - 5. Lettering: "LIFE PRESERVER" painted on in black letters, 3 inches high
- C. Manufacturers and products:
  - 1. Datrex: Model DX0300D
  - 2. Or equal

## **PART 3 - EXECUTION**

### 3.1 INSTALLATION

- A. Install all safety equipment per manufacturers written instructions.
- B. Install fire extinguishers where "FEXT" is called out on the drawings, 48" above finished floor or adjacent grade.

+ + END OF SECTION + +



## SECTION 11200

### VERTICAL TURBINE PUMPS

#### **PART 1 - GENERAL**

##### **1.1 DESCRIPTION**

- A. Scope: Provide all materials, equipment, and accessories necessary to furnish and install multi-stage vertical turbine pumps, complete and operational with drivers, suction barrels, anchor bolting systems, and variable frequency drives where specified.
- B. The following equipment numbers have been assigned to the equipment that shall be provided. See attached pump and motor data sheets for detailed descriptions:
  - 1. Booster Pump Station
    - a. WD24\_PUMP\_54100
    - b. WD24\_PUMP\_54200
    - c. WD24\_PUMP\_54300
    - d. WD24\_PUMP\_54400

##### **1.2 QUALITY ASSURANCE**

- A. Reference Standards: Comply with requirements and recommendations of the following references, except as otherwise specified:
  - 1. Hydraulic Institute (HI)
  - 2. American Water Works Association (AWWA)
  - 3. National Electric Code (NEC)
  - 4. National Electrical Manufacturers Association (NEMA)
  - 5. Institute of Electrical and Electronic Engineers (IEEE)
  - 6. American Gear Manufacturers Association (AGMA)
  - 7. American National Standards Institute (ANSI)
  - 8. ASTM International (ASTM)
  - 9. Anti-Friction Bearing Manufacturers Association (ABMA)
  - 10. American Petroleum Institute (API)
- B. Quality Certification: Manufacturer supplying equipment furnished under this section shall hold current ISO 9001 certification.
- C. Unit Responsibility: All equipment specified herein shall be coordinated and provided by the pump manufacturer. Manufacturer assumes full responsibility for coordination of all components.
- D. Factory Tests: The selected manufacturer shall provide the following factory tests for approval upon acceptance of shop drawings:
  - 1. Provide the ENGINEER with 2-weeks advance notification in writing of the test schedule. The CONTRACTOR is advised that the factory tests may be witnessed by the OWNER and/or ENGINEER.
  - 2. Provide manufacturer's standard functional test on all equipment.
  - 3. Performance Test:
    - a. Conduct on each pump in conformance with the test standards and procedures specified in the Hydraulic Institute Standards and ANSI/AWWA E101.

- b. Conduct the test using complete pump bowl assembly at manufacturer's minimum submergence, from shut-off head to maximum capacity. Record resulting curve showing head, flow, brake horsepower, speed, pump efficiency, and net positive suction head required (NPSHr). Plot results for a minimum of seven (7) evenly spaced measurements, including shut-off head, primary design point, best efficiency point, and maximum capacity.
  - c. Pump performance results compared to rated speed and capacity at the primary design point shall be within tolerances specified by Hydraulic Institute Standards.
  - d. Pumps shall not be shipped prior to ENGINEER's approval of test results.
  - 4. Hydrostatic Test: test discharge heads and bowl assemblies at either twice the total dynamic head or one and a half times the shutoff head, whichever is greater.
  - 5. Motor Test: Provide short commercial motor test per IEEE 115.
- E. Warranty:
- 1. Provide a 1-yr warranty on all equipment from date of start-up. Warranty shall cover defects in workmanship, design, and materials. If any component should fail during the warranty period, it shall be corrected and the unit restored to service at no expense to the OWNER.

### 1.3 SUBMITTALS

- A. Submit the following items to the ENGINEER for approval:
- 1. Shop drawings:
    - a. Detailed drawings showing component and assembly dimensions, location of mechanical and electrical connections, weights of all equipment, installation details, and accessory details.
    - b. Power and control wiring diagrams, including terminals and numbers.
    - c. Drawings, templates and directions for installation of anchor bolts.
  - 2. Product data:
    - a. Descriptive literature, specifications, and engineering data.
    - b. Materials of construction for all components and accessories.
    - c. Impeller type and diameter, including rated diameter and minimum and maximum diameter available for the pump model.
    - d. Pump weight, motor weight, and complete assembly weight.
    - e. Complete motor nameplate data, as defined by NEMA.
    - f. Where specified, complete variable frequency drive information.
    - g. Factory finish system description.
    - h. Critical speeds of the pumps supplied.
    - i. Motor data:
      - 1) Test results
      - 2) Motor manufacturer
      - 3) Type
      - 4) Enclosure
      - 5) Service Factor
      - 6) Phase
      - 7) Voltage
      - 8) Rated Horsepower
      - 9) Speed
      - 10) Full load and locked rotor amperage
      - 11) Temperature rating
      - 12) Estimated bearing life under design conditions.
      - 13) Minimum efficiency at  $\frac{1}{4}$ ,  $\frac{3}{4}$ , and full load.
      - 14) Descriptive literature including description of motor insulation.

3. Performance data:
    - a. Pump rated speed.
    - b. Rated and maximum pump horsepower, and driver horsepower.
    - c. Casing working pressure.
    - d. Minimum submergence.
    - e. Maximum down and up thrust.
    - f. Efficiency and NPSHr at each specified operating condition.
  4. Submit Pump Performance Curves:
    - a. Provide pump curves showing head, brake horsepower, pump efficiency, and NPSHr and capacity, for the entire operating range of the pump.
    - b. Correct curves for pump losses and shaft friction horsepower losses. Include pump losses, column and discharge head losses.
    - c. All curves shall clearly display the specified operating conditions and the manufacturers Allowable Operating Region (AOR) and Preferred Operating Region (POR) as defined under ANSI/HI 9.6.3.
    - d. Where variable speed drives are specified, curves shall have at least five (5) speeds plotted between maximum and minimum speed.
    - e. Speed shall be clearly shown on all curves.
  5. Manufacturer's Certificate of Proper Installation.
  6. Operations and Maintenance Manuals: The selected manufacturer shall provide six sets of operation and maintenance manuals for the equipment provided. The manuals shall contain the following information at minimum:
    - a. Equipment description.
    - b. Recommended and limiting operational range.
    - c. Installation instructions including assembly, alignment, and adjustment procedures.
    - d. Operation instructions including start-up and shutdown procedures, and troubleshooting guide.
    - e. Lubrication and regular maintenance instructions.
    - f. Shop drawings.
    - g. Parts list with catalog numbers.
    - h. Performance curves.
- B. Quality Control Submittals:
1. A list of any and all instances where the equipment proposed deviates from these specifications.
  2. Names and addresses of the factory authorized service organization nearest to project site.
  3. Guarantee pump efficiency and NPSHr at the specified operating points.
  4. Upon approval of shop drawings, manufacturer shall provide certified copies of factory test reports for functional, performance and hydrostatic tests as specified.
  5. Upon approval of shop drawings, manufacturer shall provide printed installation instructions.

#### 1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. All equipment and accessories shall be properly protected during shipment such that no damage or deterioration shall occur between shipment and installation.
1. Finished surfaces shall be protected by wooden blanks.
  2. Finished ferrous metal surfaces not painted shall be protected from corrosion.
  3. Each box and package shall be clearly marked with the contents and total weight.

- B. Factory assembled parts and components shall not be dismantled for shipment until permission is received in writing from the ENGINEER.
- C. Manufacturer shall provide any special storage and handling instructions.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL**

- A. Provide pumps with performance curves with constantly increasing head from maximum capacity to shut-off head.
- B. Pumps shall rotate counter-clockwise when viewed from above.
- C. Balancing: Pump assemblies shall be dynamically and statically balanced. Vibration at any point of pumps operation shall not exceed the upper limits of the Hydraulic Institute Standards.

### **2.2 PRODUCT AND MANUFACTURER:**

- A. Weir Floway (Basis of Design):
  - 1. Model 16DKL/N, 2 Stage, 10.38-in impeller diameter
- B. Fairbanks Morse
- C. Flowserve
- D. Or Equal

### **2.3 SERVICE CONDITIONS AND PERFORMANCE**

- A. See attached data sheets for service conditions and performance requirements.
- B. Pumps shall have capacity no less than 98% and no greater than 103% of the specified capacity at each of the total dynamic head operating conditions shown.

### **2.4 COMPONENTS**

- A. Coatings:
  - 1. Exterior of discharge head and motor shall be painted desert color. Prepare surfaces to be painted per coating manufacturer's requirements.
    - a. Primer: 2 coats polyamidolamine epoxy, 4-6 mil thickness
      - 1) Series N69, Hi-Build Epoxoline II
      - 2) Or Equal
    - b. Polyurethane: 1 coat Aliphatic Acrylic Polyurethane designed for exterior weathering, abrasion and corrosion resistance, 2-3 mil thickness
      - 1) Series 73, Endura-Shield
      - 2) Or Equal
  - 2. All wetted ferrous metal surfaces, including interior and exterior of suction barrel, exterior of bowl assembly, interior and exterior of column, and interior of discharge head shall be coated with an ANSI/NSF STD 61 approved bonded epoxy, minimum

thickness 8-10 mils. Prepare surfaces to be painted per coating manufacturer's requirements.

a. Coatings:

- 1) Tnemec Pota-Pox Plus Series N140
- 2) Or Equal

B. Fasteners: Provide Type 316 stainless steel fasteners, bolts, nuts and washers conforming to ASTM A276 where exposed to liquid and where fasteners contact tapped holes.

C. Suction Flange:

1. Material: Fabricated steel conforming to ASTM A36 & A53.
2. Location: below grade on suction barrel.
3. Flange rating shall be ANSI 150# minimum.

D. Suction Barrel:

1. Fabricated steel conforming to ASTM A36 & A53.
2. Barrel shall have ¼-inch minimum wall thickness.
3. Suitable for encapsulation in concrete with mortar conforming to AWWA C205.
4. Flanged mount for discharge head assembly designed to withstand 150% of maximum operating thrust loads.
5. Manufacturer shall be responsible for verification of barrel dimensions to provide acceptable hydraulic conditions at column inlet and minimal vibration per ANSI/HI 2.3.
6. Barrel shall include internal guide vanes to prevent fluid rotation.
7. Barrel shall include four (4) leveling bolts for field leveling. Leveling bolt assembly shall include steel angles and nuts welded to the bottom-exterior of the suction barrel with steel bolts, or other method as approved by ENGINEER.
8. At minimum, suction barrel shall be sized to accept one inch larger diameter bowls and one additional stage.
9. Provide one suction barrel per pump, plus suction barrel for future pump.

E. Suction Bell:

1. Material: ASTM A48 Class 30.
2. Internal vanes shall be provided.

F. Column:

1. Material: Fabricated steel conforming to ASTM A36.
2. Flanged connections shall be provided at column section, bowl, and discharge head connections.
3. Provide O-ring seals at all flange connections.
4. Column section length shall be five (5) ft maximum.
5. Align and support lineshaft bearings.
6. Column diameter:
  - a. Outside diameter shall match standard pipe outside diameters as specified in ANSI B36.10
  - b. Columns 6-inch in diameter and less shall be at least Schedule 40
  - c. Columns 8-inch to 16-inch shall be at least Schedule 30
7. The column pipe shall be sized such that the friction loss will not exceed 5 feet per 100 feet, based on the rated capacity of the pump.

G. Bowl Assembly:

1. Bowls shall be cast iron conforming to ASTM A48, Class 30, with a minimum tensile strength of 30,000 psi.
  2. Interior of bowls shall be lined with porcelain enamel or abrasion resistant epoxy.
  3. Where specified, each bowl shall have thrust-balanced replaceable wear rings with side seal to prevent slippage.
    - a. Material shall be ASTM B505 aluminum bronze, composite, or stainless steel conforming to the requirements of API 610.
  4. Bolted flange connections shall be provided between bowls with O-ring seals.
  5. Bowl bearings shall be bronze conforming to ASTM B505, C93200
  6. Bowls shall be able to withstand the greater of twice the total head or one and a half times the shutoff head.
- H. Impellers:
1. Material: ASTM B584 C83800 bronze alloy.
  2. Enclosed or semi-open design.
  3. Securely fasten impellers to impeller shaft with Type 416 stainless steel tapered lock collets.
  4. Impellers shall be vertically adjustable using an adjustable spacer coupling accessible through the discharge head openings.
- I. Shaft
1. Material: 416 stainless steel conforming to ASTM 582
  2. Shaft sizing shall conform to ANSI/AWWA E101-88, and shall be of sufficient size to prevent excessive elongation and transmit required torque without distortion in both forward and reverse direction.
  3. Maximum combined shear stress shall not exceed 30% of the elastic limit in tension or be more than 18% of the ultimate tensile strength of the shaft material.
  4. Shaft shall have a first critical speed not less than 20% above maximum operating speed.
  5. A two-piece headshaft and solid intermediate line shaft shall be provided.
  6. Maximum section length shall be ten (10) feet.
  7. Minimum of two line shaft bearings shall be provided.
  8. Maximum spacing of bearing intervals shall be 5 feet.
  9. Line shaft couplings shall be ASTM 582 416 stainless steel, left-hand threaded type with perfect butt-fit. Couplings shall be designed with safety factor equal to 1.5 times the shaft safety factor.
  10. Shaft bearings shall be neoprene or bronze, lubricated by the pumped liquid.
- J. Shaft Seal:
1. Cartridge style mechanical seal with adjustable spacer coupling shall be provided in discharge head at terminus of lineshaft.
  2. Material:
    - a. Metal parts: 316 stainless steel.
    - b. Seal faces shall be tungsten carbide or sintered silicon carbide.
    - c. Elastomer bellows secondary seal.
  3. Manufacturer:
    - a. Environamics
    - b. Flowserve ISC Series
    - c. Crane
    - d. Or Equal
- K. Discharge Head Assembly:
1. Location: above grade

2. Assembly shall be of sufficient design to support the entire weight of pump assembly and NEMA rated driver and transmit all loads to the foundation with minimum vibration.
  3. Material: Fabricated steel conforming to ASTM A36 & A53 or cast iron conforming to ASTM A48 C30.
  4. Discharge head natural frequency shall be elevated above maximum operating speed.
  5. Discharge flange rating shall conform to AWWA C207 for fabricated steel, or ANSI B16.1 Class D 150# minimum for cast iron.
  6. Openings shall be screened to prevent access to rotating equipment.
- L. Mounting Plates:
1. Manufacturer shall provide all supporting sole plates and fabricated steel base plates necessary to properly mount the equipment.
- M. Equipment Identification Plate: 16-gauge stainless steel with the following information at minimum:
1. Equipment number.
  2. Manufacturer's model and serial number.
  3. Rated capacity and discharge head.
  4. Speed.
- N. Motors
1. Motors shall be solid shaft, squirrel-cage induction motors meeting the requirements of NEMA MG 1.
  2. Motor manufacturer shall be ISO9000 certified.
  3. Where variable frequency drives are specified, motor shall be inverter duty.
  4. Motors shall be adequately sized to prevent overload above nameplate horsepower at maximum pump brake horsepower.
  5. Motors shall have the following guaranteed minimum efficiencies at full load as determined by IEEE 112-B:
    - a. 100 hp and above: 92%
  6. Motors shall have minimum power factor of 87%.
  7. Totally Enclosed Fan-Cooled enclosures shall be provided.
  8. Provide thrust bearings with a minimum L-10 life of 30,000 hours, as defined by AGMA, at the worst operating condition.
    - a. Minimum L-10 bearing life at normal operating conditions shall be 60,000 hours.
  9. Manufacturer's recommended bearing lubrication shall be provided.
  10. Where specified motors shall be provided with normally closed thermostat switches.
    - a. Switch shall shutdown the motor upon exceedance of the motor's maximum temperature rating.
  11. Where bearing thermostat switches are specified, motor and bearing thermostat contacts shall be wired in series and leads shall be wired to the motor terminal box.
  12. Where specified motors shall be provided with 120V single phase space heaters wired to a terminal box.
  13. Where specified motors shall have a vibration switch with automatic alarm and shutdown limits.
    - a. Provide adjustable time delay to prevent nuisance trips.
  14. Provide oversized terminal box with terminal for connection of equipment grounding wire.
  15. Provide stainless steel nameplate with the following information, at minimum:
    - a. Manufacturer's name, make, and serial number
    - b. Type
    - c. Voltage

- d. Frame
- e. Insulation
- f. Class
- g. HP
- h. Full load amps
- i. RPM

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Factory TestS: Performed by Manufacturer in the presence of ENGINEER or OWNER, per Quality Assurance Section above.
- B. Manufacturer's representative shall inspect and approve the installation before operation.
- C. Installation Test: Performed by manufacturer's representative in the presence of ENGINEER or OWNER
  - 1. Functional test complete assemblies for proper alignment, connection, and operation.
  - 2. Vibration Test: Results shall not exceed Hydraulic Institute Standards recommendations.
    - a. Test from shut-off head to maximum capacity.
    - b. Units exceeding the vibration limit recommendations of the Hydraulic Institute Standards shall be adjusted or modified as necessary. Units which can not meet Hydraulic Institute Standards shall be replaced.
  - 3. Installation Performance Test shall be conducted in conformance with Hydraulic Institute Standards ANSI/HI 2.6-2000. Conformance with performance requirements shall be verified.
  - 4. Monitor bearing and motor temperatures during all tests and correct overheating if necessary.

#### **3.2 MANUFACTURERS SERVICES**

- A. Pump manufacturer shall provide the services of an authorized service representative for not less than four (4) days, for the following:
  - 1. One (1) day for installation assistance.
  - 2. Two (2) days for inspection of installation, start-up instruction, performance testing supervision, and adjustment assistance.
  - 3. One (1) day for training of OWNER's personnel.

+ + END OF SECTION + +



**Section 11212**  
**Pump and Drive Data Sheet**

<b>Project</b>	<b>West Side Tank and Pump Station Project</b>
<b>Equipment Numbers</b>	<b>WD24_PUMP_54100, _54200, _54300, _54400</b>
<b>Equipment Location</b>	<b>Booster Pump Station</b>
<b>Drive Description:</b>	
Drive Type	Pumps -100 & -300 VFD Pumps -200 & -400 Soft Starter (RVSS)
Motor	3 PH, 460V, 60 HZ
Motor Horsepower	250 hp
<b>Pump Description:</b>	
Pump Type	Canned Vertical Turbine
Bowl Size	16 in
Number of Stages	2, minimum
Suction Can Diameter	30 in
Suction Flange Size	24 in
Discharge Size	16 in
<b>Operating Conditions:</b>	
Liquid Pumped	Potable water
Temperature	50 to 80 degrees F, 60 deg average
Site Altitude	100 ft
<b>Pump Operating Conditions:</b>	
Pump Rated Speed	1770 rpm
Minimum NPSHa	33.8 ft
Minimum Continuous Stable Flow	925 gpm
Minimum Shutoff Head	320 ft
<b>Pump Design Points:</b>	
1 <sup>st</sup> Operating Point:	
Capacity (gpm)	3800 gpm
Total Dynamic Head (ft)	170 ft
Minimum Efficiency	80%
2 <sup>nd</sup> Operating Point:	
Capacity (gpm)	3000 gpm
Total Dynamic Head (ft)	200 ft
Minimum Efficiency	78%
3 <sup>rd</sup> Operating Point:	
Capacity (gpm)	1000 gpm
Total Dynamic Head (ft)	250 ft
Minimum Efficiency	35%
<b>Appurtenances:</b>	
Motor Winding Temperature Switch	Yes
Bearing Thermostat Switch	No
Vibration Transmitter	Yes
Wear Rings	Yes

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## SECTION 11268

### RESERVOIR HYDRODYNAMIC MIXING SYSTEM

#### **PART 1 - GENERAL**

##### **1.1 DESCRIPTION**

- A. The Hydrodynamic Mixing System (HMS) is defined as a supplemental system installed within a potable water storage reservoir which passively utilizes the energy provided by the inlet water supply (via pumped or gravity head) and generates a sufficient inlet momentum to achieve a complete homogeneous blending of the water volume within the reservoir with the inlet supply flow. Determination of Complete Homogeneous Blending shall be defined by the modeling requirements and supporting hydraulic analysis as conducted by each individual manufacturer for their specific system configuration as defined within these specifications. System submittals not providing this validation shall not be considered as a viable Hydrodynamic Mixing System (HMS) and shall not be accepted as an equivalent to this system specification.
- B. The specifications in this section include all components of the Reservoir Hydrodynamic Mixing System (HMS) consisting of flow manifold equipped with variable orifice duckbill inlet nozzles that are certified. The HMS manufacturer shall be responsible for designing the system in accordance with the hydrodynamic criteria defined within these specifications and submit design calculations verifying compliance in accordance with the submittal requirements. The following is a description of the Hydrodynamic Mixing System.
- C. All modeling and hydraulic and mixing calculations pertaining to the HMS shall originate from the duckbill valve manufacturer. Modeling and calculations provided by parties other than the duckbill valve manufacturer are not allowed.
- D. The complete Hydrodynamic Mixing System shall be supplied by the variable orifice nozzle manufacturer to maintain single source responsibility for the system. The complete system shall be defined as all piping and appurtenances within the tank downstream of the tank penetration. Appurtenances include pipe, fittings, horizontal and vertical pipe supports, expansion joints, variable orifice duckbill check valves, and any other equipment specified within this section of the specifications. Approved manufacturer is Tideflex Technologies, Carnegie, PA 15106.
- E. The following describes the design principles of the Hydrodynamic Mixing System and the validation of its effectiveness:
  - 1. To not have any horizontal piping that requires bracing to the tank shell other than at the bottom of the reservoir.
  - 2. To be passive operating and not require any outside energy source.
  - 3. To utilize the existing differential pressure between distribution system pressure and tank head to fill the reservoir thru the inlet nozzles.
  - 4. To achieve complete mixing via multiple turbulent inlet jets (Jet-induced mixing).
  - 5. To utilize variable orifice inlet nozzles that provides a non-linear jet velocity versus flow characteristic. This maximizes the inlet momentum at all flow rates. The inlet momentum is the kinetic energy solely responsible for mixing. This also

ensures the rise height of negatively buoyant inlet jets will be maximized when the inlet water is colder than the tank water.

6. To have less than ten (10) inlet ports.
7. To have inlet ports that discharge an elliptically shaped jet that provides faster mixing and dilution of the inlet water into the tank water.
8. To have a configuration based on Computational Fluid Dynamics (CFD) modeling, conducted by the manufacturer, of a similar configuration in the same tank style.
9. To have multiple sampling studies conducted by water utilities that have conducted "before" and "after" spatial sampling of disinfectant residual and/or temperature that have proven the effectiveness of the HMS. Data can be submitted based upon the request of the engineer.

## 1.2 SUBMITTALS

### A. Independent CFD Modeling Validation

1. The mixing system designer/supplier must supply data or report from at least one project where an independent company conducted CFD modeling on their mixing system design and the modeling results verified the design achieved complete mixing.

### B. Full Scale Tracer Study Validation

1. The mixing system designer/supplier must supply data or report from at least one project where a full scale tracer study using calcium chloride was conducted on a circular reservoir and the tracer study results verified the mixing system design achieved complete mixing.
2. The mixing system designer/supplier must supply data or report from at least one project where a full scale tracer study using calcium chloride was conducted on an elevated tank and the tracer study results verified the mixing system design achieved complete mixing.

### C. Tideflex Inlet Nozzle and Waterflex Outlet Valve Testing and Validation

1. Verification of independent hydraulic testing to determine headloss and jet velocity characteristics on a minimum of eight (8) sizes of duckbill valves ranging from 2" through 48". The testing must include multiple constructions (stiffness) within each size and must have been conducted for free discharge (discharge to atmosphere) and submerged conditions.
2. Verification of Independent Laboratory Testing for Manufacturing Consistency - the duckbill valve manufacturer shall provide summary documentation of a report conducted by an Independent Laboratory for hydraulic testing where multiple duckbill valves (at least four) of the same size and construction (stiffness) were tested to validate the submitted headloss characteristics and to prove the repeatability and consistency of the manufacturing process to produce the same hydraulic characteristics.
3. Report of independent testing that studied the flow distribution characteristics of duckbill valves installed on multiport manifolds. The manufacturer must have been in the business of manufacturing duckbill valves at the time the report was published.
4. Verification of Finite Element Analysis (FEA) of duckbill valves. The duckbill valve manufacturer shall provide summary documentation of Finite Element Analysis modeling on representative duckbill nozzle sizes to determine deflection, stress and strain characteristics under various load conditions. Modeling must have been done for flowing conditions (positive differential pressure) and reverse differential pressure.

5. Verification of independent hydraulic testing to determine headloss characteristics on a minimum of three (3) sizes of perforated disc/elastomeric membrane check valves ranging from 6" through 36". Testing must have been conducted with and without the membrane installed. At least two (2) sizes shall have tested two (2) different membrane thicknesses.
  6. Verification of Finite Element Analysis (FEA) modeling on a perforated disc/elastomeric membrane check valve to determine stress and deflection characteristics under reverse differential pressure.
- D. Validation of Long-term performance
1. The mixing system designer/supplier must supply at least one inspection report showing proper operation of, and no deterioration of, the duckbill valves after being in service in a water storage tank mixing application for a minimum of 10 years.
- E. ANSI/NSF 61 Certification
1. Copy of the Certified listing for the valves used in the Hydraulic Mixing System (HMS).
  2. The valves themselves must be NSF61 certified, not just the elastomer used in construction of the valves. NSF61 approved/certified materials will not be accepted in lieu of valve certification.
  3. The NSF61 Certification for the valves must be for a minimum volume of 2,000 gallons. Valves with NSF61 Certification for minimum volume of greater than 2,000 gallons are not acceptable.
- F. Test Report on Elastomer Exposure to Chlorine and Chloramine
1. Copy of test report from an accredited independent laboratory that confirmed there is no degradation in the elastomer when exposed to chlorine and chloramine per the ASTM D471-98 "Standard Test Method for Rubber Property – Effect of Liquids."
- G. System Installation Drawings
1. The HMS manufacturer shall be responsible for providing engineering installation drawings of the complete manifold piping system as supplied by the manufacturer. These drawings shall include plan view piping arrangement, sections and elevations as required, support bracket installation details, duckbill nozzle orientation details, and all dimensions required for locating the system within the specified dimensions of the tank.
- H. Design Calculations
1. All Design Calculations, curves, and reference information listed below must originate and be submitted by the duckbill valve manufacturer. Calculations, curves, and reference information provided by contractors relating to the HMS are not allowed. The duckbill valve manufacturer must include within the submittal package the following design calculations, curves, and reference information:
  2. Calculations showing the fill time required, under isothermal conditions, for the HMS system to achieve complete mix of the reservoir volume at minimum, average and peak fill rates. Complete mixing defined as 95% homogenous solution. The theory and equations used in calculating the mixing times must be from a published AWWA reference manual or paper. The reference document(s) must be submitted with the equations and calculations.
    - a. Calculations showing the water level drawdown required to achieve complete mixing on the fill cycles at minimum, average, and peak flow rates.

- b. Calculations of average storage tank water age for both fill-then-draw, and simultaneous fill and draw scenarios. Theory used in calculating water age must be submitted with the calculations.
- c. A representative Computational Fluid Dynamics (CFD) model evaluation of the proposed HMS system configuration applied within a reservoir of similar geometry. Model output documentation shall include all design variables applied for the simulation, plot of the 3-D geometry showing the mesh definition, velocity magnitude vector and contour plots at different cross-sections throughout the water volume, simulated tracer animations showing the spatial and temporal distribution of inlet water in real time during the fill cycle.
- d. Hydraulic calculations showing the resulting jet velocities of each inlet nozzle at minimum, average, and peak fill rates.
- e. Hydraulic calculations showing the flow distribution among all inlet ports at minimum, average, and peak fill rates.
- f. Manifold hydraulic calculations showing the total headloss of the HMS at minimum, average, and peak fill and draw rates. Headloss shall include all minor losses and headloss of nozzles and outlet check valves.
- g. Hydraulic curves showing thrust vs. flow for the inlet nozzles.
- h. Hydraulic curves for each outlet check valves showing headloss vs. flow.
- i. Calculations showing the terminal rise height of the jets that discharge at an angle above horizontal. The terminal rise height shall be calculated assuming 10°F and 20°F colder inlet water and calculated at minimum, average and peak fill rates. The theory and equations used to calculate the terminal rise height shall be included.
- j. Hydraulic curves for each inlet nozzle of Densimetric Froude number vs. flow
- k. If the calculations and supporting data provided do not show compliance with the hydrodynamic requirements of the system as interpreted by the Engineer or Owner then the submittal shall be rejected.

### 1.3 INSTALLATION, OPERATION AND MAINTENANCE MANUALS

- A. The manuals shall be in the following format and include the listed required information as a minimum:
  - 1. Enclosed in a 3-ring binder with project title and system designation shown on the front cover and side binder.
  - 2. Table of contents
  - 3. Copy of design calculations for the manifold system as defined in the previous section.
  - 4. Copy of complete set of the installation plans.
  - 5. Copy of Certified Listing for the valves
  - 6. Parts and equipment list with specification numbers for ordering of replacement parts.
  - 7. Product specification sheets for nozzles, expansion joints, concrete anchors, and any other specialized items supplied with the system.
  - 8. Installation guidelines for the HMS manifold system.
  - 9. Operational procedures for the HMS manifold system.
  - 10. Guidelines for repair of system components.
  - 11. Schedule for suggested periodic maintenance of the manifold system.

### 1.4 DELIVERY, STORAGE, AND MATERIAL HANDLING

- A. Individual nozzles shall be packaged separately from the piping equipment.

- B. All flanges shall be protected by using plastic inserts or plank wood, pipe sections are to be fully supported to prevent pipe deflection or damage to fittings or connections.
- C. All equipment shall be shipped on pallets capable of fully supporting the pipe sections across their entire length. Pallets should be accessible for fork lift transport or strap and hoist means without causing any load to the pipe equipment.
- D. All stainless steel components shall be stored separately away from any carbon steel components or other materials that could stain or deface the stainless steel finish from run-off of oxidized ferrous materials.
- E. All pipe equipment should be covered and stored in areas free from contact with construction site sediment erosion to prevent accumulation of materials within the pipe and fittings.
- F. Duckbill nozzles should be protected from contact with rigid objects during handling and storage. The contractor shall be responsible for replacing any duckbill nozzles or elastomeric components that are damaged after arrival on the site through installation and start-up of the system.

## **PART 2 - PRODUCTS**

### **2.1 VARIABLE ORIFICE DUCKBILL INLET NOZZLES**

- A. Inlet ports/nozzles shall be duckbill-style check valves that allow fluid to enter the reservoir during fill cycles and prevent flow in the reverse direction through the nozzle during draw periods. Inlet ports/nozzles may not be fixed-diameter ports or pipes.
- B. Inlet ports/nozzles shall have a variable diameter versus flow hydraulic profile that provides a non-linear jet velocity versus flow characteristic and a linear headloss versus flow characteristic. The hydraulic characteristics of the duckbill valves shall be defined by "Hydraulic Code".
- C. The inlet ports/nozzles shall discharge an elliptically shaped jet. The nozzle must have been modeled by an independent laboratory using Laser Induced Fluorescence (LIF).
- D. Manufacturer shall have conducted independent hydraulic testing to determine headloss and jet velocity characteristics on a minimum of eight (8) sizes of duckbill valves ranging from 2" through 48". The testing must include multiple constructions (stiffness) within each size and must have been conducted for free discharge (discharge to atmosphere) and submerged conditions.
- E. Manufacturer shall have conducted an independent hydraulic test where multiple valves (at least four) of the same size and construction (stiffness) were tested to validate the submitted headloss characteristics and to prove the repeatability of the manufacturing process to produce the same hydraulic characteristics.
- F. Manufacturer shall have conducted independent hydraulic testing to study the flow distribution characteristics of duckbill valves installed on multiport manifolds.

- G. Manufacturer to have conducted Finite Element Analysis (FEA) on various duckbill valves to determine deflection, stress, and strain characteristics under various load conditions. Modeling must have been done for flowing conditions (positive differential pressure) and reverse differential pressure.
- H. Manufacturer must have conducted in-house backpressure testing on duckbill valves ranging from ¾" to 48".
- I. Manufacturer shall have at least fifteen (15) years experience in the manufacturing of "duckbill" style elastomeric valves.
- J. Manufacturer must have duckbill valves installed on manifold piping systems in at least 100 distribution system reservoirs.
- K. Manufacturer must have representative inspection videos showing the duckbill valves discharging water into the reservoir during an initial fill (unsubmerged). Manufacturer must also have representative underwater inspection videos showing the operation of the valves when submerged. Representative videos can be submitted upon request from the engineer.
- L. The duckbill style nozzles shall be one-piece elastomer matrix with internal fabric reinforcing designed to produce the required discharge velocity and minimum headloss requirements as stipulated in the Submittals section. The flange portion shall be an integral portion of the nozzle with fabric reinforcing spanning across the joint between the flange and nozzle body.
- M. The elastomer used in construction of the duckbill valves must have been tested by an accredited independent laboratory that confirmed there is no degradation in the elastomer when exposed to chlorine and chloramine per the ASTM D471-98 "Standard Test Method for Rubber Property – Effect of Liquids."
- N. The manufacturer's name, plant location, serial number and product part number which designates nozzle size, material and construction specifications shall be bonded onto the surface of the nozzle.

## 2.2 STAINLESS STEEL PIPE AND FITTINGS

- A. Stainless steel pipe and fittings shall conform to the associated standards.
- B. Dimensions for stainless steel fittings shall conform to AWWA C110, unless otherwise specified.
- C. Piping shall be Schedule 10s stainless steel 304L fabricated from material per ASTM-A240.
- D. All flanges shall be plate ring flanges. Flange drilling pattern shall be in accordance with ANSI B16.1/B16.5 standards.
- E. Ring flanges shall be continuously welded on both sides.
- F. All shop welds shall be manually scrubbed or brushed with non-metallic pads or stainless steel wire brushes to remove weld discoloration. Welds to be chemically passivated with nitric or citric acid.

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- G. Field welding of stainless steel pipe and fittings will not be allowed unless approved by the Engineer.

### **2.3 FLANGE GASKETS**

- A. Flange gaskets shall be full-faced and shall be in accordance with ASTM D1330.
- B. Flange gasket drilling pattern shall conform to ANSI B16.1/B16.5.
- C. Flange gaskets shall be 1/8" thick.
- D. Gasket material shall be EPDM.

### **2.4 FASTENERS**

- A. Hex head bolts and nuts shall be stainless steel 316 conforming to ANSI/ASME B18.2.1 and ANSI/ASME B18.2.2.

### **2.5 PIPE SUPPORTS**

- A. All components of the bracket assembly shall be stainless steel 304 in accordance with the associated standards.
  - 1. The bracket assemblies shall consist of four components:
  - 2. A base plate. For concrete tanks, the base plate will have four thru holes for expansion anchors.
  - 3. A top-works weldment that consists of structural channel and angle iron. The TMS piping shall rest on the angle iron. The angle iron has predrilled holes for the U-bolt.
  - 4. U-bolt with four hex nuts.
  - 5. An 1/8" thick EPDM strip with a length equivalent to the circumference of the pipe. The strip shall be placed between the pipe and the angle iron and U-bolt.
- B. The channel of the top-works weldment shall be field fit and modified to the required length. The channel shall then be field welded to the base plate.
- C. For concrete tanks, the support shall be anchored to the concrete floor with stud type expansion anchors, the pull-out rating of the combined anchors shall be a minimum of 10 times greater than the static weight of the vertical pipe section.

### **2.6 DRAIN**

- A. Provide a 1 inch drain on the inlet pipe 4-inches above where the TMS attaches to the tank floor. The drain shall have a ball corporation valve.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Installation of the manifold system shall be in accordance with the installation plans and guidelines provided by the HMS manufacturer and as specified in the installation section of the IOM manual. Refer to section on Submittals for quantities and delivery schedules of the documents.

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### 3.2 START-UP AND TESTING PROCEDURES

- A. The TMS manufacturer shall provide one (1) day start-up services by a factory representative to verify that the system has been installed in accordance with the design specifications and requirements listed within this section.

### 3.3 START-UP FLOW TESTING

- A. Following installation of the complete manifold piping system, the contractor shall open the upstream isolation valve to allow flow into the tank through the manifold system. The isolation valve must be opened slowly to prevent surge or over-pressurization of the manifold system. The isolation valve must be fully opened to inspect the flow characteristics of the manifold system.
- B. The contractor and factory representative shall visually inspect the entire piping system for leakage.
- C. The contractor and factory representative shall visually inspect all of the inlet nozzles to ensure flow is being discharged into the tank through all nozzles.

### 3.4 SPARE PARTS

- A. Spare parts are not required, unless otherwise specified.

### 3.5 WARRANTY

- A. The complete manifold piping system shall be supplied by the HMS manufacturer to maintain single source responsibility for the system. The complete system shall be defined as all piping and appurtenances within the tank downstream of the tank penetration. Appurtenances include pipe, fittings, horizontal and vertical pipe supports, expansion joints, duckbill valves, and any other equipment specified within this section of the specifications.
- B. All piping, pipe support brackets, joint connections, expansion joints, and anchors shall be warranted by the HMS manufacturer against failure under design conditions for a period on one (1) year from the date of final installation approval by the Engineer.
- C. Inlet nozzles shall be warranted by the manufacturer against failure under design operating conditions for a period of one (1) year from the date of final installation approval by the Engineer. Elastomer components damaged because of maintenance activities, foreign debris, or excessive exposure to direct ultraviolet and thermal radiation shall be excluded warranted coverage.

+ + END OF SECTION + +

## SECTION 11405

### CHEMICAL METERING PUMP SYSTEM

#### **PART 1 - GENERAL**

##### **1.1 DESCRIPTION**

- A. Work Included: This specification covers the supply and testing of completely functional, skid-mounted chemical metering pump systems. The chemical metering pump system shall include skid assembly containing chemical metering pumps, integral electric motors, controls, integral variable speed drives, valves, meters, control panels and all necessary piping, fittings, supports and accessories as shown on the Drawings and specified herein. The chemical metering pump system supplier shall be responsible for supplying all components of the skid-mounted chemical metering pump system.

##### **1.2 QUALITY ASSURANCE**

- A. A single metering pump system supplier shall be responsible for the assembly, supply and coordination of all equipment and appurtenances specified herein.
- B. System supplier shall provide reference list of no less than three installations where fully integrated chemical metering pump systems were provided.
- C. Provide a factory operational and performance test on the pre-assembled system and documentation of results prior to shipment.
- D. Provide operational and performance field test.
- E. Warranty: The chemical metering pump system supplier shall provide a two-year warranty on the metering pump mechanical drive and a one-year warranty on the liquid end, pump accessories, and the skid-mounted system.

##### **1.3 SUBMITTALS**

- A. Submittals shall be in accordance with Section 01330, Submittal Procedures.
- B. Shop Drawings:
1. Detailed metering pump diagram
  2. Control and power wiring diagrams
  3. Enclosure dimensions
  4. Connection point locations and sizes
  5. Skid mounting details
  6. Piping and fittings details
  7. Control panel dimensions, connection details, and wiring diagrams
  8. Location of all specified appurtenances
- C. Product Data:
1. Complete catalog information, descriptive literature, and specifications, including but not limited to the following:
    - a. Total assembly weight
    - b. Materials of construction

- 1) Confirmation that all wetted parts are compatible with specified service chemical
    - c. Control system details
    - d. Appurtenance details
    - e. Hydraulic calculations confirming pump sizing and range for service conditions
    - f. Documentation of accuracy over flowrate range specified herein
  - 2. Recommended spare parts list
  - 3. Complete motor nameplate data
  - 4. Factory finish system
  - 5. Complete O&M manual for each pump model and control system
- D. Quality Assurance Submittals
- 1. Factory operational and performance testing results
  - 2. System Suppliers certificate of compliance with these specifications

#### 1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. System supplier shall provide special shipping, handling, and storage instructions.

### **PART 2 - PRODUCTS**

#### 2.1 PRODUCT AND SYSTEM SUPPLIER: PROVIDE:

- A. BRAVO pre-engineered systems manufactured and marketed by SEEPEX INC.
- B. Or Equal

#### 2.2 SERVICE CONDITIONS AND PERFORMANCE

- A. Sodium Hypochlorite Metering Pump System
  - 1. Location: As shown on Drawings
  - 2. Equipment Identification Numbers:
    - a. Sodium Hypochlorite Pump No. 1: WD23\_PUMP\_54101
    - b. Sodium Hypochlorite Pump No. 2: WD23\_PUMP\_54102
  - 3. Service Chemical: 12.5% Sodium Hypochlorite
    - a. Specific Gravity: 1.2
    - b. Temperature: 50 to 90 deg F
  - 4. Flowrate Range:
    - a. 0.5 to 5.0 gallons per hour (gph)
  - 5. Rated Pressure: 100 psig
  - 6. Minimum NPSHa: 33 FT
  - 7. Piping/pump arrangement: See Drawings.

#### 2.3 SYSTEM ASSEMBLY

- A. System Design:
  - 1. Chemical Metering Pump System supplier shall provide completely assembled, skid-mounted Chemical Metering Pump Systems and include the following features:
    - a. Pumps shall be vertically mounted with pump drives and electronics located above the piping.
    - b. Shall be scalable to incorporate 1, 2, or 3 pumps as required.
    - c. Shall include removable drip pans with threaded drains (1/2" FNPT threaded)

- d. Specifically engineered to achieve the required structural strength using vacuum molded HWMPE, formed HWMPE sheet material and powder coated structural stainless-steel angle for critical support areas.
- e. The entire pump system shall be serviceable from the front of the system.
- f. Piping shall be secured to the system frame using KiwiBlock pipe supports or equal. Pipe Mounting system to incorporate the following features:
  - 1) Polypropylene mounting blocks with minimum tensile strength of 3800 psi and must be UV resistant.
  - 2) Blocks secured to system frame using two three #8-10 self-tapping screws constructed of stainless steel.
  - 3) Piping shall be secured to the piping brackets using two tie wraps each rated for 300 lbs. Tie wraps shall be cut using tie wrap gun to avoid sharp edges that pose a safety hazard.
  - 4) Pipe securing system shall not require access to the rear to replace or remove parts.
  - 5) Pipe mounting system shall incorporate UR rating to be suitable for securing electrical components in accordance with UL recommendations.
- 2. The Chemical Metering Pump Systems shall not include any loose-shipped parts. It shall be completely shop or factory assembled and shall require no field assembly other than field connections of piping and wire.
- 3. The Chemical Metering Pump System\ shall be designed in accordance with the Drawings, providing the shown inlet and outlet connections, features and appurtenances.

## 2.4 COMPONENTS

- A. General: All wetted materials shall be specifically selected for resistance to specified service chemical.
- B. Piping: CPVC conforming to ASTM D2846
  - 1. The piping of the feed system shall be constructed of schedule 80, solvent welded CPVC.
  - 2. All plumbing on the system must be hard piping.
  - 3. All fittings shall be socket welded and not threaded to prevent leaks
  - 4. Piping shall be in such a manner that unions will allow for all major components to be removed without the entire pipe assembly being removed
- C. Solvent welded connections:
  - 1. Squarely cut, deburred, externally beveled ends (10-15°)
  - 2. Connection shall have maximum depth into the socket portion of the welded joint.
  - 3. Pipe section must be solvent welded radially and axially against socket shoulder for maximum joint strength.
  - 4. Components to be rotated a minimum of 90° during insertion.
  - 5. Solvent welded connections shall be chemically prepared using Weld-On P-75 "Wet R' Dry" Primer or equal
  - 6. Joints shall be solvent welded within 30 seconds of primer application if not pipe must be re-primed prior to solvent welding.
  - 7. Joint pieces shall still be "wet" from the primer when cement is applied.
- D. Calibration column:
  - 1. Provide calibration column on the common suction header for each pump skid assembly.

2. Column shall be sized to run a minimum of 30 seconds at maximum flow rate.
  3. If the prescribed size of the calibration column exceeds 2,000 mL, a 2,000 mL column will be provided.
  4. The Calibration column assembly shall include a ball valve to isolate the calibration column from the chemical supply and a ball valve to isolate the chemical supply tank from the suction line.
  5. The Calibration column shall be constructed of clear and gray PVC and include sealed end caps.
  6. Provide threaded connection at top of column for connection to common vent.
  7. Pump system must include a means to fill calibration column when the tank level falls below the level of the calibration column.
    - a. In these instances, the pump may be used to actively fill the calibration column using pre-plumbed valves and piping.
  8. Calibration columns shall be sealed as manufactured by Griffco Valve or equal
- E. Ball valves: Provide ball valves for all shut-off, isolation, and flow control applications.
1. Features:
    - a. CPVC
    - b. True union integral union
    - c. FPM O-ring seals
    - d. Ball shall be drilled to relieve pressure from off-gassing
  2. Manufactures:
    - a. ASAHI Type 21 (true union)
    - b. Or Equal
- F. Metering Pumps:
1. WD23\_PUMP\_54101, WD23\_PUMP\_54102: Self-priming, positive displacement, progressing cavity type.
    - a. The system shall be a duplex configuration constructed with pumps in a Duty/Duty configuration.
    - b. The pumps shall be of the compact, close-coupled design that incorporates SEEPEX IMP metering pump controller or equal.
    - c. The integral pump controller shall be capable of varying pump performance throughout the entire operating range. The metering pump controller shall have IP65/ NEMA 4X for indoor use and include the following features:
      - 1) The metering pump controller shall be designed to work solely with the pump and motor to deliver up to 350: 1 speed performance and flow performance up to 1000: 1 without requiring encoders or blower cooling.
      - 2) Metering pump controller shall run on single phase power at 120 VAC or 230 VAC at 48-62 Hz. Frequency and voltage capability to be separate.
      - 3) The integral metering pump motor shall have IP55 certification and controller and motor shall be designed to maintain a constant torque of 8.75 lb. ft. from 20 to 600 RPM and constant power (up to 1.0 hp) from 600-1,800 RPM. The drive shall be capable of 5.0 lb. ft. at 10 RPM and 3.0 lb. ft. at 5 RPM.
      - 4) The metering pump controller system shall be able to produce a minimum of 18 lb. ft. of starting torque for a minimum of 15 seconds and 12 lb. ft. for 60 seconds. The drive shall be capable of operating at ambient temperatures of 50 to 90 degrees Fahrenheit without requiring derating.
  2. Pumping Equipment:
    - a. Rotor and Stator: Each pump shall be a minimum single-staged design employing a single helix rotor operating in a double helix stator.
      - 1) Convolutions configured to form a cavity between the rotor and stator

- 2) Cavity shall progress from the pump's inlet to discharge port with operation of the rotor
  - 3) A seal preventing leakage from the discharge back to the inlet shall be formed by the fit between the rotor and stator at the point of contact
  - 4) Stator shall be molded with a seal integral to the stator elastomer
  - 5) Separate gaskets or "O" rings are not permitted to form the seal
  - b. Rotor and Drive train: Shall be warranted for three years from the manufacturer regarding materials and workmanship
  - c. Joints: Each pump rotor shall be driven through a positively sealed and lubricated pin joint.
    - 1) Pin constructed of high speed steel, air hardened to 64 HRC
    - 2) Grease-lubricated joint with a high temperature (450° F)
    - 3) PTFE filled synthetic grease
    - 4) Covered with elastomeric sleeve
    - 5) Positively sealed with hose clamps
    - 6) Constructed of Hastelloy C, PVDF or 316ss
  - d. Casing: NPT connection shall be provided at both the inlet and discharge ports of the pump.
    - 1) 1" FNPT suction side
    - 2) ½" discharge side FNPT
    - 3) Casing constructed of CPVC
  - e. Bearings: each pump shall be provided with oil lubricated thrust and radial bearings designed for all loads.
  - f. Shaft seal: shaft seal be sealed using single-acting mechanical seal with atmospheric quench or double acting mechanical seals.
    - 1) Solid shaft through mechanical seal area
    - 2) Shaft shall be a two-part design allowing for removal of mechanical seal and all other wetted tool rotating parts without requiring disassembly of pump or gear motor bearings
    - 3) Silicon carbide faced seals, metal parts and elastomers to be compatible with sodium hypochlorite.
  3. Features:
    - a. The piping system must contain a vent for each pump or pump head with the following features:
      - 1) Vent must be located within 12" of the pump inlet
      - 2) Incorporate a minimum 2° angle
      - 3) Capable of being isolated to permit suction lift conditions
    - b. Pumps shall incorporate a run dry protection sensor to protect pump from running dry in event of inadequate chemical supply and include the following features:
      - 1) Integral drive and sensor shall be designed to work in coordination
      - 2) Factory tested to stop metering pump controller when there is fluid loss
      - 3) Universal sensor shall be compatible with Sodium Hypochlorite
      - 4) Sensor shall be compatible with conductive and non-conductive chemicals
  4. Products:
    - a. WD23\_PUMP\_54101, WD23\_PUMP\_54102:
      - 1) SEEPEX Series MD with NSF61 certification
      - 2) Or equal
- G. Pump Suction Side:
1. The suction lines on the feed system shall be designed with the following features:
    - a. Located as low as possible on the chemical feed system
    - b. Minimum 1" pipe size
    - c. Incorporate a fully ported ball valve

- d. Valve shall be able to be mounted on either side of the system
- 2. The suction inlet shall incorporate a ½" standpipe with the following features:
  - a. Isolation valve to purge entrapped vapor
  - b. Vapor shall be routed back to the top of the day tank during flood suction operation
  - c. Negate frictional losses associated with the flow in the piping from the day tank to skid inlet
  - d. Valve shall be able to be closed when suction lift is required
- H. Pump discharge side:
  - 1. The discharge lines terminating at the skid from each pump shall be ½" socketed union. Placement on feed system shall be exiting the top of the feed system.
  - 2. Discharge line to be plumbed so that an external relief valve discharges back to suction line.
  - 3. Line from pressure relief valve and back to suction side must include a section of clear PVC.
  - 4. Each discharge line will include a 160 psig gauge with a minimum of 2-1/2" face diameter and include the following features:
    - a) Liquid filled type with glycerin filled gauge protector
    - b) Polypropylene non-wetted parts
    - c) CPVC/PTFE wetted parts
    - d) Diaphragm separating wetted parts and non-wetted parts
    - e) Minimum full-scale accuracy of 1.5%
    - f) Gauge shall be OBS-M series by Trufo® or equal
- I. Pressure Gauges and Isolators: A pressure gauge and isolator shall be provided for the discharge line of each pump.
  - 1. Constructed of 316ss, CPVC, polypropylene and PTFE
  - 2. Scale of 0-160 psig, display pressure in psig
  - 3. Must be isolated from product being pumped
  - 4. Glycerin filled gauge protector constructed of CPVC/Polypropylene
  - 5. Minimum 2-1/2" face
  - 6. OBS-M Series by Truflo® or equal
- J. Pressure Relief Valve: Provide adjustable pressure relief valve for each pump discharge. The valve, gauge, and gauge isolator shall all be located prior to any pump isolation valves.
  - 1. Factory preset at 125 psig
  - 2. Adjustable from 10-150 psig
  - 3. Body constructed of solid CPVC
  - 4. ½" socketed connections
  - 5. Valve top constructed of Noryl and shall not come in contact with process fluid
  - 6. Two separate ports
  - 7. Maximum pressure rating of 350 psig
  - 8. Opening set point adjustable using hand tools
  - 9. Capable of bypassing 300 US GPH minimum
  - 10. Union installed on both sides
  - 11. Valve shall be ½" 2-port M Series as provided by Griffco Valve Inc. or equal
- K. Equipment Identification: Provide stainless steel plate with ¼-inch die-stamped equipment identification numbers mounted in a visible location.



- L. Lifting lugs: Provide for equipment weighing over 100 pounds.
- M. Anchor Bolts: Provide all anchor bolts necessary for proper installation of the metering pump system frame or rack.
  - 1. All metals shall be Type 316 stainless steel
  - 2. Sized by equipment manufacturer
- N. Skid-Mount: Each Chemical Metering Pump System shall be completely assembled, calibrated, tested mounted and shipped on a single skid.
  - 1. Components to be mounted include metering pumps, piping, valves, and all piping appurtenances specified herein. Vertical back panels and frame-mounted enclosures shall be provided as required to fully support all equipment and appurtenances.
  - 2. Forklift truck cut-outs shall be provided.
  - 3. The strength of the skid and supporting frame shall be suitable for shipping, offloading, installation and long-term support of the metering pumps.
  - 4. Frame or rack shall have accommodations for concrete floor mounting.
  - 5. No bare metal parts shall be allowed.

## 2.5 INTEGRATED SYSTEM CONTROLS

- A. The pre-packaged chemical feed system shall be complete with an advanced multi-pump process controller with the following features:
  - 1. Color touch screen operator interface that measures 5.7" diagonally
  - 2. Red 3.1 eight segment LED display that can be programmed to represent any engineering unit from 0.0 to 999.9 units
  - 3. The integral variable speed drive must incorporate the following manual operator interfaces
    - a. Start membrane button
    - b. Stop membrane button
    - c. UP button to increase pump speed
    - d. DOWN button to decrease speed
    - e. Forward/ Reverse button
    - f. Red, 8-segment, 3.1 LED digital display
    - g. Mode button to access and change user configuration parameters
- B. The metering pump controller must include the following inputs and output capabilities:
  - 1. Remote two-wire start/stop discrete input.
  - 2. Remote analog speed reference input.
    - a. 0-20 mA current signal
    - b. 4-20 mA DC current signal
    - c. 0-10 VDC signal
    - d. 2-10 VDC signal
    - e. Speed potentiometer input
  - 3. Three programmable discrete input signals
  - 4. One programmable discrete output
  - 5. One programmable (NO/NC) dry-contact relay for 2 Amps up to 24 VDC resistive and 3 Amps 85-265 VAC resistive
  - 6. One programmable analog output
    - a. 0-10 VDC
    - b. 2-10 VDC
    - c. 0-20 mA DC (into 500  $\Omega$  load)
    - d. 4-20 mA DC (into 500  $\Omega$  load)

- e. The metering pump controller must incorporate the capability of using remote mounted sensor/transmitter to create a closed-loop control system complete with integral PID controller. Such options could be but not limited to pH, ORP, flow, residuals, turbidity, color, etc.
  - f. The metering pump controller shall be able to be controlled via the following communication bus strategies, as preferred by OWNER. Manufacturer shall coordinate communication bus strategy with CONTRACTOR for necessary wiring requirements and Applications Programmer:
    - 1) Ethernet/IP / TCP/IP / Modbus TCP/IP
  - g. The integral metering pump drive shall have the capability of performing 16-segment speed segmentation with separate acceleration/ deceleration profiles and programmable repetitions of sequences.
7. Each pumps controls/display shall be clearly marked with the pump equipment number
- C. Provide all cables, connectors, and a terminal junction box for termination of remote signal circuits.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Installation shall be in complete accordance with manufacturer's instructions.
- B. Installation shall include furnishing and applying an initial supply of any pump spare parts, lubricants, rebuild kits, etc, recommended by manufacturer.
- C. Check and align all pumps, motors, valves, piping, etc. after pump assemblies have been installed to ensure alignment and assembly has been unchanged from factory assembly conditions. Make adjustments required to place system in proper operating condition.

#### **3.2 MANUFACTURER'S FIELD SERVICES**

- A. A factory trained representative shall be provided for installation supervision, start-up and test services, and operation and maintenance personnel training services. The serviceman shall make three (3) visits to the site. The first visit shall be for assistance in the installation of equipment. The second visit shall be for checking the completed installation and start-up of the system. The third visit shall be for instruction of operations personnel.

+ + END OF SECTION + +

## SECTION 13205

### HIGH DENSITY POLYETHYLENE STORAGE TANKS

#### **PART 1 - GENERAL**

##### **1.1 DESCRIPTION**

- A. Scope: Design and manufacture of high density polyethylene storage tanks complete with appurtenances, including overflow pipe with braces, fittings, ladders, manway, anchorage system, and other details as shown on the attached Tank Data Sheet and specified herein.
- B. Equipment Identification Numbers: the following equipment identification numbers have been assigned to the equipment that shall be provided under this section:
  - 1. Sodium Hypochlorite Storage Tank: WD23\_TANK\_54100

##### **1.2 QUALITY ASSURANCE**

- A. Reference Standards: Tanks and appurtenances shall be designed, fabricated and inspected according to the latest edition of the following standards:
  - 1. American Society of Testing Materials (ASTM) D618: Conditioning Plastics and Electrical Insulating Materials for Testing
  - 2. ASTM D638: Tensile Properties of Plastics
  - 3. ASTM D790: Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
  - 4. ASTM D883: Standard Definitions of Terms Relating to Plastics
  - 5. ASTM D1525: Test Method for Vicat Softening Temperature of Plastics.
  - 6. ASTM D1693: ESCR Specification Thickness 0.125" F50-10% Igepal.
  - 7. ASTM D1998-15: Standard Specification for Polyethylene Upright Storage Tanks
  - 8. ASTM D2765: Degree of Crosslinking in Crosslinked Ethylene Plastics as Determined by Solvent Extraction.
  - 9. ASTM D2837: Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.
  - 10. ASTM D3892: Practice of Packaging/Packing of Plastics.
  - 11. ASTM D4883: Standard Test Method for Density of Polyethylene by the Ultrasound Technique
  - 12. ASTM F412: Definitions and Terms Relating to Plastic Piping Systems.
  - 13. Association of Rotational Molders (ARM) Low Temperature Impact Resistance (Falling Dart Test Procedure).
  - 14. American National Standards Institute (ANSI) B16.5: Pipe Flanges and Flanged Fittings
  - 15. California Building Code (latest edition)
- B. Factory Tests:
  - 1. Dimensions and Tolerances Tests: Measurements shall be taken with the tank in the vertical position with the tank completely empty.
    - a. Tolerances for outside diameter out of roundness shall be per ASTM D1998-15.
    - b. Tolerances for fittings placement will be +/- 0.5 inches in elevation and 2 degrees radial at ambient temperature.

2. Visual Inspection: Verification that the tank is free of visual defects such as foreign inclusions, air bubbles, pinholes, pimples, crazing, cracking, and delaminations that will impair the performance of the tank.
  3. Low Temperature Impact Test:
    - a. In accordance with ASTM D 1998-15
    - b. Test specimens shall be taken from fittings location or piggy-back test molds.
    - c. Test specimens shall be conditioned at -40 deg F for a minimum of two (2) hours.
    - d. Test specimens > ½" wall thickness shall be tested at 200 ft-lb. Test specimens < ½" wall thickness shall be tested at 100 ft-lb.
  4. Degree of Crosslinking Test:
    - a. Conduct o-xlene insoluble fraction (gel test) per ASTM D2765 Method C for the determination of the ortho-xlene insoluble fraction (gel) of crosslinked polyethylene.
    - b. The percent gel level for crosslinked tanks on the inside 1/8 inch of the wall shall be a minimum of 65%.
  5. Ultrasonic Tank Thickness Test: All tanks shall meet design wall thickness requirements and tolerances.
    - a. All tanks with capacity greater than 2,000 gallons shall be measured for tank wall thickness at 6 inches, 1 ft, 2 ft, 3 ft and 4 ft on the tank sidewall height at 0 and 180 deg around the tank circumference with 0 deg being the tank manway and in the counter-clockwise direction per ANSI standard drafting specifications.
    - b. All tanks with capacity less than 2,000 gallons shall be measured for tank wall thickness at 6 inches, 1 ft and 2 ft on the tank sidewall height at 0 and 180 deg around the tank circumference with 0 deg being the tank manway and in the counter-clockwise direction per ANSI standard drafting specifications.
  6. Hydrostatic test in accordance with ASTM D 1998-15
- C. Warranty:
1. Manufacturer shall provide a minimum five (5) year full replacement warranty in the OWNERS name for each tank, by serial number and chemical service.

### 1.3 SUBMITTALS

- A. In accordance with Specification Section 01330, Submittal Procedures.
1. Shop Drawings:
    - a. Complete drawings and details of the tank and all dimensions, connections, appurtenances, anchorage and restraint system.
    - b. Details of inlet and outlet fittings, manways, flexible connections, and vents.
  2. CONTRACTOR shall supply seismic anchorage calculations for each tank as required by Specification Section 01610.
  3. Product Data:
    - a. Detailed descriptive literature including tank weight, materials of construction, manufacturing details, resin manufacturer data sheet, and wall thickness.
    - b. Confirmation from resin manufacturer that the proposed resin system is suitable for storage of the specified chemicals using the fabrication technique proposed.
    - c. Complete design calculations for tank, reinforcement, and anchorage system.
      - 1) Hoop stress shall be calculated using 550 PSI at 100 degrees F as prescribed in ASTM D 1998-15.
      - 2) Tank restraint system calculations for seismic and wind loading criteria specified herein, signed and sealed by a Civil or Structural Engineer licensed in California.
    - d. Tank capacity chart indicating storage volume in gallons and height in feet.

- e. Manufacturer's recommended procedures for unloading, handling, and installing the tank and appurtenances, including recommended bolt torque for all bolted connections.
- f. Color chart showing available colors.
- 4. Quality Control Submittals:
  - a. Certificate of Compliance with these specifications and ASTM D 1998-15.
  - b. Copy of the Manufacturer's Quality Assurance Program
  - c. Complete Factory Testing Report
  - d. Manufacturer's warranty

#### 1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Tank shall not be shipped until ENGINEER has approved Factory Testing Report.
- B. All packing, packaging, and marking provisions of ASTM D3892 shall apply.
- C. Each tank shall be shipped clearly marked with the Manufacturer's standard identification system indicating the following, at minimum:
  - 1. Name of Manufacturer.
  - 2. Date of Manufacture.
  - 3. Tank Capacity.
  - 4. Model Number.
  - 5. Serial Number.
- D. Tank and all components shall be protected from damage during shipment and handling. Details of protection procedures shall be the full responsibility of the Manufacturer, with the following minimum measures taken:
  - 1. Tank shall be supported during shipment to prevent contact with bulkhead or bed of vehicle.
    - a. Tank shipped horizontally shall have padded cradle supports
    - b. Tank shipped vertically shall be placed on a skid.
  - 2. All fittings shall be installed, removed, and shipped separately.
  - 3. Prevent damage to flanged connections using wooden blinds bolted to the flange and having a diameter two (2) inches greater than the outside diameter of the flange.
  - 4. All unflanged components shall be plugged to prevent deflection and protected by adequate exterior wrapping.
  - 5. All components shipped shall be firmly fastened and padded to prevent shifting or flexing during transport.
  - 6. No items shall be shipped loose inside the tank.

### **PART 2 - PRODUCTS**

#### 2.1 PRODUCT AND MANUFACTURER:

- A. Assmann, Inc.
  - 1. Model Numbers:
    - a. T71-00: ICT 550
- B. Poly Processing, Inc.
- C. Or Equal

## 2.2 SERVICE CONDITIONS

### A. General:

1. Maximum fluid temperature: 95 deg F
2. Minimum fluid temperature: 35 deg F
3. Maximum ambient air temperature: 110 deg F
4. Minimum ambient air temperature: 20 deg F
5. Operating Pressure: Atmospheric

### B. Service Conditions Table:

<b>Tank</b>	<b>WD23_TANK_54100</b>
Liquid Stored	Sodium Hypochlorite
Approximate Concentration	12.5%
Specific Gravity	1.20
pH	12.0
Tank Type	Crosslinked

## 2.3 DESIGN CRITERIA

### A. General:

1. Tanks shall be rotationally-molded crosslinked polyethylene, one-piece seamless construction, cylindrical in cross-section and vertical in axis.
2. Tanks shall fully conform to ASTM D 1998-115.
3. Dimensions shall be as shown in the attached Tank Data Sheets.
4. All tank fitting attachments shall be provided with flexible couplings or other provisions to allow for movement without rupture or separation of connections.
  - a. Flexible couplings shall allow minimum 4% deflection in all directions.
5. Tanks shall be clearly marked with manufacturer, date of manufacture, and serial number.
6. All opening cut edges shall be trimmed smooth.

### B. Design Loads:

1. Resistance of both wind and seismic loads shall be provided for both tank full and tank empty conditions and in accordance with Section 01 60 00, General Equipment Requirements.
2. T29-00 and T72-00 (outdoor installations): 35 psf snow load.
3. Tank Anchorage System:
  - a. Manufacturer shall be fully responsible for design and provision of adequate anchorage system for the service conditions. Design of the anchorage system shall be coordinated with the supporting foundation shown in the Contract Drawings. Anchorage designs requiring re-design of the tank foundation shown in the Contract Drawings shall not be acceptable.
  - b. All anchorage systems shall be 316 stainless steel unless otherwise specified.
  - c. Contractor shall refer to Drawing 70-SM-4 regarding special anchorage configuration for T71-00.

### C. Tank type, style, capacity, dimensions, and fittings orientation shall be as shown in the attached Tank Data Sheets.

### D. Materials:

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1. General:
  - a. Tanks shall be virgin polyethylene resin as compounded and certified by the Manufacturer.
  - b. Resin shall contain a minimum of a UV 8 stabilizer as compounded by the resin manufacturer.
  - c. Color shall be natural.
  - d. Pigments, where specified, shall not exceed 0.25% dry blend total weight.
2. Resin:
  - a. Crosslinked polyethylene as manufactured by ExxonMobil Chemical, or resin of equal physical and chemical properties.
    - 1) Mechanical Properties:

Property	ASTM	Value
Specific Gravity	D1998	1.9
Hoop Stress	D1998	600 PSI
Density (Resin)	D1505	0.938-0.946 g/cc
Tensile (Yield Stress 2-inch/min)	D638	3000 PSI
Elongation at Break (2-inch/min)	D638	>300%
ESCR (100% Igepal, Condition A, F50)	D1693	>1000 hours
ESCR (100% Igepal, Condition B, F50)	D1693	>1000 hours
Vicat Softening Degrees F	D1525	250
Flexural Modulus	D790	100,000 PSI

3. Fittings, Gaskets, and Fasteners:

Tank	WD23_TANK_54100
Liquid Stored	Sodium Hypochlorite
Fittings Material	PVC
Gasket Material	Viton
Bolt/Fastener Material	Titanium

- E. Wall Thickness: Minimum required wall thickness for the cylinder must be sufficient to support its own weight in an upright position without any external support, as determined by the following equation, and not less than 0.187 inches:

$$T = 0.433 \times SG \times H \times OD \div (2 \times SD)$$

Where:

- T = wall thickness (inches)  
 SG = specific gravity (g/cm<sup>3</sup>)  
 H = fluid head (feet)  
 SD = hydrostatic design stress (PSI)  
 OD = outside diameter (inches)

- 1) In accordance with the above formula, the tank shall have a stratiform (tapered wall thickness) wall.
- 2) Flat areas shall be provided to allow locating large fittings on the cylinder straight shell.
- 3) Hydrostatic Design Stress:
  - a) As determined by multiplying the hydrostatic design basis, determined by ASTM D2837 using rotationally molded samples, with a service factor selected for the application.

- b) The hydrostatic design stress is 550 PSI at 73 deg F.
- c) Hydrostatic design stress shall be derated for service above 100 deg F and for mechanical loading of the tank.

F. Top Head:

- a. Integrally molded with cylinder straight shell.
- b. Minimum thickness equal to the top of the cylinder straight shell.
- c. Top head for tanks with capacities in excess of 2000 gallons shall be designed to provide a minimum of 1300 square inches of flat area for fittings locations.

G. Bottom Head:

- a. Integrally molded with cylinder straight shell.
- b. Flat.
- c. Knuckle radius shall be 1-1/2 inches minimum.

H. Fittings:

1. Manway:
  - a. Tanks less than 2,000 gallons: Minimum 16-inch threaded polyethylene, vented and easily accessible.
  - b. Tanks greater than 2,000 gallons: Minimum 24-inch threaded polyethylene, vented and easily accessible.
2. Threaded Bulkhead (THR):
  - a. Threaded bulkhead fittings shall not be allowed for connections greater than 2 inches.
  - b. Where used bulkhead fittings shall be constructed of PVC.
  - c. Gaskets shall be a minimum of 1/4" thickness and constructed of 40-50 durometer EPDM or 60-70 durometer Viton as specified herein and in the Tank Data Sheets.
3. Bolted Double 150 lb. Flange Fittings (FLG):
  - a. Bolted double flange fitting shall be constructed with two (2) 150 lb. flanges and two (2) 150 lb. flange gaskets, and the correct number and size of all-thread bolts for the flange specified by the flange manufacturer.
  - b. Flanges shall be constructed of PVC Type I, Grade I, or other specified material.
  - c. Gaskets shall be a minimum of 1/4" thickness and constructed of 40-50 durometer EPDM or 60-70 durometer Viton as specified herein and in the Tank Data Sheets.
  - d. Provide a minimum of four (4) full thread bolts, material as specified in the attached Tank Data Sheets.
    - 1) The bolts may have gasketed flanged metal heads or bolt heads encapsulated in polyethylene material.
      - a) Encapsulated bolts shall be designed to prevent metal exposure to the liquid in the tank and prevent bolt rotation during installation.
      - b) The polyethylene encapsulation shall fully cover the bolt head and a minimum of 1/4" of the threads closest to the bolt head.
      - c) Polyethylene shall be color coded to distinguish bolt material (white - 316 S.S., yellow - Hastelloy C276, red - Monel, green - Titanium).
      - d) Each encapsulated bolt shall have a gasket to provide a sealing surface against the inner flange.
    - 2) Bolted double flange fittings shall have bolt holes straddling the principal centerline of the tank in accordance with ANSI/ASME B-16.5 unless otherwise specified.
4. Lifting Lugs: Tanks shall have a minimum of three lifting lugs integrally molded in the cylinder straight shell.



- a. Lifting lugs shall be designed and located to enable erection of an empty tank.
  - b. Lifting lugs shall be Type 316 stainless steel.
- 5. Tie-downs:
  - a. Provide a minimum of four (4) tie-down lugs integrally molded into the top head.
  - b. Tie-down lugs shall be designed to allow tank retention in wind and seismic loading without damage to the tank.
- 6. Flexible Tank Fittings:
  - a. Flexible fittings for all tank piping connections shall be supplied by the tank manufacturer.
  - b. Flexible expansion joint with low spring rate for protection of stress sensitive connections. Provide one at each connection to HDPE chemical storage tanks.
  - c. Pressure Rating: 100 psi
  - d. Material: 100% PTFE resin conforming to ASTM D4894.
  - e. Ends: 150# ANSI flanged ends.
  - f. 316 SS bolts.
  - g. EPDM gaskets.
  - h. Provide stainless steel restraint cables to prevent over-extension of joint.
  - i. Performance Specifications:
    - 1) Axial Travel: >0.47".
    - 2) Lateral Deflection: >0.35".
    - 3) Angular Deflection: > 24°
  - j. Manufacturers and Products:
    - 1) Ethylene - Flexijoint
    - 2) Or Equal

## 2.4 APPURTENANCES

- A. General:
  - 1. Provide the following appurtenances where called for on the Tank Data Sheet for each tank.
  - 2. Uncoated or exposed carbon steel appurtenances, fasteners, or anchorage will not be accepted.
- B. Down Pipes and Fill Pipes:
  - 1. Down pipes and fill pipes shall be PVC or material compatible with chemical stored.
  - 2. Down pipes and fill pipes shall be supported at 6-inch intervals.
- C. U-Vent: Each tank must be vented for the material and flow and withdrawal rates expected. U-vents shall be furnished complete and shall be constructed of PVC or material compatible with the chemical stored.
- D. Level Sensor Flange Mount: Provide flange on top of tank for mounting a level sensor. Coordinate flange size with electrical drawings for sensor mounting detail.
- E. Supports: Provide pipe supports for fill and vent piping.
- F. Tank Identification Plate:
  - 1. Each tank shall be provided with a nameplate indicating the equipment number and title as shown on the tank data sheet.
- G. Secondary Containment Basin:
  - 1. Rectangular Containment Basin:
    - a. Linear medium density polyethylene.

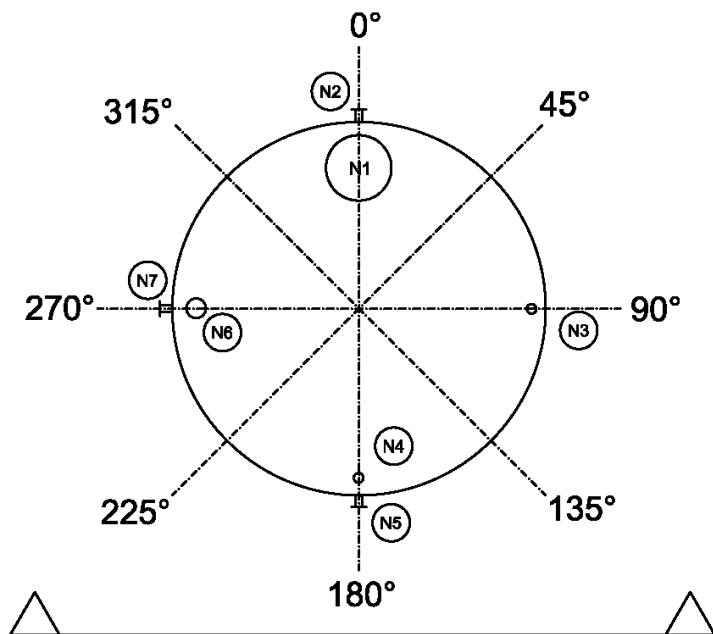
- b. Complies with 40 CFR-264.193.
- c. All wall thicknesses conform to ASTM D-1998.
- d. Provide containment volume of 550 gallons.

### **PART 3 - EXECUTION**

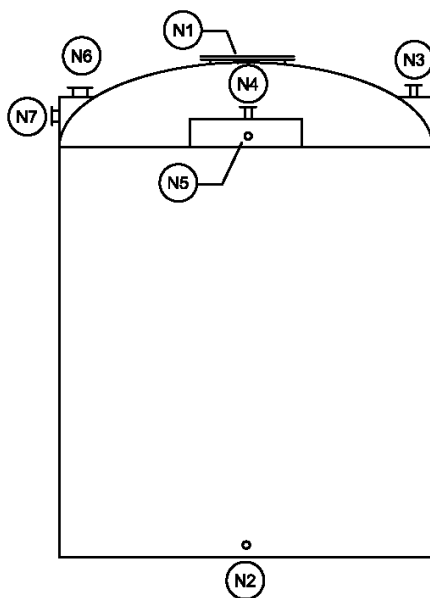
#### **3.1 INSTALLATION**

- A. Install tank in complete conformance with manufacturer's written instructions and Engineer's approved shop drawings
- B. Concrete tank pad shall be level and smooth to the tolerances recommended by the tank manufacturer.

+ + END OF SECTION + +



**PLAN**



**ELEVATION**

<b>Item No.</b>	WD23_TANK_54100
<b>Name</b>	Sodium Hypochlorite Storage Tank
<b>Liquid Stored</b>	12.5% Sodium Hypochlorite
<b>Working Capacity</b>	550 Gallons
<b>Tank Inside Diameter</b>	4'-0"
<b>Design Code</b>	ASTM D1998-15
<b>Materials:</b>	
<b>Resin</b>	Cross Linked
<b>Gaskets</b>	Viton
<b>Bolts</b>	Titanium
<b>Roof</b>	Domed
<b>Shell</b>	Vertical Cylinder
<b>Bottom</b>	Flat

#### Nozzle Schedule

MK	Size/Type	Service
N1	16"	Manway
N2	1" THR	Outlet at lowest possible elevation on tank wall no flush bottom
N3	1/2" THR	Pressure Relief
N4	1" THR	Tank Vent
N5	3/4" THR	Inlet
N6	6" FLG	Level Transmitter
N7	2" THR	Overflow

#### Accessories

<b>Ladder</b>	
<b>Lifting Lugs</b>	X
<b>Access Manway</b>	X
<b>Insulate</b>	
<b>Containment Basin</b>	X

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## SECTION 13251

### BLADDER-TYPE HYDROPNEUMATIC TANK

#### **PART 1 - GENERAL**

##### **1.1 DESCRIPTION**

- A. Scope: Provide bladder-type hydropneumatic tank and all appurtenances required to provide a complete fully functional system.
- B. All equipment specified in this Section shall be supplied by a single system supplier or Manufacturer.

##### **1.2 QUALITY ASSURANCE**

- A. Quality Control Submittals:
  - 1. Tank Manufacturer's written instructions.
  - 2. Manufacturer's Certificate of Compliance that tank is certified and stamped in accordance with ASME Section VIII, Division 1.
  - 3. Manufacturer's Certificate of Proper Installation.
  - 4. Statements of Qualification: Tank welders shall be ASME certified.
  - 5. The tank Manufacturer shall certify that all wetted tank materials are in compliance with NSF Standard 61.
  - 6. Test Reports:
    - a. Date and time of testing.
    - b. Description of method of testing, including pumping combinations and pressure records.
    - c. Description of any observed leaks or failures and method and date of repair.
    - d. Description of catastrophic failures.
    - e. Signature of the CONTRACTOR and Manufacturer's representative.

##### **1.3 SUBMITTALS**

- A. Shop Drawings:
  - 1. Complete dimensional fabrication drawings of hydropneumatic tank and accessories certified correct by system supplier.
  - 2. Complete piping schematic drawings showing all piping and flows directly associated with hydropneumatic tank.
  - 3. Structural design calculations, sealed and signed by a Civil or Structural engineer, licensed in the State of California.
- B. Field Assembly Instructions: Provide instructions for unloading and installing hydropneumatic tank.
- C. Operation and Maintenance Manuals: Submit complete manuals including copies of all approved Shop Drawings, test reports, maintenance data and schedules, description of operation, and spare parts information.
- D. Warranty: Submit 1-year minimum warranty.

## **PART 2 - PRODUCTS**

### **2.1 PRODUCT AND MANUFACTURER:**

- A. Pulsco Corporation
- B. Young Engineering Manufacturing, Inc.
- C. Or approved equal

### **2.2 DIMENSIONAL AND PHYSICAL DATA**

- A. Physical Data for Tank:
  - 1. Total Volume: 2,000 gallons
  - 2. Initial Air Volume (high pressure): 1,200 gallons
  - 3. Working Volume: 215 gallons
  - 4. Configuration: Vertical cylinder with elliptical dished ends
  - 5. Shell Diameter: 6'-0"
  - 6. Design Minimum Pressure: 55 psi
  - 7. Design Maximum Pressure: 180 psi
  - 8. Water Seal at Minimum Pressure: 25% of Total Volume
  - 9. Design Pressure Rating: 200 psi
  - 10. Design Temperature: 15 - 115°F
  - 11. Liquid Service: Potable Water

### **2.3 MATERIALS:**

- A. Heads and Cylinder: SA 516 Grade 70 carbon steel
- B. Nozzles: SA 106 Grade B carbon steel
- C. Flanges: SA 105 carbon steel
- D. Support Saddles: SA 36 carbon steel

### **2.4 STRUCTURAL DESIGN**

- A. The hydropneumatic tank and its major components, including anchor bolts and other supporting and restraining parts, shall be designed by a Civil or Structural engineer, licensed in the State of California, to resist lateral forces in accordance with the International Building Code, latest edition. Forces shall be based on the empty, operating, or flooded weights, whichever is greatest.
- B. Support Saddles:
  - 1. Hydropneumatic tank vendor shall supply steel support saddles as required to support tank.
  - 2. Support saddles shall be integral with tank.
  - 3. Support saddle shall be designed to keep the bottom of the tank minimum 2-feet off of the ground.
  - 4. Hydropneumatic tank vendor shall size stainless steel anchor bolts for installation into concrete slab or equipment pad as shown on the Drawings. Anchor bolts shall be supplied by CONTRACTOR.

5. Hydropneumatic tank vendor shall provide transfer-load values to the ENGINEER for the design of the concrete footings.
- C. Design Requirements:
  1. In accordance with Section 01610, General Product Requirements
- D. Proof of Compliance:
  1. Structural integrity and anchorage shall be certified by an approved calculation that demonstrates the adequacy of the anchorage system for seismic forces. This calculation may be based on principles of structural analysis and engineering mechanics or based on similarity to approved shake-table tests.
  2. The CONTRACTOR shall submit for review and approval test data or calculations certified by a Civil or Structural Engineer registered in the State of California to show compliance with the above requirements.

## 2.5 FABRICATION

- A. Fabricate tank in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, latest edition.
- B. Plate Thicknesses: Determine in accordance with allowable stresses listed in the Code for material, pressure, and temperature specified.
- C. Heads: As specified in ASME Code, Section VIII, Division 1.
- D. Corrosion Allowance:
  1. For Liquid Service of Potable Water or Recycled Water, no corrosion allowance is required.
- E. Stamp and certify tank in accordance with ASME Code Section VIII, Division 1.

## 2.6 COATINGS

- A. Exterior of tank shall be painted as follows. Prepare surfaces to be painted per coating manufacturer's requirements.
  1. Primer: 2 coats polyamidolamine epoxy, 4-6 mil thickness
    - a. Tnemec, Series V69, Hi-Build Epoxoline II
    - b. Or Equal
  2. Top Coat: 1 coat Polyurethane designed for exterior weathering, abrasion and corrosion resistance, 3-4 mil thickness
    - a. Tnemec, Series 750 UVX
    - b. Or Equal
- B. Tank interior shall be coated with an ANSI/NSF STD 61 approved bonded epoxy, minimum thickness 8-10 mils. Prepare surfaces to be painted per coating manufacturer's requirements.
  1. Coatings:
    - a. Tnemec, Pota-Pox Plus Series N140
    - b. Or Equal

## 2.7 COMPONENTS AND APPURTENANCES

- A. Bladder:

1. Type: Gas-in-Bladder
  2. Material:
    - a. Heavy-duty flexible polyvinyl chloride membrane suitable for potable water service.
    - b. Bladder material shall meet the requirements of ANSI/NSF 61.
- B. Manhole(s): One minimum, 18-inch diameter, designed and fabricated in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Article D-10.
- C. Nozzles:
1. Nozzles shall be in accordance with ASME Code, Section VIII, Article D-6.
    - a. Sizes 2-1/2 Inches and Larger: Class 150 flanged, ANSI B16.5.
    - b. Sizes 2 Inches and Smaller: Class 3000 threaded, ANSI B16.11 (weldolet)
  2. Nozzles, size and purpose:
    - a. Inlet/Outlet: 12-inch, flanged.
    - b. Drain: 2-inch, threaded.
    - c. Blow-Off Valve: 1/2-inch, threaded.
    - d. Air Fill/Relief: 1/2-inch, threaded.
- D. Inlet/Outlet and Drain piping shall enter the tank from the bottom.
- E. Blow Off Valve with Enclosure:
1. In accordance with Boiler and Pressure Vessel Code, Section VIII, GENERAL REQUIREMENTS, UG-125 and 126.
  2. Size and setting per tank manufacturer.
- F. Integral saddle supports for bolting to concrete foundation.
- G. Mounting brackets for all tank-mounted appurtenances and controls.
- H. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.
- I. Equipment Identification Plates:
1. Provide 16-gauge Type 304 stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location.
  2. Plate shall bear 3/8-inch high block type black enamel filled equipment identification number and letters as indicated in this Specification.
- J. Anchor Bolts: Type 304 stainless steel, sized and furnished by supplier of hydropneumatic control tanks according to design criteria listed in this Specification.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Manufacturer shall provide written installation instructions.

#### **3.2 FIELD QUALITY CONTROL**

- A. Field Static Test:



1. Hydrostatically test installed hydropneumatic tank for 4 hours minimum at 1.3 times design pressure, before dynamic testing.
  2. Repair leaks detected during testing.
- B. Functional Test: Inspect and test components for alignment, operation, and connection, and performance.
- C. Manufacturer's Field Services: A Manufacturer's representative for the hydropneumatic tank shall be present at the jobsite for the minimum person-days listed for the services hereinunder, travel time excluded:
1. 1 person-day for installation assistance, inspection, certification of the installation, testing, startup, and training of Owner's operations personnel.

+ + END OF SECTION + +

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**SECTION 15010**  
**PIPING SUPPORT SYSTEMS**

**PART 1 - GENERAL**

**1.1 SUBMITTALS**

- A. Shop Drawings:
  - 1. Details and location of each pipe support type used.

**PART 2 - PRODUCTS**

**2.1 SUPPORT SYSTEMS:**

- A. Channel-type support systems
  - 1. 304 Stainless Steel
    - a. Unistrut
    - b. B-Line
    - c. Or Equal.
  - 2. Non-metallic
    - a. Aikenstrut
    - b. CLIC
    - c. Or Equal.
- B. Hanger- and Clevis-type support systems
  - 1. B-line
  - 2. Anvil
  - 3. Or Equal
- C. Stanchion-type support systems
  - 1. B-Line
  - 2. Anvil
  - 3. Or Equal
- D. Adjustable Pipe Saddle Support
  - 1. B-Line, Figure B-3092
  - 2. Or Equal
- E. Wall Bracket (14-inch to 24-inch pipe)
  - 1. B-Line Figure B-3067 Heavy Duty Angle Bracket
  - 2. Or Equal
- F. Wall Bracket (8-inch to 12-inch pipe)
  - 1. B-Line Figure B-3066 Medium Duty Angle Bracket
  - 2. Or Equal
- G. Wall Bracket (4-inch to 6-inch pipe)
  - 1. B-Line Figure B-3068 Light Duty Angle Bracket
  - 2. Or Equal

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## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. In addition to the pipe supports specifically called for on the drawings, CONTRACTOR shall provide pipe supports as required to fully support all piping systems.
- B. CONTRACTOR shall design, supply and install pipe support system using manufacturer's standard available pipe support hardware.
- C. Pipe supports shall, at a minimum, be installed at the following locations:

- 1. On both sides of each valve, piece of equipment or other appurtenance, such that allowance is made for removal of the valve, piece of equipment, or other appurtenance while leaving the pipe system fully supported. Support piping connections to equipment by pipe support and not by the equipment.
- 2. Along straight runs of pipe, the maximum distance between supports shall be as listed below:

Pipe Diameter	Maximum Distance Between Supports	Minimum Hanger Rod Diameter (if Hanger Rods are used)
2" and smaller	6-feet	1/2"
2-1/2" to 6"	8-feet	3/4"
8" to 12"	10-feet	2 @ 3/4"
14" to 18"	10-feet	2 @ 1"
Over 18"	Custom Design	

- 3. Directly supporting valves 8-inch in diameter and larger.
  - 4. At least two supports on each side of flexible couplings or flanged coupling adapters to provide that no load is applied to the flexible coupling.
  - 5. On the pipe within two pipe diameters of each side of elbows and each branch of tees and crosses.
  - 6. Where piping passes through walls, such that no load is transferred to the wall.
- D. Install support systems in accordance with MSS SP 69, Pipe Hangers and Supports-Selection and Application and MSS SP 89, Pipe Hangers and Supports-Fabrication and Installation, unless shown otherwise.
    - 1. Support no pipe from the pipe above it.
    - 2. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.
  - E. Bracing and lateral support:
    - 1. Provide lateral sway bracing on 10-foot maximum centers
      - a. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing.
    - 2. Install lateral supports for seismic loads at all changes in direction.
  - F. Thermal expansion and thrust restraint
    - 1. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
  - G. Support types:
    - 1. Horizontal Suspended Piping:
      - a. Single Pipes: Adjustable swivel-ring, splint-ring or clevis hangers.

- b. Grouped Pipes: Trapeze hanger systems.
    - c. For insulated piping, furnish galvanized steel protection shields, welding insulation saddles, or precut sections of rigid insulation (with vapor barrier) at all hanger locations.
  - 2. Horizontal Piping Supported From Walls:
    - a. Single Pipes: Wall brackets or wall clips attached to wall with anchors. Clips attached to wall-mounted framing also acceptable.
    - b. Stacked Piping:
      - 1) Wall-mounted framing system and clips acceptable for piping smaller than 3-inch minimal diameter.
      - 2) Piping clamps that resist axial movement of pipe through support not acceptable.
    - c. Insulated piping shall have the insulation removed in the vicinity of wall brackets and piping clips to allow only direct pipe wall contact with the support system.
  - 3. Horizontal Piping Supported From Floors:
    - a. Stanchion Type:
      - 1) Pedestal type; adjustable with stanchion, saddle, and anchoring flange.
      - 2) Use yoked saddles for piping whose centerline elevation is 18 inches or greater above the floor and for all exterior installations.
      - 3) Provide neoprene waffle isolation pad under anchoring flanges, adjacent to equipment or where otherwise required to provide vibration isolation.
    - b. Floor-Mounted Channel Supports:
      - 1) Use for piping smaller than 3-inch nominal diameter running along floors and in trenches at piping elevations lower than can be accommodated using pedestal pipe supports.
      - 2) Attach channel framing to floors with anchor bolts.
      - 3) Attach pipe to channel with clips or pipe clamps.
    - c. Concrete Cradles:
      - 1) Use for piping larger than 3-inch along floor and in trenches at piping elevations lower than can be accommodated using stanchion type.
  - 4. Vertical Pipe:
    - a. Support with wall brackets and base elbow or riser clamps on floor penetrations.
    - b. Insulated piping shall have the insulation removed in the vicinity of wall brackets and riser clamps, to allow only direct wall contact with the support system.
- H. Standard Attachments:
- 1. To Concrete Ceilings: Concrete inserts.
  - 2. To Steel Beams: I-beam clamp or welded attachments.
  - 3. To Wooden Beams: Lag screws and angle clips to members not less than 2-1/2 inches thick.
  - 4. To Concrete Walls: Concrete inserts or brackets or clip angles with anchor bolts.
  - 5. Existing Walls and Ceilings: Install as specified for new construction, unless shown otherwise.
  - 6. Repair mounting surfaces to original condition after attachments are made.
- I. Isolation:
- 1. Install elastomeric inserts designed to isolate piping from pipe supports where copper pipe is run in stainless steel supports, or where other dissimilar metals are in contact with pipe supports.
- J. Materials:
- 1. Channel-type, hanger-type and trapeze-type support systems and pipe racks constructed of channel systems:

- a. Provide non-metallic support systems in all chemical storage and feed areas or as otherwise noted on the Drawings. Provide type 316 stainless steel fasteners.
- b. Provide type 304 stainless steel support systems and fasteners in all other areas.
- 2. Stanchion-type support systems
  - a. Provide steel and ductile iron stanchion components
  - b. Coat stanchions after assembly per specification Section 09900, Painting.

+ + END OF SECTION + +

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## SECTION 15080

### PIPING INSULATION

#### **PART 1 - GENERAL**

##### **1.1 SUBMITTALS**

- A. Shop Drawings:
  - 1. Manufacturer's data on materials, construction, end connections, ratings, overall lengths, etc.

#### **PART 2 - PRODUCTS**

##### **2.1 PIPE INSULATION**

- A. **INS-02:** Rigid Fiberglass with PVC Cover
  - 1. Material:
    - a. Insulation: UL rated, preformed, sectional rigid fiberglass
    - b. Vapor Barrier Jacket: Kraft paper with aluminum foil with pressure sensitive adhesive lap
    - c. Cover: Preformed PVC Cover
      - 1) UV resistant
      - 2) Joints designed to shed water
      - 3) Color: White.
      - 4) Provide Identification Labels per the requirements of 10400 – Identification Devices
  - 2. Temperature Rating: 0 degrees to 850 degrees Fahrenheit
  - 3. Conductivity in accordance with ASHRAE 90.1 and minimum of 0.27 BTU-in/hr-ft<sup>2</sup> degrees F at 75 degrees F per ASTM C177 or ASTM C518.
  - 4. Minimum water vapor transmission of 0.02 perm-inch per ASTM E96
  - 5. Flame Spread Rating: Less than 25 per ASTM E84
  - 6. Fittings and valves:
    - a. Insulate with fabricated sections of insulation
    - b. Wrap with vapor barrier jacket
    - c. Provide preformed PVC fitting cover specifically designed for fitting or valve
  - 7. Manufacturers and Products:
    - a. Owens-Corning Fiberglass; ASJ/SSL-II with PVC Cover
    - b. Johns Manville Corp; Micro-Lok with Zeston 2000 PVC Cover
    - c. Or Equal.

#### **PART 3 - EXECUTION**

##### **3.1 INSTALLATION**

- A. Insulate all piping, valves and fittings for the piping systems where insulation is called for in the Pipe Schedule or Drawings.
- B. Install insulation according to manufacturer's instructions
  - 1. Install insulation only after piping system has passed pressure testing.

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2. Requirement for insulation does not negate the requirement for coating of the piping system. Apply piping coating system as called for in the Pipe Schedule. Allow coating system to completely cure prior to installation of pipe insulation.
  3. Do not "gap" insulation at pipe supports. Trim insulation to allow for pipe support while providing continuous insulation of piping in those parts of the pipe not in contact with pipe support.
  4. Install removable/replaceable insulation sections and cover panels over fittings or valves which require maintenance access.
  5. Use accessories, adhesives and tapes per manufacturer's recommendations.
- C. Finishing
1. Overall installation shall result in smooth, straight, neat and clean piping insulation system. No frayed ends, irregular lumps or other unsightly installation result will be acceptable.

+ + END OF SECTION + +



**SECTION 15100**  
**PIPE AND FITTINGS**

**PART 1 - GENERAL**

**1.1 SUBMITTALS**

- A. Shop Drawings:
  - 1. Product data sheets for each piping system.
    - a. Include information on pipe, fittings and joint systems.
  - 2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
  - 3. Complete descriptions and data for all coatings and linings.
  - 4. Tests and inspection data for pipe and coatings/linings.
  - 5. Qualifications for welders and/or technicians performing joining processes that requires specialized equipment to perform the work or as specifically identified herein.
- B. Operation and Maintenance Data as specified in Section 01330, SUBMITTAL PROCEDURES.

**1.2 PRODUCT DELIVERY, STORAGE, AND HANDLING**

- A. In accordance with manufacturer's directions.

**PART 2 - PRODUCTS**

**2.1 PIPING SYSTEM DATA SHEETS**

- A. Piping system data sheets (PSDS) have been attached to this Specification and are incorporated herein by reference. Provide piping systems in accordance with piping system data sheets.

**2.2 THRUST RESTRAINT**

- A. Provide rigid or restrained joints and fittings for all piping systems specified with a test pressure in the Pipe Schedule.
- B. Unless otherwise specified in the Pipe Schedule or shown on the Drawings, thrust blocks shall not be used.

**PART 3 - EXECUTION**

**3.1 PIPE SCHEDULE**

- A. A Pipe Schedule has been included on the Drawings and is incorporated herein by reference. Install piping systems in accordance with Pipe Schedule.

- B. For pipe which is shown on the Drawings, but not referenced in the Pipe Schedule, CONTRACTOR to provide pipe material and fittings which are appropriate for the intended service and acceptable to the ENGINEER.

### 3.2 PREPARATION

- A. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.
- B. Repair any coatings or linings which were damaged during shipping and handling using manufacturer-approved coating and lining repair materials in accordance with manufacturer's instructions.

### 3.3 INSTALLATION

- A. General:
  - 1. Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.
- B. Joint Assembly:
  - 1. Flanged Joints (FLG):
    - a. Bolt Holes: Straddle vertical centerlines, aligned with connecting equipment flanges or as shown.
    - b. Follow a bolt tightening pattern which produces uniform bearing pressure.
    - c. Do not over-tighten bolts. Follow manufacturer's recommendation for bolt torque.
    - d. Provide gasket at every flanged joint.
    - e. Provide insulating flange kit where indicated on Drawings and required in this Specification.
  - 2. Threaded and Coupled Joints (THR):
    - a. Conform to ANSI B1.20.1.
    - b. Produce sufficient thread length to ensure full engagement when screwed home in fittings.
    - c. Ream pipe ends and clean chips and burrs after threading.
    - d. Make connections with not more than three threads exposed.
    - e. Lubricate male threads only with thread lubricant or tape as specified on Piping Data Sheets.
    - f. PVC Threaded Joints:
      - 1) Provide Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.
      - 2) Use strap wrench for tightening threaded plastic joints. Do not overtighten fittings.
    - g. HDPE Threaded Joints:
      - 1) Joining HDPE pipe with threaded connections is not allowed unless specifically approved by the ENGINEER
    - h. Provide dielectric union or insulating coupling where indicated on Drawings and required in this Specification.
  - 3. Grooved-End Joints (GRV):
    - a. Type: Rigid, except where joints are used to correct misalignment, to provide flexibility, and where shown otherwise, in which case provide flexible type.
    - b. Grooved end joints are not allowed for plastic pipes unless approved by the ENGINEER.
  - 4. Soldered Joints (SLD):
    - a. Before soldering, remove stems and washers from solder joint valves.

- b. Use only solder specified for particular service.
- c. Cut pipe ends square and remove fins and burrs.
- d. Protect adjacent surfaces from damage during soldering.
  - 1) Protect from high temperatures due to flame
  - 2) Protect from damage due to dripping flux or solder
- e. After thoroughly cleaning pipe and fitting of oil and grease using solvent and emery cloth, apply noncorrosive flux to the male end only.
- f. Solder Joint
- g. Wipe excess solder from exterior of joint before hardened.
- 5. Solvent Welded Joints (SLV):
  - a. Use only solvent cement which is rated for use in the service intended. Check compatibility of solvent cement with service, especially in pipelines which carry chemicals.
  - b. Observe all manufacturer's requirements for environmental conditions for use of solvent cement.
  - c. Cut pipe ends square and remove fins and burrs.
  - d. Apply appropriate primer.
  - e. Apply solvent cement and assemble joint.
    - 1) Hold in place long enough for solvent cement to set-up and hold joint, as assembled, until solvent cement has cured.
  - f. Wipe excess solvent cement from exterior of joint before hardened.
- 6. Proprietary Restrained Mechanical Joints (PRJ):
  - a. PRJ piping shall be furnished with factory-fabricated retainer weldment on spigot end.
  - b. If PRJ piping is field cut, the pipe joint shall be restrained using Restrained Mechanical Joint (RMJ) Glands as specified in Section 15120, Piping Specialties. Field welding of retainer weldment will not be allowed.
- 7. Welded Steel and Stainless Steel Joints (WLD)
  - a. Field welded joints shall be in accordance with AWWA C206
  - b. Welder Qualifications:
    - 1) 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.
    - 2) Welders shall be qualified by the CONTRACTOR under the provisions of ASME BPVC for shop welds and ANSI/AWS D1.1 for field welds.
    - 3) Furnish all material and bear the expense of qualifying welders.
  - c. Backing rings will not be permitted for 30-inch and smaller pipe. Single field-welded butt joints with outside backing rings may be used for pipe larger than 30 inches in diameter.
  - d. Where exterior welds are performed, adequate space shall be provided for welding and inspection of the joints.
  - e. Butt Straps
    - 1) Butt straps shall be used as closure pieces and where shown on the Drawings.
    - 2) Where used or required, shall be as shown on the Contract Drawings or as approved during shop drawing review.
    - 3) When fitting up the ends of pipe to be welded or fitting butt-strap pieces, minor jacking or clamping will be allowed. Cold working the metal and sledges or localized application of heat and working the metal and sledges will not be allowed. If field displacement of joints, where butt strap joints are indicated, does not allow proper fit-up with the tolerances indicated, special closure butt straps or mitered pieces shall be shop fabricated and installed.
    - 4) Butt straps shall be welded on both the inside and outside of the pipe and at each end of the pipe and strap to avoid stress multiplication.

- f. Prior to the backfilling or beginning the welding procedure, any tack welds or joint stops used to position the pipe during laying shall be removed. Any annular space between the faying surfaces of the bell and spigot shall be equally distributed around the circumference of the joint by shimming, jacking, or other suitable means. The weld shall then be made in accordance with ANSI/AWWA C206. Where more than one pass is required, all dirt, slag, and flux shall be removed before the succeeding bead is applied.
    - g. Repair of Welds: All welds that are defective shall be repaired by the CONTRACTOR to meet the requirements of this section at no additional cost to the OWNER. Defects in welds or defective welds shall be removed, and that section of the joint shall then be re-welded. Only sufficient removal of defective material that is necessary to correct the defect is required. After the repair is made, the joint shall be checked by repeating the original test procedure. Welds deficient in size shall be repaired by adding weld metal.
  - 8. Insulating Flanges, Couplings, and Dielectric Unions:
    - a. Applications: Provide insulating flange, coupling or di-electric union for all joints at the following locations:
      - 1) Dissimilar metal piping connections.
      - 2) Cathodically protected piping penetration to buildings.
      - 3) Submerged to unsubmerged metallic piping connections.
      - 4) Where required for electrically insulated connection.
    - b. Installation:
      - 1) Insulating joints connecting immersed piping to non-immersed piping shall be installed above maximum water surface elevation.
      - 2) Align and install insulating joints according to manufacturer's recommendations to avoid damaging insulating materials.
- C. Exposed Piping Installation:
  - 1. Piping Runs:
    - a. Parallel to building or column lines and perpendicular to floor, unless shown otherwise.
    - b. Piping upstream and downstream of flow measuring devices shall provide straight lengths as required for accurate flow measurement.
  - 2. Supports: As specified in Section 15010, PIPING SUPPORT SYSTEMS.
  - 3. Group piping wherever practical at common elevations; install to conserve building space and not interfere with use of space and other work.
  - 4. Provide unions or flanges at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal.
  - 5. Install piping so that no load or movement in excess of that stipulated by equipment manufacturer will be imposed upon equipment connection;
  - 6. Install piping to allow for contraction and expansion without stressing pipe, joints, or connected equipment.
  - 7. Piping clearance, unless otherwise shown:
    - a. Over Walkway and Stairs: Minimum of 7 feet 6 inches, measured from walking surface or stair tread to lowest extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
    - b. Between Equipment or Equipment Piping and Adjacent Piping: Minimum 3 feet 0 inch, measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
    - c. From Adjacent Work: Minimum 1 inch from nearest extremity of completed piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.

- d. Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.
- e. Headroom in front of openings, doors, and windows shall not be less than the top of the opening.
- f. Do not install piping containing liquids or liquid vapors in transformer vaults or electrical equipment rooms.
- g. Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical work.

D. Buried Pipe Installation:

1. Pipe Placement:

- a. Keep trench dry until pipe laying and joining are completed.
- b. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.
- c. Prevent foreign material from entering pipe during placement.
  - 1) Close and block open end of last laid pipe section when placement operations are not in progress and at close of day's work.
- d. Lay pipe upgrade with bell ends pointing in direction of laying.
- e. Deflect pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. Utilize a maximum of 75 percent of manufacturer's recommended allowable joint deflection.
  - 1) If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, provide:
    - a) Shorter pipe lengths.
    - b) Fittings/bends.
- f. Secure pipe which has been placed from movement or damage while placing the next section of pipe.
- g. Prevent uplift and floating of pipe prior to backfilling.

E. Cleaning:

- 1. Following assembly and testing, and prior to disinfection and final acceptance, flush pipelines with water at 2.5 fps minimum flushing velocity until foreign matter is removed. At a minimum, flush for a period of time which will flush the entire pipeline volume three times.
  - a. If impractical to flush large diameter pipe at 2.5 fps, clean in-place from inside by brushing and sweeping, then flush line at lower velocity. If lower velocity is used, flush the entire pipeline volume five times.
- 2. Provide temporary means of removing flushing water from pipeline during flushing.
- 3. Provide means for removal/screening of debris from the flushing water, disposal of debris and disposal of flushing water.

### 3.4 TESTING

- A. Pressure test piping in accordance with the Pipe Schedule, and Section 15990, Pressure Testing of Piping Systems.

### 3.5 SUPPLEMENTS

- A. The following supplements are attached to this Specification section and incorporated herein by reference:
  - 1. Pipe Schedule (see Drawings)
  - 2. 15100 PSDS BSP – Black Steel Pipe

3. 15100 PSDS CHE – Chemical Tubing and Pipe System
4. 15100 PSDS COP – Copper Pipe
5. 15100 PSDS CPVC – Solvent Welded CPVC Pipe
6. 15100 PSDS DIP – Ductile Iron Pipe
7. 15100 PSDS HDPE1 – High Density Polyethylene Dual Wall Solid Drainage Pipe
8. 15100 PSDS HDPE2 – High Density Polyethylene Dual Wall Perforated Drainage Pipe
9. 15100 PSDS PVC1 – Solvent Welded Polyvinyl Chloride Pipe
10. 15100 PSDS PVC2 – PVC Pressure Pipe
11. 15100 PSDS PVC3 – Polyvinyl Chloride Drain, Waste and Vent Pipe
12. 15100 PSDS PVC4 – PVC Sewer Pipe
13. 15100 PSDS SSTP – Stainless Steel Pipe
14. 15100 PSDS SSTT – Stainless Steel Tubing
15. 15100 PSDS WSP – Welded Steel Pipe
16. 15100 PSDS WSSTP – Welded Stainless Steel Pipe

+ + END OF SECTION + +

**SECTION 15100 PSDS BSP****PIPING SYSTEM DATA SHEET – BLACK STEEL PIPE**

ITEM	SIZE	DESCRIPTION
Pipe	2 inch & smaller 2-1/2 thru 6 inch	Carbon steel, ASTM A106, Grade B seamless or ASTM A53 Rev A, Grade B seamless or ERW. Schedule 80. Schedule 40.
Joints	3 inch & smaller 4 inch & larger	Threaded or flanged at valves and equipment. Flanged at valves and equipment.
Fittings		Threaded: ASTM A105 Class 3000 Forged Steel, threaded ASME B16.11.
Branch Connections		Tee or reducing tee in conformance with Fittings, above, galvanized 2,000-pound WOG threadolet or welding boss; galvanize after welding.
Flanges		Galvanized forged carbon steel, ASTM A105/A105M, ANSI B16.5 Class 150 or Class 300, threaded, 1/16-inch raised face.
Unions		Threaded malleable iron, ASTM A197 or A47, 300-pound WOG, brass to iron seat, meeting the requirements of ANSI B16.3.
Plugs		Forged carbon steel, ASTM A181/A181M Rev A, Grade II, round head, threaded, galvanized.
Bolting		Flanges: Carbon steel ASTM A307, Grade A hex head bolts and ASTM A563, Grade A hex head nuts.
Gaskets	All Flanges	Flanged, Water and Sewage Service: 1/8-inch thick, red rubber (SBR), hardness 80 (Shore A), rated to 200 degrees F., conforming to ANSI B16.21, AWWA C207, and ASTM D1330, Grades 1 and 2.  Blind flanges shall be gasketed covering the entire inside face with the gasket cemented to the blind flange.
Thread Lubricant	2 inch & smaller	Teflon tape or joint compound that is insoluble in water.

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15100-2 PSDS BSP



## SECTION 15100 PSDS CHE

### PIPING SYSTEM DATA SHEET – CHEMICAL TUBING AND CONDUIT

ITEM	DESCRIPTION																										
General	For liquid chemical service, provide color-coded LLDPE tubing, colors as listed in the Pipe Schedule. For gas chemical service, provide HDPE tubing, natural color (semi-opaque white). Install tubing in electrical conduit for ease of installation/replacement as well as non-pressure rated secondary containment. Tubing manufacturer shall confirm chemical compatibility of tubing with chemical system being served.																										
Tubing	<p>Tubing size references on the Drawings or in the Specifications refer to outside diameter, unless noted otherwise. Provide tubing with the following corresponding inside diameter and pressure rating where outside diameter is called for:</p> <table><tr><th rowspan="2">OUTSIDE DIAMETER</th><th rowspan="2">INSIDE DIAMETER</th><th colspan="2">PRESSURE RATING AT 70 DEG. F</th></tr><tr><th>LLDPE</th><th>HDPE</th></tr><tr><td>3/8"</td><td>1/4"</td><td>214 psi</td><td>272 psi</td></tr><tr><td>1/2"</td><td>3/8"</td><td>153 psi</td><td>194 psi</td></tr><tr><td>5/8"</td><td>1/2"</td><td>119 psi</td><td>151 psi</td></tr><tr><td>3/4"</td><td>5/8"</td><td>97 psi</td><td>123 psi</td></tr><tr><td>1"</td><td>3/4"</td><td>154 psi</td><td>195 psi</td></tr></table> <p>HDPE tubing shall be suitable for full vacuum service (14 psi vacuum)</p> <p>LLDPE Characteristics:</p> <ul style="list-style-type: none"><li>• Specific Gravity (ASTM D792): &lt;0.920</li><li>• Tensile strength (ASTM D638): 2800 psi @ 73 deg. F</li><li>• Elongation (ASTM D638): 530%</li><li>• Hardness (ASTM D785): 44D Rockwell Durometer</li><li>• Heat Distortion (ASTM D648): 120 deg. F @ 66 psi</li><li>• Color:<ul style="list-style-type: none"><li>▪ 3/8" I.D. and smaller - red, green, blue, white, gray, yellow, orange, purple, or black</li><li>▪ Larger than 3/8" I.D. - semi-opaque or black</li></ul></li></ul>	OUTSIDE DIAMETER	INSIDE DIAMETER	PRESSURE RATING AT 70 DEG. F		LLDPE	HDPE	3/8"	1/4"	214 psi	272 psi	1/2"	3/8"	153 psi	194 psi	5/8"	1/2"	119 psi	151 psi	3/4"	5/8"	97 psi	123 psi	1"	3/4"	154 psi	195 psi
OUTSIDE DIAMETER	INSIDE DIAMETER			PRESSURE RATING AT 70 DEG. F																							
		LLDPE	HDPE																								
3/8"	1/4"	214 psi	272 psi																								
1/2"	3/8"	153 psi	194 psi																								
5/8"	1/2"	119 psi	151 psi																								
3/4"	5/8"	97 psi	123 psi																								
1"	3/4"	154 psi	195 psi																								

15100-1 PSDS CHE

ITEM	DESCRIPTION												
	<p>HDPE Characteristics:</p> <ul style="list-style-type: none"> <li>• Specific Gravity (ASTM D792): 0.955</li> <li>• Tensile strength (ASTM D638): 3900 psi @ 73 deg. F</li> <li>• Elongation (ASTM D638): &gt;500%</li> <li>• Hardness (ASTM D785): 65D Rockwell Durometer</li> <li>• Heat Distortion (ASTM D648): 151 deg. F @ 66 psi</li> <li>• Color: Semi-Opaque or Black</li> </ul> <p>For all tubing runs, use continuous lengths of tubing with no splices. Tubing Manufacturers: Hudson Extrusions, or equal</p>												
Conduit	<p>Conduit for chemical tubing shall be PVC electrical conduit, as specified in Division 16. Sizes shall be as listed below:</p> <table> <tr> <th>TUBING OUTSIDE DIAMETER</th><th>CONDUIT SIZE</th></tr> <tr> <td>3/8"</td><td>2"</td></tr> <tr> <td>1/2"</td><td>2"</td></tr> <tr> <td>5/8"</td><td>2"</td></tr> <tr> <td>3/4"</td><td>3"</td></tr> <tr> <td>1"</td><td>3"</td></tr> </table>	TUBING OUTSIDE DIAMETER	CONDUIT SIZE	3/8"	2"	1/2"	2"	5/8"	2"	3/4"	3"	1"	3"
TUBING OUTSIDE DIAMETER	CONDUIT SIZE												
3/8"	2"												
1/2"	2"												
5/8"	2"												
3/4"	3"												
1"	3"												
Fittings	<p>Provide all necessary fittings, clamps and adapters for connection of tubing at the chemical metering pump outlet, chemical feed point, and any other connections shown on the Drawings. Provide barbed- or compression-style fittings, specifically designed for use with the tubing being provided, and compatible with the service (both with the fluid being carried in pipe and pressure rating). Fittings shall be located so that they are accessible at all times. No fittings shall be located in the carrier pipe.</p> <p>All connections shall be constructed per tubing manufacturer's recommendations to provide a connection which is equal to or greater than tubing pressure rating. All parts or fittings in contact with the fluid in the tubing shall be compatible with the chemical being carried.</p>												

## SECTION 15100 PSDS COP

### PIPING SYSTEM DATA SHEET – COPPER PIPE

ITEM	DESCRIPTION
Tubing	Seamless, conforming to ASTM B88 as follows: Potable water (buried) .....Type K, soft or hard temper Potable water (exposed) .....Type L, hard drawn Compressed air service .....Type L, hard drawn P-Trap priming service .....Type L, soft temper
Fittings	Commercially pure wrought copper, socket joint, conforming to ASTM B75, dimensions conforming to ANSI B16.22. Brass fittings: ¾" to 2" Conductive Compression CTS Connection Manufacturers: Jones, Mueller, Ford, or approved equal Copper Tubing, Type K Manufacturers: Cambridge Lee, Mueller Streamline, Aqua Shield, or approved equals
Flanges	Commercially pure wrought copper, socket joint, conforming to ASTM B75, faced and drilled 150-pound ANSI B16.24 standard.
Bolting	ASTM A307, carbon steel, Grade A hex head bolts, and ASTM A563 Grade A hex head nuts.
Gaskets	1/16-inch thick nonasbestos compression type, full face, Cranite, John Manville.
Solder	Joints 2-1/2 Inch and Smaller: Wire solder (95 percent tin), conforming to ASTM B32 Alloy Grade Sn95. Do not use cored solder.  Joints Larger Than 2-1/2 Inch: Wire solder, melt range approximately 440 degrees F to 660 degrees F, conforming to ASTM B32 Alloy Grade HB or HN. Do not use cored solder.

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## SECTION 15100 PSDS CPVC

### PIPING SYSTEM DATA SHEET – SOLVENT WELDED CHLORINATED POLYVINYL CHLORIDE PIPE

ITEM	DESCRIPTION
Pipe	Schedule 80 CPVC: Type IV, Grade I or Class 23447-B conforming to ASTM D1784 and ASTM F441. Manufactured with 2 percent titanium dioxide for ultraviolet protection. Threaded nipples shall be schedule 80.
Fittings	Schedule 80 CPVC as Specified Under Pipe Above: Conforming to the requirements of ASTM F439 Rev A for socket-weld type and ASTM F437 for threaded type. Manufactured with 2 percent titanium dioxide for ultraviolet protection.
Joints	Solvent socket-weld except where connection to valves and equipment may require future disassembly.
Flanges	One piece, molded hub Type CPVC flat face flange in accordance with Fittings above; 125-pound ANSI B16.1 drilling.
Bolting	Flat Face Mating Flange or In Corrosive Areas: ASTM A193/A193M Rev A Type 316 stainless steel Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex head nuts. Raised Face Mating Flange: Carbon steel ASTM A307 Grade B square head bolts and ASTM A563 Grade A heavy hex head nuts.
Gaskets	Flat-Face Mating Flange: Full faced 1/8-inch thick EPDM rubber. Raised-Face Mating Flange: Flat ring 1/8-inch EPDM rubber, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.
Solvent Cement	As recommended by the pipe and fitting manufacturer conforming to ASTM F493 Rev A.
Thread Lubricant	Teflon tape.

15100-1 PSDS CPVC

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## SECTION 15100 PSDS DIP

### PIPING SYSTEM DATA SHEET – DUCTILE IRON PIPE

ITEM	DESCRIPTION
Pipe	<p><b>Buried Piping:</b> Pressure class as indicated in the pipe schedule. If not indicated:</p> <ul style="list-style-type: none"> <li>• All pipe 12" diameter and smaller shall be pressure class 350.</li> <li>• All pipe 14" through 20" shall be pressure class 250.</li> <li>• All pipe larger than 20" shall be pressure class 200.</li> </ul> <p><b>Flanged Piping:</b> Special Thickness Class 53 Pressure class shall be per AWWA C150/A21.50 and AWWA C151/A21.51</p> <p>All buried pipes designed to carry recycled water shall be distinctively wrapped in purple tape.</p> <p>Manufacturers:</p> <p>Tyler Union US Pipe Or approved equal</p>
Lining	<p><b>Water and Reclaimed Water:</b> Cement-Mortar: AWWA C104/A21.4.</p> <p><b>Wastewater:</b> Modified Polyamine Ceramic Epoxy as follows:</p> <ol style="list-style-type: none"> <li>1. 100% Solids with 20% by volume of ceramic microspheres for abrasion resistance.</li> <li>2. Minimum lining thickness: 40 mils nominal dry film thickness.</li> <li>3. All Wastewater lined DIP is subject to holiday inspection prior to installation.</li> <li>4. All Wastewater lined DIP is subject to CCTV inspection before and after installation. All areas identified where coating is damaged shall be repaired by the CONTRACTOR in accordance with the manufacturer's recommendations, at no cost to OWNER.</li> <li>5. Manufacturer and Product:             <ol style="list-style-type: none"> <li>a. Perma-Shield PL Series 431, Tnemec</li> </ol> </li> </ol> <p><b>Water, Reclaimed Water:</b> Ceramic Epoxy</p> <ol style="list-style-type: none"> <li>1. Amine cured epoxy containing ceramic quartz pigment</li> <li>2. 100% volume solids content</li> <li>3. NSF-61 approved for potable water</li> <li>4. Minimum lining thickness: 30 mils nominal dry film thickness</li> <li>5. Manufacturer and Product:</li> </ol>

15100-1 PSDS DIP

ITEM	DESCRIPTION
	<ul style="list-style-type: none"> <li>a. Induron Protective Coatings, Perma-Clean 100 Ceramic Epoxy Lining</li> <li>b. Or Equal</li> </ul> <p><b>Wastewater, Sludge, Scum, as noted in Pipe Schedule:</b> Glass lining as follows:</p> <ul style="list-style-type: none"> <li>1. The glass powder shall be specially formulated to prevent the adherence of grease and crystalline metal salt deposits in sludge, scum, and sewage pipelines, and shall be hard, smooth, vitreous and inorganic.</li> <li>2. Minimum lining thickness: 10 mils nominal dry film thickness.</li> <li>3. Glass lining shall be exposed to a maturing temperature of approximately 1400 degrees F.</li> <li>4. Hardness: 5-6 on the Mohs scale.</li> <li>5. Density: 2.5 to 3.0 grams per cubic centimeter per ASTM D 792.</li> <li>6. The following tests must be run on coupons from factory lined Ductile Iron pipe: <ul style="list-style-type: none"> <li>a. Per the recommended industry standards under ASTM D-5162-01, NACE RP 0188-99, and SSPC Coating Manual, Volume 1, Section XIV, the glass lining shall be tested by "low voltage, wet sponge, non-destructive holiday detection unit", with only isolated voids permitted due to casting anomalies. Test procedure and acceptance criteria shall be per the attachment "MP-9.2, Porcelain Enamel Continuity Testing", and documentation shall be furnished with each shipment of material listing the test results by identifying "mark" or "tag" numbers.</li> <li>b. The glass lining shall be capable of withstanding an instantaneous thermal shock of 350 degrees F.</li> <li>c. The finished lining shall be able to withstand a strain of 0.001 inch/inch (the yield point of the base metal) without damage to the glass.</li> <li>d. The glass lining shall be capable of withstanding an instantaneous thermal shock of 350 degrees F differential without crazing, blistering or spalling.</li> <li>e. The glass lining shall be resistant to corrosion of between PH-3 and PH-10 at 125 degrees F.</li> <li>f. There shall be no visible loss of surface gloss to the lining after immersing a production sample in an 8% sulfuric acid solution at 148 degrees F for a period of 10 minutes.</li> <li>g. When tested according to ASTM C-283, it shall show a weight loss of not more than 3 milligrams per square inch.</li> </ul> </li> <li>6. Manufacturer and Product: <ul style="list-style-type: none"> <li>a. FerroRock MEH-32</li> </ul> </li> </ul>

15100-2 PSDS DIP



ITEM	DESCRIPTION
	b. VITCO SG-14 c. Ceramic Coating Company SL-31 d. Or Equal.
Coating	Unless otherwise specified in the Pipe Schedule, piping shall be coated as follows: <b>Buried Piping:</b> <ul style="list-style-type: none"> <li>• AWWA C151/A21.51: Minimum 1-mil asphaltic coating.</li> <li>• AWWA C105/A21.5: Polyethylene encasement, 4-mil high-density cross laminated or 8-mil linear-low density, color as required by local/state regulations.</li> </ul> <b>Exposed/Immersed Piping:</b> <ul style="list-style-type: none"> <li>• Primer Coating: Where shop primer is applied to protect pipe during shipping, storage and handling, primer shall be compatible with pipe coating requirements of Section 09900, Painting.</li> </ul>
Fittings	Lined and coated same as pipe. <b>Push-On (PO):</b> AWWA C110/A21.10 and C111/A21.11, gray or ductile iron, 250 psi minimum working pressure. American Cast Iron Pipe Co., Fastite Joint; U.S. Pipe and Foundry, Tyton Joint. <b>Mechanical (MJ):</b> AWWA C110/A21.10, C111/A21.11, and C153/A21.53 gray or ductile iron, 250 psi minimum working pressure. Follower glands shall be ductile iron. <b>Restrained Mechanical Joint (RMJ):</b> Standard MJ Fittings with RMJ Gland conforming to requirements of Section 15120, PIPING SPECIALTIES. <b>Proprietary Restrained (PRJ):</b> AWWA C111/A21.11 and C153/A21.53, ductile iron, 250 psi minimum working pressure. Clow Corp., Super-Lock Joint; American Cast Iron Pipe Co., Flex-Ring or Lok-Ring Joint; U.S. Pipe, TR Flex. <b>Grooved End (GRV):</b> AWWA C606 and C110/A21.10, ductile iron, 250 psi minimum working pressure. Victaulic. <b>Flange (FLG):</b> AWWA C110/A21.10 ductile iron, faced and drilled, 125-pound flat face. Gray cast iron will not be allowed.
Joints	<b>Push-On (PO):</b> 250 psi minimum working pressure, AWWA C110/A21.10 and C111/A21.11. American Cast Iron Pipe Co., Fastite Joint; U.S. Pipe and Foundry, Tyton Joint. <b>Mechanical (MJ):</b> 250 psi minimum working pressure. <b>Restrained Mechanical Joint (RMJ):</b> Standard MJ Joint with RMJ gland conforming to requirements of Section 15120, PIPING SPECIALTIES. <b>Proprietary Restrained (PRJ):</b> 150 psi minimum working pressure. Clow Corp., Super-Lock; American Cast Iron Pipe Co., Flex-Ring or Lok-Ring; U.S. Pipe, TR Flex. <b>Grooved End (GRV):</b> Rigid type radius cut conforming to AWWA C606, 250 psi minimum working pressure. Victaulic.

15100-3 PSDS DIP

ITEM	DESCRIPTION
	<p><b>Flange (FLG):</b> 125-pound flat face, ductile iron, threaded conforming to AWWA C115/A21.15. Gray cast iron will not be allowed.</p> <p>Branch connections 3 inches and smaller, shall be made with service saddles as specified in Section 15120, PIPING SPECIALTIES.</p>
Couplings	<p><b>Grooved End:</b> 250 psi minimum working pressure, malleable iron per ASTM A47 or ductile iron per ASTM A536. Victaulic.</p> <p><b>Grooved End Adapter Flanges:</b> 250 psi minimum working pressure, malleable iron per ASTM A47 or ductile iron per ASTM A536. Victaulic.</p>
Bolting	<p><b>T-Bolts and other specialty bolts:</b> Manufacturer's standard.</p> <p><b>Hex Bolts:</b> ASTM A307, Grade B carbon steel hex head bolts</p> <p><b>Nuts:</b> ASTM A563, Grade A carbon steel hex head nuts.</p> <p><b>T-Bolts and other specialty bolts:</b> Type 304 stainless steel</p> <p><b>Hex Bolts:</b> ASTM A193 B8, Type 304 stainless steel</p> <p><b>Nuts:</b> ASTM A194 Grade 8, Type 304 stainless steel</p>
Gaskets	<p><b>Push-On, Mechanical, and Proprietary Restrained Joints:</b> Red Rubber (SBR) conforming to ANSI/AWWA C111/A21.11.</p> <p><b>Grooved End Joints:</b> Halogenated butyl conforming to ASTM D2000 and AWWA C606.</p> <p><b>Flanged, Water and Sewage Service:</b> 1/8 inch-thick, red rubber (SBR), hardness 80 (Shore A), rated to 200 degrees F, conforming to ANSI B16.21, AWWA C207, and ASTM D1330, Grades 1 and 2.</p> <p>Full face for 125-pound flat-faced flanges, flat-ring type for 250-pound raised-face flanges. Blind flanges shall be gasketed covering the entire inside face with the gasket cemented to the blind flange.</p> <p>Gasket pressure rating to equal or exceed the system hydrostatic test pressure.</p>
Joint Lubricant	Manufacturer's standard.
Manufacturers	<p>Pacific States</p> <p>Tyler</p> <p>US Pipes</p> <p>Griffin</p> <p>American Or approved equals</p>

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15100-5 PSDS DIP

## SECTION 15100 PSDS HDPE1

### PIPING SYSTEM DATA SHEET – HIGH DENSITY POLYETHYLENE DUAL WALL SOLID DRAINAGE PIPE

ITEM	DESCRIPTION
Pipe	High Density Polyethylene Pipe, smooth inside, corrugated outside intended for storm drainage application. Meeting the requirements of ASTM F2648, AASHTO M-252/M-294, Type S. Meets H-20 loading requirements with 1-foot of soil cover. Provide dual wall solid pipe as per the Drawings. ADS N-12 WT IB or equal.
Fittings	Use Bell and Spigot connections meeting the watertight joint performance requirements of ASTM F2306. Elbows shall be radius, not segmented/beveled. Do not use fabricated HDPE fittings. Lab test certified to 10.8 psi in accordance with ASTM D3212. ADS Dual Wall Fittings or equal.
Joints	Water-tight joints, integral bell/spigot ends with an integral reinforcing collar on the bell in accordance with ASTM D3212. Provide gasket on the spigot end. Provide transition couplings and adapters as required to couple with other piping systems. Apply joint lubricant per manufacturer on the gasket and bell during assembly. Lab test certified to 10.8 psi, in accordance with ASTM D3212.
Couplings	HDPE wrap-around sleeve with self-contained tightening straps. Lab test certified to 5 psi, minimum. Same manufacturer as pipe.
Gaskets	Rubber gasket meeting the requirements of ASTM F-477.
Lining	None
Test Pressure	5 psi - conduct pressure testing in accordance with Specification 15990.
Coating System / Color	None

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15100-2 PSDS HDPE1

## SECTION 15100 PSDS HDPE2

### PIPING SYSTEM DATA SHEET – HIGH DENSITY POLYETHYLENE PERFORATED DUAL WALL DRAINAGE PIPE

ITEM	DESCRIPTION
Pipe	High Density Polyethylene Pipe, smooth inside, corrugated outside intended for storm drainage application. Meeting the requirements of AASHTO M-252/M-294, Type S. Meets H-20 loading requirements with 1-foot of soil cover. Provide "slotted" pipe as per the Drawings. ADS N-12 ST IB or equal.
Fittings	Use PVC thermo-molded sanitary fittings, which are constructed to specifically work with the HDPE pipe system. Lab test certified to 10.8 psi, minimum, meeting the requirements of ASTM D3212. Elbows shall be radius, not segmented/beveled. Do not use fabricated HDPE fittings. ADS Series 35 or equal.
Joints	Soil-tight joints, integral bell/spigot ends with an integral reinforcing collar on the bell. Provide gasket on the spigot end. Lab test certified to 10.8 psi, minimum, meeting the requirements of ASTM D3212. Provide transition couplings and adapters as required to couple with other piping systems.
Couplings	HDPE wrap-around sleeve with self-contained tightening straps. Lab test certified to 5 psi, minimum. Same manufacturer as pipe.
Gaskets	Rubber gasket meeting the requirements of ASTM F-477
Lining	None
Test Pressure	None
Coating System / Color	None

15100-1 PSDS HDPE2

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15100-2 PSDS HDPE2

## SECTION 15100 PSDS PVC1

### PIPING SYSTEM DATA SHEET – SOLVENT WELDED POLYVINYL CHLORIDE PIPE

ITEM	DESCRIPTION
Pipe	Schedule 80 Polyvinyl Chloride (PVC), unless indicated otherwise. Type I, Grade I or Class 12454-B conforming to ASTM D1784 and ASTM D1785. Pipe shall be manufactured with 1% titanium dioxide for ultraviolet protection.  All pipes designed to carry recycled water shall be colored purple or distinctively wrapped in purple tape.
Fittings	Schedule to match pipe above, ASTM D2466 and ASTM D2467 for socket weld type and Schedule 80 ASTM D2464 for threaded type. Fittings shall be manufactured with 1% titanium dioxide for ultraviolet protection.
Joints	Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.
Flanges	One piece, molded hub type PVC flat face flange in accordance with Fittings above, 125-pound ANSI B16.1 drilling
Bolting	<b>Hex Bolts:</b> ASTM A193 B8, Type 304 stainless steel <b>Nuts:</b> ASTM A194 Grade 8, Type 304 stainless steel
Gaskets	Flat-Face Mating Flange: Full-faced 1/8-inch thick EPDM rubber.
Solvent Cement	As recommended by the pipe and fitting manufacturer conforming to ASTM D2564, except solvent weld cement for PVC pipe joints in sodium hypochlorite service shall be free of silica filler and shall be certified by the manufacturer to be suitable for that service. Certification shall be submitted.
Thread Sealant	Teflon Tape.

15100-1 PSDS PVC1



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## SECTION 15100 PSDS PVC2

### PIPING SYSTEM DATA SHEET – POLYVINYL CHLORIDE PRESSURE PIPE

ITEM	DESCRIPTION
Pipe	Conform to the requirements of AWWA C900-16 (4-inch to 60-inch) for PVC water transmission pipe, pressure class as shown in pipe schedule. If no pressure class is shown in pipe schedule, provide pressure class adequate to accommodate test pressure shown in pipe schedule. All pipes designed to carry recycled water shall be colored purple.
Fittings	Ductile Iron per 15100 PSDS DIP – Ductile Iron Pipe. Transition fittings necessary for the proper connection shall be the standard of, and provided by, the manufacturer of the fittings.
Joints	Rubber-gasketed bell and spigot or rubber-gasketed couplings. No restrained joint PVC piping shall be allowed. In sections where joint restraint is required, transition piping to Ductile Iron Pipe with restrained joint fittings or as shown on the drawings.
Gaskets	Conforming to the requirements of ASTM F477.
Joint Lubricant	Manufacturer's standard.
Pipe Manufacturers	Certa Lock Diamond Plastics Corporation JM Manufacturing Pacific Western Pipe Vinyl Tech-White Knight Pressure-Flex Pipe PW Eagle North American Pipe Corp Or approved equal
Fittings Manufacturers	Sigma Star Tyler Union US Pipe Or approved equal

15100-1 PSDS PVC2

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## SECTION 15100 PSDS PVC3

### PIPING SYSTEM DATA SHEET – POLYVINYL CHLORIDE DRAIN, WASTE AND VENT PIPE

ITEM	DESCRIPTION
Pipe	PVC Drain Waste and Vent type, ASTM D1785, Type 2110, Schedule 40.
Fittings	Schedule to match pipe above, ASTM D2665 Drain, Waste and Vent Type
Joints	Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.
Solvent Cement	As recommended by the pipe and fitting manufacturer conforming to ASTM D2564.
Thread Sealant	Teflon Tape.
Special Installation Instructions for DWV Piping	<ol style="list-style-type: none"><li>1. Approximate routing as shown on drawings. Provide drain waste and vent piping to produce a complete, code-compliant drain, waste and vent system.</li><li>2. Provide and install all required fittings, adapters, etc. to produce a complete system.</li><li>3. Set piping above floor slab true and plumb.</li><li>4. Set risers in CMU walls where possible, set exposed risers as close to walls as possible.</li><li>5. Where vent stacks pass through roof, fit with flashing sleeve secured to roof.</li><li>6. Extend vents minimum 1 foot above roof.</li></ol>

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## SECTION 15100 PSDS PVC4

### PIPING SYSTEM DATA SHEET – POLYVINYL CHLORIDE GRAVITY SEWER PIPE

ITEM	DESCRIPTION
Pipe	Conform to the requirements of ASTM D3034 (4 to 15-inch) and ASTM F679 (18 to 24-inch). Provide minimum SDR-26 sewer pipe with a minimum pipe stiffness of 115 PSI. PWEagle, or Equal.
Fittings	Conform to the requirements of ASTM D3034 (4 to 15-inch) and ASTM F679 (18 to 24-inch). GPK, or Equal.
Joints	Rubber-gasketed bell and spigot or rubber-gasketed couplings conforming to ASTM D3212.
Gaskets	Conforming to the requirements of ASTM F477.
Joint Lubricant	Manufacturer's standard.

15100-1 PSDS PVC4

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## SECTION 15100 PSDS SSTP

### PIPING SYSTEM DATA SHEET – STAINLESS STEEL PIPE

ITEM	SIZE	DESCRIPTION
Pipe	2 inch & smaller 2-1/2 thru 6 inch	Austenitic stainless steel, ASTM A312, Grade TP 316 seamless, or welded Schedule 80 Schedule 40
Joints	3 inch & smaller 4 inch & larger	Threaded or flanged at valves and equipment. Flanged at valves and equipment.
Couplings		Threaded, Type 316 Stainless Steel, Class 3000: LF2 ASME B16.11, SA182
Flanges		Class 150, F316/316L, ASTM A102, ANSI B16.5 Class 150 or Class 300, threaded, 1/16-inch raised face.
Unions		Threaded Type 316 Stainless Steel, Class 3000: MSS SP83 ,SA182
Plugs		Threaded Type 316 Stainless Steel, Class 3000: Threads conform to ASME B1.20.1 NPT; Materials conform to ASTM A182, Dimension conform to ASME B16.11
Bolting		Hex Bolts: ASTM A320/A320M, Type 316 stainless steel, grade 5 Nuts: ASTM F594, Type 316 stainless steel, grade 5
Gaskets	All Flanges	Flanged, Water and Sewage Service: 1/8-inch thick, red rubber (SBR), hardness 80 (Shore A), rated to 200 degrees F., conforming to ANSI B16.21, AWWA C207, and ASTM D1330, Grades 1 and 2.  Blind flanges shall be gasketed covering the entire inside face with the gasket cemented to the blind flange.
Thread Lubricant	2 inch & smaller	Heavy duty anti-seize joint lubricant for stainless steel threads that is insoluble in water.

15100-1 PSDS SSTP



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## SECTION 15100 PSDS SSTT

### PIPING SYSTEM DATA SHEET – STAINLESS STEEL TUBING

ITEM	DESCRIPTION
Tubing	<p>Tubing shall be manufactured from 316 alloy stainless steel to be a seamless product. Material shall meet the requirements of ASTM A269. Tubing wall thickness shall be selected to result in a minimum pressure rating of 3000 psig, or the test pressure listed in the Pipe Schedule, whichever is greater.</p> <p>Tubing shall not be bent without the use of an approved tube bending tool sized appropriately for tubing being bent.</p>
Finish	<p>Pickle interior and exterior of all stainless steel tubing, fittings, and finished assemblies following fabrication to remove all mill scale, weld inclusions and color; in accordance with ASTM A380. Passivate inside and out in accordance with ASTM A967.</p> <p>Outer surface shall be bead blasted per ASTM A380.</p>
Fittings	<p>Compression</p> <p>Compression fittings shall be Type 316 alloy stainless steel and shall use two ferrules to provide water or air tight seal. Fittings shall be selected to match the tubing diameter. Fittings shall not transmit torque to tubing during installation.</p> <p>Threaded</p> <p>Threaded pipe, gauge or instrument connections shall be made using stainless steel, 150-pound, threaded half-couplings conforming to ASTM A182 or ASTM A276, adapted using compression fittings at the locations specified or shown on the drawings.</p>
Joints	<p>Joints and tees shall be made with union, elbow, or tee fittings only as described above.</p>
Thread Lubricant	<p>Teflon Tape</p>

15100-1 PSDS SSTT

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## SECTION 15100 PSDS VCP

### PIPING SYSTEM DATA SHEET – VITRIFIED CLAY GRAVITY SEWER PIPE

ITEM	DESCRIPTION
Pipe	All VCP to be in conformance with City of Roseville Design & Construction Standards. VCP shall be considered Extra Strength with no solution or glazing for enhanced air pressure test performance.  VCP to conform to the requirements of ASTM C700, C301, C828.
Fittings	Conform to the requirements of ASTM C700 with watertight preformed joints used with VCP.
Joints	Two part polyurethane mixture joint with bell and spigot conforming to ASTM C425. Joints shall have resilient properties.
Gaskets	Conform to the requirements of ASTM C700.
Joint Lubricant	Vegetable based soap lubricant and as per Manufacturer's standard.

15100-1 PSDS VCP

## SECTION 15100 PSDS WSP

### PIPING SYSTEM DATA SHEET – WELDED STEEL PIPE

ITEM	DESCRIPTION
Pipe	Carbon steel ASTM A283/A283M Rev A Grade C or ASTM A285/A285M Grade C, sheet or coil, fabricated in accordance with AWWA C200, straight or spiral seam, thickness designed for 66 percent of minimum yield stress at hydrostatic test pressure, minimum thickness 1/4-inch, sizes are to be nominal outside diameters conforming to ASME B36.10M.
Linings/Coatings	Lining: Cement-Mortar: AWWA C205 Coating: Per 15100PS – Pipe Schedule and 09900 – Painting Factory Applied Lining and Coating: Fusion Bonded Epoxy per AWWA C-213, 16 mil thickness. 3M Scotchkote 206N, or equal. Field Coating: Per 15100P, Pipe Schedule and 09900 – Painting
Joints	Full penetration butt-welded, flanged, rolled grooved end where shown and/or required.
Fittings	All fittings 6" and smaller shall be forged. Fittings 8" to 24 inches may be forged or fabricated, unless shown otherwise on the Drawings.  Fabricated: Carbon steel fabricated from pipe in accordance with AWWA C208; elbows to have a 22.5-degree maximum miter section angle and a radius of 2.5 times the diameter, unless shown otherwise; wyes, tees, crosses, and outlets to be reinforced in accordance with AWWA M-11.  Forged: Butt-welding fittings, ASTM A234/A234M, Grade WPB meeting the requirements of ANSI B16.9. Fitting wall thickness to match adjoining pipe. Elbows to be long radius unless shown otherwise.
Flanges	AWWA C207, Class D (150 psi), Class E (250 psi), or Class F (275 psi) hub or ring type. Pressure class to match pipe.
Bolting	Carbon steel ASTM A307, Grade A hex head bolts and ASTM A563, Grade A hex head nuts.  Bolts for rolled grooved ends shall be manufacturer's standard.

15100-1 PSDS WSP

ITEM	DESCRIPTION
Gaskets	<p><u>Potable Water and Sewage Service:</u> 1/8-inch thick, cloth-inserted rubber, corrosive acid and alkali free conforming to ANSI B16.21 and AWWA C207.</p> <p>Provide full-face gaskets for flat-face flanges; flat ring gaskets for raised-face flanges.</p> <p>Gaskets for rolled grooved ends shall be as recommended by manufacturer for sewage service.</p>

15100-2 PSDS WSP

## SECTION 15100 PSDS WSSTP

### PIPING SYSTEM DATA SHEET – WELDED STAINLESS STEEL PIPE

ITEM	DESCRIPTION
Pipe	ANSI/AWWA C220, Standard for Stainless Steel Pipe, 1/2-inch diameter and larger, latest revision. Pressure class to accommodate test pressure listed in Pipe Schedule. Type as indicated in the Piping Schedule. Minimum Schedule 10.
Linings/Coatings	None
Joints	Full penetration butt-welded, flanged, rolled grooved end, or threaded where shown and/or required.
Fittings	<p>Fabricated: Type 304 stainless steel fabricated in accordance with AWWA C208; elbows to have a 22.5-degree maximum miter section angle, minimum of three sections; wyes, tees, crosses, and outlets to be reinforced in accordance with AWWA M-11.</p> <p>Forged: Butt-welding fittings, ASTM A403M, type 304 stainless steel. Fitting wall thickness to match adjoining pipe.</p> <p>Threaded: Piping 4" and less, threaded per ANSI B1.20.1, pressure class to accommodate test pressure, stainless grade to match pipe grade (ASTM A351 CF8 for grade 304 pipe and CF8M for grade 316 pipe).</p>
Flanges	AWWA C207, Class D (150 psi), Class E (250 psi), or Class F (275 psi) hub or ring type. Type 304 stainless steel, pressure class to match pipe.
Bolting	Hex Bolts: ASTM A320/A320M, Type 304 stainless steel, grade 5 Nuts: ASTM F594, Type 304 stainless steel, grade 5
Gaskets	<p>1/8-inch thick, cloth-inserted rubber, corrosive acid and alkali free for intended service conforming to ANSI B16.21 and AWWA C207; full-face gaskets for flat-face flanges; flat ring gaskets for raised-face flanges.</p> <p>Gaskets for rolled grooved ends shall be as recommended by manufacturer for intended service.</p>
Thread Lubricant	Nonseizing, industrial grade thread sealing compound that is insoluble in water

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15100-2 PSDS WSSTP

City of Roseville  
West Side Tank and Pump Station Project (Phase 2)  
17-083

November 2019  
Final Design Submittal



**SECTION 15120**  
**PIPING SPECIALTIES**

**PART 1 - GENERAL**

**1.1 SUBMITTALS**

- A. Shop Drawings:
  - 1. Manufacturer's data on materials, construction, end connections, ratings, overall lengths, etc.

**PART 2 - PRODUCTS**

**2.1 SERVICE SADDLES**

- A. Double-Strap Iron:
  - 1. Pressure Rating: Capable of withstanding 150 psi internal pressure without leakage or over stressing.
  - 2. Run Diameter: Compatible with outside diameter of pipe on which saddle is installed.
  - 3. Taps: Iron pipe threads.
  - 4. Materials:
    - a. Body: Malleable or ductile iron, or PVC.
    - b. Straps: Galvanized steel.
    - c. Hex Nuts and Washers: Steel.
    - d. Seal: Rubber.
  - 5. Manufacturers and Products:
    - a. PVC:
      - 1) Jones J-996
      - 2) Mueller H-13490/1/2/3/4
      - 3) Ford S912
      - 4) Or Equal
    - b. DIP:
      - 1) Jones J-996
      - 2) Mueller BR2B0474IP, BR2B0684IP, BR2B0899IP, BR2B1104IP, BR2B1314IP, BR2B1732IP
      - 3) Ford
      - 4) Or Equal

**2.2 FLEXIBLE COUPLINGS**

- A. Flexible Couplings (FC)
  - 1. Features:
    - a. Description: Sleeve-type flexible couplings
    - b. Pressure and Service: Same as connected piping.
    - c. Sleeve material: Carbon steel for carbon steel and ductile iron piping systems, or stainless steel for stainless steel piping systems.
    - d. Coating and Lining: All cast and carbon steel components shall be epoxy lined and coated, minimum 16 mils thickness. For potable water service, lining shall be NSF-61 certified.
    - e. Gasket: EPDM

- f. Bolts and Nuts: Alloy steel, corrosion-resistant, prime coated. Buried couplings shall have Type 316 stainless steel bolts and nuts.
  - 2. Manufacturers and Products:
    - a. Ductile Iron Pipe:
      - 1) Dresser Piping Specialties; Style 153.
      - 2) Smith-Blair, Inc.; Style 411.
      - 3) Or Equal.
- B. Flanged Coupling Adapters (FCA)
- 1. Features:
    - a. Description: One end of adapter shall be flanged, and the other end shall have a sleeve type flexible coupling.
    - b. Pressure and Service: Same as connected piping.
    - c. Adapter body material: Cast iron or steel.
    - d. Gasket: EPDM
    - e. Bolts and Nuts: Alloy steel, corrosion-resistant, prime coated. Buried couplings shall have Type 316 stainless steel bolts and nuts.
  - 2. Manufacturers and Products:
    - a. Ductile Iron Pipe:
      - 1) Dresser Piping Specialties; Style 227.
      - 2) Smith-Blair, Inc.; Style 127.
      - 3) Or Equal.
- C. Restrained Flanged Coupling Adapters (RFCA)
- 1. Features:
    - a. Description: One end of adapter shall be flanged, and the other end shall have a sleeve type flexible coupling.
    - b. Pressure and Service: Same as connected piping.
    - c. Adapter body material: Cast iron or steel.
    - d. Gasket: EPDM
    - e. Bolts and Nuts: Alloy steel, corrosion-resistant, prime coated. Buried couplings shall have Type 316 stainless steel bolts and nuts.
    - f. Restraining lug.
  - 2. Manufacturers and Products:
    - a. Ductile Iron Pipe:
      - 1) Flange Adapters: For use with AWWA grooved end pipe and fittings, for mating to ANSI Class 125 flanged components.
      - 2) Victaulic Style 341.
      - 3) Romac Industries; RFCA
      - 4) Or Equal.
- D. Restraint Rods for Flexible Couplings: As shown on the Drawings

## 2.3 RESTRAINED COUPLINGS

- A. Restrained Mechanical Joint Glands (RMJ)
  - 1. Pressure Rating:
    - a. Minimum Working Pressure Rating: Not less than 150 psi.
    - b. Safety Factor: Not less than two times working pressure and shall be supported by manufacturer's proof testing.
  - 2. RMJ gland shall be designed for use with standard mechanical joint pipe. Pipe restraint products designed for use with push-on joints will not be acceptable.
  - 3. Thrust Restraint:

- a. Provide hardened steel wedges that bear against and engage outer pipe surface, and allow articulation of pipe joint after assembly while wedges remain in their original setting position on pipe surface.
    - b. Products employing set screws that bear directly on pipe will not be acceptable.
  - 4. Manufacturer and Product:
    - a. Ductile Iron Pipe Only
      - 1) EBAA Iron Sales Co.; Megalug.
      - 2) Romac Industries Inc.: RomaGrip
      - 3) Or Equal.
- B. Dismantling Joint
- 1. Pressure Rating
    - a. Minimum Working Pressure Rating: Not less than 150 psi
    - b. Pressure rating to be no less than test pressure for piping system in which the Restrained Dismantling Joint is used.
    - c. Safety Factor: Not less than two times working pressure and shall be supported by manufacturer's proof testing.
  - 2. Thrust Restraint
    - a. Provide steel tie rods, ASTM A 193 GR B7
    - b. Number and arrangement of tie rods to provide dismantling joint assembly which meets pressure rating requirement.
  - 3. Materials of Construction
    - a. Flanged Adapter Body: Steel
    - b. Follower Flange: Ductile Iron
    - c. Gasket: Buna-N, NSF-61 approved
    - d. Flange: Steel, per AWWA C207
    - e. Spigot: Steel
    - f. Studs: Type 304 stainless steel
    - g. Coating: NSF-61 approved epoxy
  - 4. Manufacturer and Product
    - a. Smith-Blair, Model 975 or 972, as required for pressure rating
    - b. Romac Industries, Style DJ400
    - c. Or Equal.

## 2.4 FLEXIBLE EXPANSION JOINTS

- A. Service: Water.
- B. Features:
  - 1. Flexible expansion joints shall be installed in the locations indicated on the drawings and shall be manufactured of ductile iron conforming to the material requirements of ASTM A536 and ANSI/AWWA C153/A21.53. Foundry certification of material shall be readily available upon request.
  - 2. Each flexible expansion joint shall be pressure tested prior to shipment against its own restraint to a minimum of 250 PSI. A minimum 2:1 safety factor, determined from the published pressure rating, shall apply.
  - 3. Each flexible expansion joint shall consist of an expansion joint designed and cast as an integral part of a ball and socket type flexible joint, having a minimum per ball deflection of: 25°, 4" - 8"; 20°, 10" - 12"; 15°, 14+" and 6-inches minimum expansion. The flexible expansion fitting shall not expand or exert an axial imparting thrust under internal water pressure. The flexible expansion fitting shall not increase or decrease the internal water volume as the unit expands or contracts.

4. All internal surfaces (wetted parts) shall be lined with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C213. Sealing gaskets shall be constructed of EPDM. The coating and gaskets shall meet ANSI/NSF-61.
  5. Exterior surfaces shall be coated with a minimum of 6 mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C116/A21.16.
  6. Polyethylene sleeves, meeting ANSI/AWWA C105/A21.5, shall be included for direct buried applications.
- C. Manufacturers and Products:
1. FLEX-TEND Force Balanced manufactured by EBAA Iron, Inc. Eastland, TX., U.S.A.
  2. Or equal.

## 2.5 MODULAR MECHANICAL SEAL

- A. Type: Interconnecting synthetic rubber links shaped and sized to continuously fill annular space between pipe and sleeve, blockout, or core-drilled opening in concrete slabs or walls.
- B. Features:
1. Links: EPDM
  2. Bolts and nuts: Type 316 stainless steel
  3. Pressure plates: composite
  4. Temperature range: -40 to 250 degrees Fahrenheit
  5. Pressure rating: guaranteed by the manufacturer to provide a water-tight seal with a differential hydrostatic head of 40-feet of water
- C. Manufacturers and Products:
1. PSI-Thunderline; Link-seal, Type S-316
  2. Or equal

## 2.6 PIPE TO MANHOLE CONNECTORS

- A. Type: Resilient rubber male-to-female wedge-style flexible connector between a circular gravity pipe and a circular opening core-drilled into a precast or cast-in-place concrete structure.
- B. Performance Requirements:
1. Able to hold 10 psi head pressure for 10 minutes with no leakage
  2. Load Rating: 150 lbs per inch pipe diameter
- C. Materials:
1. Body: resilient rubber material conforming to ASTM C923
  2. Hardware: 300 Series Stainless Steel conforming to ASTM C923, ASTM A666 and ASTM A240
- D. Manufacturer and Products
1. Trelleborg Pipe Seals Milford, Inc., Model Kor-N-Seal I – 106 Series for pipes up to 18" diameter and Kor-N-Seal II – 206 Series for pipes from 20" to 54" in diameter.
  2. Or Equal

## 2.7 CHEMICAL CONNECTION

- A. Type: Lockable Male Cam-lock
  - 1. Materials:
    - a. Adapter and Cap: Glass-reinforced polypropylene
    - b. Gaskets and O-rings: Viton
    - c. Handles, Rings, and Pins: Stainless Steel
  - 2. Temperature Rating: 0 to 150 deg F
  - 3. Pressure Rating:
    - a. 0 deg F: 100 psi
    - b. 70 deg F: 125 psi
    - c. 150 deg F: 70 psi
  - 4. Adapter:
    - a. 2" FNPT x Male quick connect adapter
  - 5. Cap
    - a. 2" Lockable Type
- B. Manufacturers and Products:
  - 1. Banjo
    - a. Adapter: 200A with Viton gasket
    - b. Cap: 200CAP with Viton gasket
  - 2. Or equal

## 2.8 NON-METALLIC CORPORATION STOP WITH INJECTION QUILL

- A. Type: Complete assembly of corporation stop, injection quill, and safety chain, designed for use on process pipes 4" or larger. Construction shall be fully compatible with service conditions.
- B. Corporation Stop:
  - 1. Process Connection: 3/4" Male NPT.
  - 2. Rated 150 psi at 195 degrees F.
  - 3. ASTM D1784, Type I, Grade 1 chlorinated polyvinyl chloride body, ball, and stem, end entry.
  - 4. Threaded ends.
  - 5. Viton or Teflon seat.
  - 6. Viton O-rings and stem seals.
  - 7. Manufacturers
    - a. Jones
    - b. Mueller
    - c. Ford
    - d. AY McDonalds MFG Co
    - e. or approved equal
- C. Injection Quill:
  - 1. Process Connection: 1/2" female NPT.
  - 2. Dimensions:
    - a. Minimum 1/4" inside diameter.
    - b. Tapered injector tip, oriented to maximize chemical dispersion.
    - c. Select injection quill length such that tip of quill extends into process pipe between one-third and one-half of process pipe diameter. Minimum distance from pipe wall to injector tip shall be 2-inches.
  - 3. Materials:

- a. Solution Tube Assembly: CPVC.
  - b. Ring, Sleeve and Capture Nut: PVDF.
- 4. Minimum Pressure Rating: 150 psi.
- D. Safety Chain:
  - 1. Designed to prevent injection quill withdrawal before corporation stop is closed.
- E. Manufacturers and Products:
  - 1. Hydro Instruments, CS-075-CPVC.
  - 2. Neptune, CS2-75-PVC.
  - 3. Or Equal

## 2.9 STRAINERS

- A. CPVC Y-STRAINER, 4" diameter and smaller
  - 1. Materials:
    - a. Body: CPVC
    - b. Hex Cleanout Cap: CPVC
    - c. Screen: CPVC
    - d. O-rings and gaskets: Viton
  - 2. 1/32" perforated screen
  - 3. Minimum Pressure Rating: 150 psi
  - 4. Size and connection as shown on the Drawings
  - 5. Manufacturer:
    - a. Hayward Flow Control Systems
    - b. Or Equal
- B. BRONZE Y-STRAINER, 4" diameter and smaller
  - 1. Material:
    - a. Body: Bronze
    - b. Hex Cleanout Cap: Brass or Bronze
    - c. Screen: 304 stainless steel, 1/32" perforations
    - d. O-rings and gaskets: PTFE or Teflon
  - 2. Minimum Pressure Rating: 300 psi
  - 3. Size and connection as shown on the drawings
  - 4. Manufacturer:
    - a. Apollo 59 series
    - b. Or equal

## 2.10 WATER METERS:

- A. General: Purchase water meters through environmental utilities department, water division.
- B. Meter Idlers:
  - 1. Manufacturers:
    - a. Ford; Idler #3-ML, #4-ML, 889-0900-NL, Idler #6-NL
    - b. Jones; E-2208
    - c. Spears; 884-017, 885-107
      - 1) No lead
    - d. Or approved equal
- C. Meter Setters

1. Manufacturers:
  - a. Ford; 40 series
  - b. Jones
  - c. Mueller; B-24118-2N, B-2423-99000N
  - d. AY McDonald; 718 412JC
- D. Meter Spud Couplers
  1. Manufacturers:
    - a. Ford; C38-33-NL, CF31-66-NL, CF31-77-NL
    - b. Jones; E-129, E-130
    - c. AY McDonalds MFG Co; 718412JC
    - d. Mueller; H-10890N, 10-H90-99029N

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. General
  1. Follow all manufacturer's directions
- B. Flexible Couplings (FC)
  1. Follow all manufacturer's directions
  2. No more than 1-inch gap between pipe ends
  3. Center flexible coupling in joint
  4. Tighten bolts in an alternating pattern to provide even tension around the coupling
  5. Tighten bolts to specified torque
  6. In buried installations, wrap coupling with plastic fastened to pipe to protect bolts and coupling from backfill material
- C. Flanged Coupling Adapters (FCA)
  1. Follow all manufacturer's directions
  2. No more than 1-inch gap between pipe plain end and flange face
  3. Tighten flange bolts prior to tightening coupling bolts
  4. Tighten bolts in an alternating pattern to provide even tension around the coupling
  5. Tighten bolts to specified torque
  6. In buried installations, wrap coupling with plastic fastened to pipe to protect bolts and coupling from backfill material
- D. Restrained Mechanical Joint Glands (RMJ)
  1. Follow all manufacturer's directions
  2. Tighten mechanical joint gland bolts before tightening restraint lugs
  3. Tighten restraint lugs until torque head breaks off
  4. In buried installations, wrap joint with plastic fastened to pipe to protect bolts and coupling from backfill material
- E. Pressure Gages
  1. Follow all manufacturer's directions
  2. Install diaphragm seals where process liquid would be detrimental to gage life (wastewater, chemical service, etc.)
  3. Check gage accuracy
- F. Victaulic Couplings

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1. Install in accordance with manufacturer's latest recommendations. Follow the instructions listed in the latest Victaulic I-300 assembly manual.
2. Pipe ends shall be clean and free from indentations and projections in the area from pipe end to groove.
3. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified.
4. Provide on site training for contractor's field personnel in the proper use of grooving tools, application of groove, and product installation.
5. Gaskets used on potable water systems shall be UL classified in accordance with ANSI/NSF-61.
6. Victaulic's factory trained representative shall periodically visit the job site and review installation. Contractor shall remove and replace any improperly installed products.

+ + END OF SECTION + +



**SECTION 15200**  
**VALVES AND OPERATORS**

**PART 1 - GENERAL**

**1.1 SUBMITTALS**

- A. Shop Drawings:
  - 1. Product data sheets for make and model.
  - 2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
  - 3. Certificate of Compliance for: Butterfly valves; full compliance with AWWA C504.
- B. Tests and inspection data.
- C. Operation and Maintenance Data as specified in Section 01330, SUBMITTAL PROCEDURES.

**1.2 PRODUCT DELIVERY, STORAGE, AND HANDLING**

- A. In accordance with manufacturer's directions.

**PART 2 - PRODUCTS**

**2.1 GENERAL**

- A. All valves shall be the same size as the pipe in which they are installed, unless specifically noted otherwise on the Drawings.
- B. All valves shall include all appurtenant parts (operators, chainwheels, handwheels, valve stems, floor stands, gear boxes, operating nut, etc.) for a complete operating valve.
  - 1. Valve shall be, as much as practical, fully factory assembled.
- C. All valves shall open by turning counter-clockwise. Maximum force required for operation shall be 40 lbs.
- D. Where Lead-Free Bronze or Brass is specified, materials shall be in compliance with California Health & Safety Code Section 116875. Not more than a weighted average of 0.25 percent of the wetted surface of the valve shall be lead. Valve shall be provided with a "hang tag" or other marking that easily identifies the valve as Lead-Free.
- E. Coatings and Linings:
  - 1. Provide factory-applied coatings as described herein.
  - 2. Where liquid epoxy coatings are specified, coatings shall conform to AWWA C550.
  - 3. Field coat the exterior of all valve bodies with the same coating as is required for the adjacent pipe in Section 09900, PAINTING and Section 15100, PIPE AND FITTINGS, unless otherwise specified.
- F. Nuts, Bolts and Washers
  - 1. Hex Bolts: ASTM A320/A320M, Type 304 stainless steel, Grade B8, Class 2

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2. Nuts: ASTM F594, Type 304 stainless steel, Grade B8, Class 2
3. Washers: Type 304 stainless steel

## 2.2 BALL VALVES

### A. **BAV-01LF:** Lead-Free Ball Valve, 3 inches and smaller:

1. Service: Potable Water
2. Features:
  - a. Two-piece, end-entry type
  - b. Lead-Free Brass & Bronze Materials in compliance with California Health & Safety Code Section 116875. Not more than a weighted average of 0.25 percent of the wetted surface of the valve shall be lead. Valve shall be provided with a "hang tag" or other marking that easily identifies the valve as Lead-Free.
  - c. Lead-Free Bronze (Alloy C89836, C89833 or C69300) body
  - d. Chrome-plated lead-free brass (Alloy C27450 or C69300) ball
  - e. RTFE or PTFE seats and packing
  - f. Zinc-coated steel hand lever operator with vinyl grip
  - g. Rated 600-psig WOG, 150-psig SWP.
3. Manufacturer and Products:
  - a. Threaded:
    - 1) Apollo 70LF100 Series
    - 2) Milwaukee; UPBA100
    - 3) Nibco T-685-80-LF
    - 4) Or Equal
  - b. Soldered:
    - 1) Apollo 70LF200 Series
    - 2) Milwaukee; UPBA150
    - 3) Nibco S-685-80-LF
    - 4) Or Equal

### B. **BAV-03:** Stainless Steel Ball Valve, 3 Inches and Smaller

1. Service: Water, air.
2. Features:
  - a. Threaded ends
  - b. Rated minimum 800 psig WOG (Water-Oil-Gas)
  - c. Stainless steel body
  - d. Polished stainless steel ball
  - e. Teflon seat
  - f. Stainless steel lever-type handle
3. Manufacturers and Products:
  - a. Apollo, Type 76
  - b. Watts Type S-FBV-1
  - c. Or Equal

### C. **BAV-06:** CPVC Ball Valve 4 Inches and Smaller:

1. Service: Water, Chemical Duty.
2. Features:
  - a. Rated 150 psi at 73 degrees F
  - b. ASTM D1784, Type I, Grade 1 chlorinated polyvinyl chloride body, ball, and stem, end entry
  - c. Double union design
  - d. Flanged-end if noted in Valve Schedule, otherwise solvent-weld socket ends
  - e. Viton or Teflon seat

- f. Viton O-rings and stem seals
    - g. Vented ball
  - 3. Manufacturers and Products:
    - a. Nibco; Chemtrol Tru-Bloc.
    - b. ASAHI/America; Type 21/21A.
  - 4. Or Equal.
- D. **CRP-01:** Ball Corporation Valve 3/4 Inch to 2 Inch:
  - 1. Features:
    - a. Rated 300 psi at 73 degrees F
    - b. Brass alloys C89520 or C89833 with a maximum lead content of 0.25% by weight. Brass alloys shall meet AWWA C800, paragraph 4.1.2.
    - c. Full round-port ball valve, no reduced port permitted
    - d. Ends as required
    - e. Double O-ring stem seals
    - f. Key operator
  - 2. Manufacturers and Products:
    - a. Mueller Company; 300N Series Ball Corporation Valves
    - b. Ford Meter Box Company; FB-NL Series Ballcorp Ball Corporation Valves
    - c. Or Equal.

### 2.3 BUTTERFLY VALVES

- A. **BFV-10:** Butterfly Valve 4 Inches to 72 Inches:
  - 1. Service: Water.
  - 2. Features:
    - a. Flanged end, short body type.
    - b. AWWA C504, Class 150B.
    - c. Features:
      - 1) Body:
        - a) Cast iron
      - 2) Disc:
        - a) Cast or ductile iron disc
        - b) On valves 24-inch and larger, provide non-hollow discs
      - 3) Shaft:
        - a) Type 304 stainless steel shaft,
        - b) Self-adjusting V-type or O-ring shaft seals.
      - 4) Seat:
        - a) Valves 3- to 20- inch:
          - 1. Buna N or NBR rubber seat bonded or molded in body only.
          - 2. Elastomer seats which are bonded or vulcanized to the body shall have adhesive integrity of bond between seat and body assured by testing, with minimum 75-pound pull in accordance with ASTM D429, Method B.
        - b) Valves 24-inch and larger:
          - 1. Buna N or NBR rubber seat retained within a dovetail groove in the valve body and mechanically locked in place by use of an epoxy filler.
          - 2. Valve to be adjustable from either side
          - 3. Valves using seat fasteners or retaining rings are not allowed
        - c) Provide stainless steel seating surface.
      - 5) Coatings and Linings:
        - a) Liquid epoxy, 12 mil minimum, for valve interior and exterior.
        - b) For potable water applications, epoxy lining shall be NSF 61 approved.

- c) Epoxy to be holiday free
- d. Valve shall be suitable for throttling operations and infrequent operation after periods of inactivity.
- e. Valve shall be bubble-tight with rated pressure applied from either side.
- f. Smooth flow stream on valve body interior
  - 1) No travel stops for disc on interior of body.
  - 2) Isolate metal-to-metal thrust bearing surfaces from flowstream.
- 3. Manufacturers and Products:
  - a. Henry Pratt Company
    - 1) 3" to 12": Model 2FII
    - 2) 16" to 72": Groundhog
  - b. Mueller
    - 1) 16" to 72": Linesal III
  - c. Or Equal.

## 2.4 CHECK VALVES

- A. **CKV-06:** CPVC Ball Check Valve 4" and smaller
  - 1. Service: Water, Chemical Duty.
  - 2. Features:
    - a. Materials:
      - 1) CPVC body and ball, conforming to ASTM D1784 Cell Classification 23567-A.
      - 2) FPM (FKM) uni-seats and seal
    - b. Connections: True union or flanged as shown on the Drawings
    - c. 150 psi minimum pressure rating
    - d. 5 psi minimum shutoff
  - 3. Manufacturers and Products:
    - a. Asahi/America Inc.
    - b. Nibco, Chemtrol True Union Ball Check (3" and smaller)
    - c. Or Equal
- B. **CKV-10:** Swing Check Valve (2" to 24")
  - 1. Service: Water.
  - 2. Style: Swing Check, outside lever and spring, flanged-end connections
  - 3. General: Valves shall comply with AWWA C508.
  - 4. Body: Valve body and cover shall be fabricated with cast iron conforming to ASTM A 126 with flanged ends conforming to ANSI B16.1.
  - 5. Disc: The valve disc shall be fabricated of cast iron or ductile iron and rubber faced.
  - 6. Seat and Rings: The valve seat and rings shall be fabricated of bronze conforming to ASTM B62 or B148 or of Buna-N.
  - 7. Disc Bolt: A307 Steel
  - 8. Hinge: Ductile Iron
  - 9. Hinge Pin: The hinge pin shall be fabricated of stainless steel.
  - 10. Provide check valve with limit switch.
  - 11. Coatings and Linings:
    - a. Liquid epoxy, 12 mil minimum, for valve interior and exterior.
    - b. For potable water applications, epoxy lining shall be NSF 61 approved.
  - 12. Manufacturer:
    - a. M&H; Style 259-02, Lever and Spring
    - b. Milliken; Figure 8001, Lever and Spring
    - c. Or equal.
- C. **CKV-30:** Globe-Style Silent Check Valve

1. Service: Water
2. Working Pressure: 150 psi
3. Features:
  - a. The operation of the valve shall not be affected by the position in the pipeline.
  - b. The valve disk shall be concave to the flow in the pipeline and guided by center shaft.
  - c. The check valve shall have an open area equal to or greater than the pipe diameter.
  - d. Valves 10" and smaller shall be capable of mounting directly to a butterfly valve.
  - e. Check valve shall be spring-loaded, normally-closed by means of a heavy-duty center-guided, stainless steel spring. Flow from the pumps shall cause the valve to open and upon pump shut down, the torsion spring will shut the valve before reverse flow starts and at a point of zero velocity of non-slam closure.
  - f. Ends: ANSI B16.1 Class 125 flanged
4. Materials:
  - a. Body: cast or ductile iron.
  - b. Seat and disk/plug: lead-free bronze or Type 316 Stainless Steel.
  - c. Seating shall be resilient and watertight. The sealing element shall be Buna-N.
  - d. Torsion spring: stainless steel.
  - e. All component parts shall be field replaceable.
5. Manufacturer:
  - a. Apco Series 600
  - b. Valmatic Type 1800.1
  - c. Golden Anderson Model 280
  - d. Or Equal

## 2.5 GATE VALVES

### A. **GAV-01LF:** Lead Free Gate Valve, 3 Inches and Smaller

1. Service: Potable Water
2. Features:
  - a. Lead-Free Brass & Bronze Materials in compliance with California Health & Safety Code Section 116875. Not more than a weighted average of 0.25 percent of the wetted surface of the valve shall be lead. Valve shall be provided with a "hang tag" or other marking that easily identifies the valve as Lead-Free.
  - b. Screwed bonnet
  - c. Single solid wedge gate
  - d. Non-rising stem
  - e. Rated 200-pound WOG.
3. Manufacturers and Products:
  - a. 2" – 2 ½" Threaded:
    - 1) Nibco-113 bronze, threaded end.
    - 2) Or Equal
  - b. Soldered:
    - 1) Stockham; LFB-104, soldered end.
    - 2) Crane; LF1320, soldered end.
    - 3) Or Equal

### B. **GAV-10:** Resilient-Seated Gate Valve, 2 Inches to 24 Inches:

1. Service: Water.
2. Features:
  - a. Conforms to AWWA C509 (2") or AWWA C515 (3" to 24")
  - b. Iron body

- c. Resilient seat, bronze mounted
- d. Full port
- e. Valve Ends:
  - 1) Mechanical joint ends for buried service, unless shown otherwise on drawings or valve schedule
  - 2) Flanged ends for exposed service
- f. Non-rising stem
- g. Actuator for Buried Service:
  - 1) Stem extension, as required, to bring operating nut to within 12" of ground surface.
  - 2) 2-inch operating nut
- h. Actuator for Exposed Service:
  - 1) Handwheel
- i. Design working water pressure: 250 psig
- j. Coatings and Linings:
  - 1) Liquid epoxy, 12 mil minimum, for valve interior and exterior.
  - 2) For potable water applications, epoxy lining shall be NSF 61 approved.
- 3. Manufacturers and Products:
  - a. Mueller 2360 RS
  - b. M&H Valve; 4067R W
  - c. Clow: AFC
  - d. Or Equal.

## 2.6 PLUG VALVES

- A. **PLV-10:** Eccentric Plug Valve, 3 Inches to 20 Inches:
  - 1. Service: Water, sewage.
  - 2. Features:
    - a. Non-lubricated type.
    - b. Drip-tight shutoff with pressure from either direction.
    - c. Features:
      - 1) Body: Cast iron Type ASTM A126 Class B.
      - 2) Plug:
        - a) Cast iron or 316 stainless steel.
        - b) Round or rectangular port of no less than 80 percent of connecting pipe area.
        - c) Coated with Buna-N, Chloroprene, or Hycar.
      - 3) Seats: Type 316 stainless steel or nickel.
      - 4) Stem:
        - a) Bearing: Self-lubricating stainless steel or reinforced Teflon.
        - b) Seal:
          - 1. Multiple V-rings, U-cups, or O-rings of nitrile rubber.
          - 2. Externally adjustable and re-packable without removing the bonnet or actuator from the valve under pressure.
        - c) Provide upper and lower grit seals on stem.
      - 5) Ends:
        - a) Exposed service: Flanged per ANSI B16.1 or grooved, as shown on Drawings or indicated on Valve Schedule.
        - b) Buried service: Mechanical joint per ANSI A21.11.
      - 6) Actuators:
        - a) Exposed:
          - 1. Valves 3 Inches through 6 Inches: Wrench lever manual actuator.

- 2. Valves 8 Inches through 20 Inches: Totally enclosed, geared, manual actuator with handwheel
  - b) Buried: 2-inch nut per Valve Schedule.
- 7) Coatings and Linings:
  - a) Liquid epoxy, 12 mil minimum, for valve interior and exterior.
  - b) For potable water applications, epoxy lining shall be NSF 61 approved.
- d. Pressure Rating:
  - 1) Valves 3 Inches through 12 Inches: 175 psi.
  - 2) Valves 14 Inches through 20 Inches: 150 psi.
- 3. Manufacturers and Products:
  - a. DeZurik; Style PEC.
  - b. Pratt; Ballcentric.
  - c. Milliken; Millcentric.
  - d. Or Equal.

## 2.7 HOSE VALVES

- A. **HSV-01:** ¾" Angle-Pattern Hose Valve, non frost-proof
  - 1. Service: Water.
  - 2. Features:
    - a. ¾-inch NPT female inlet,
    - b. ¾-inch male hose thread outlet,
    - c. Heavy rough brass body rated 125 psi,
    - d. Removable handle,
    - e. Atmospheric vacuum breaker conforming to ASSE Standard 1011 and IAPMO code
  - 3. Manufacturers and Products:
    - a. Acorn; 8131
    - b. Or Equal.
- B. **HSV-03:** Non-Freeze Post Hydrant, ¾" through 2"
  - 1. Features:
    - a. Bronze Non-Freeze Post Hydrant with valve and drain hole below grade and stem extension to 30-inch high post so that hose connection is 30" above grade
    - b. Provide NPT threaded drain hole where drawings show a piped drain.
    - c. Cast Iron Casing Guard
    - d. T-handle key
    - e. Threaded ends, Female NPT inlet and male hose connection outlet
    - f. Atmospheric vacuum breaker conforming to ASSE Standard 1011 and IAPMO code on ¾" size
  - 2. Manufacturers and Products
    - a. Jay R Smith, Figures 5910, 5911, 5912, 5913, 5914
    - b. Zurn, Figures Z1385, Z1390
    - c. Or Equal
  - 3. Manufacturers and Products:
    - a. Jay R Smith, Figure 5509QT
    - b. Zurn, Figure Z1330-C
    - c. Or Equal.

## 2.8 FIRE HYDRANTS

- A. **HYD-20:** WET-BARREL FIRE HYDRANT
  - 1. Service: Water.
  - 2. Features:

- a. Hydrant shall be manufactured in accordance with AWWA Standard C-503
- b. Hydrant head shall be made of gray cast iron, meeting ASTM A126 Class B specifications. It shall be capable of withstanding a hydrostatic test pressure of 4 (four) times the working water pressure without stressing the material beyond its yield point per Section 4.6.3.2 of AWWA C503.
- c. Valved Ports:
  - 1) Wet-barrel fire hydrants shall feature independently-valved ports. The working parts shall be engineered to function as a unit and to give trouble-free service over 200 pounds working pressure and tested to 400 pounds hydrostatic pressure.
  - 2) Fire hydrants shall be provided with two outlet ports: one 2-1/2" diameter and one 4-1/2" diameter.
- d. All hydrants shall be permanently marked to identify the model number of the hydrant, the manufacturer and the year in which the hydrant was manufactured.
- e. Hose and pumper nozzle threads shall be in conformance with the standard for fire hose connections, NFPA 1963, unless otherwise specified.
- f. Protector caps shall be grey cast iron unless otherwise specified by the purchaser. They shall be securely chained to the hydrant barrel and furnished an inner gasket.
- g. Standard nut size of valve/stem and protector caps shall be of pentagonal shape and furnished with a nut of 1 1/8" measured from point to flat of the pentagon.
- h. Coatings and Linings:
  - 1) Liquid epoxy lining, 12 mil minimum, for fire hydrant interior.
  - 2) For potable water applications, epoxy lining shall be NSF 61 approved.
  - 3) Exterior of hydrants shall receive a primer coat and be furnished with a traffic yellow enamel finish coat for potable water, or a purple enamel finish coat for recycled water.
- 3. Manufacturers and Products
  - a. Jones, Model 4040
  - b. Clow Valve Company, Model 850
  - c. Or equal
- 4. Hydrant Bury:
  - a. South Bay Foundry, MJ
  - b. Clow, MJ
  - c. Or approved equals
- 5. Hydrant Bury Extensions:
  - a. South Bay Foundry, MJ
  - b. Clow; Model CW-EXT-BO
  - c. Tyler
  - d. Or approved equal

## 2.9 CONTROL VALVES

- A. **PRV-01LF:** Lead-Free Pressure Regulator, 1/2" to 1"
  - 1. Service: Potable Water
  - 2. Type: Type: Adjustable spring-loaded, self-contained pressure regulator
  - 3. Materials:
    - a. Body: Lead-Free Brass & Bronze Materials in compliance with California Health & Safety Code Section 116875. Not more than a weighted average of 0.25 percent of the wetted surface of the valve shall be lead. Valve shall be provided with a "hang tag" or other marking that easily identifies the valve as Lead-Free.
    - b. Trim, Valve Seat and Spring: Stainless Steel
    - c. Diaphragm: Reinforced Buna-N

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4. Pressures:
    - a. Maximum Inlet Pressure: 300 psig
    - b. Outlet Pressure Range: 15 to 70 psig.
  5. Manufacturer/Model:
    - a. Watts Model LF223
    - b. Or Equal.
- B. **ALT-01:** Electronic Control Valve (Altitude Valve with Pressure Relief):
1. Service: Water.
  2. Design Conditions:
    - 1) Valve Size: 16-inch.
    - 2) Flow: 4,000 - 11,000 gpm
    - 3) Inlet Pressure: 50 – 90 psi
    - 4) Outlet Pressure: 0 – 20 psi
    - 5) Initial Pressure Relief Setting: 100 psi (field adjustable)
  3. Warranty:
    - a. The Control Valve manufacturer shall warrant the valve to be free of defects in material and workmanship for a period of three years from date of shipment provided the valve is installed and used in accordance with all applicable instructions. Electrical components shall have a one-year warranty.
  4. Function:
    - a. The Electronic Control Valve shall be capable of controlling downstream pressure, rate of flow, upstream pressure sustaining, tank level control (altitude and modulating), valve position, blending, pressure management or select combinations of any of these applications. Solenoid pilot controls equipped onto the electronic control valve are actuated by electrical signals received from the PLC and/or a local VC-22D electronic valve controller (see Electrical Drawings). The solenoid pilots either add or relieve line pressure from the cover chamber of the control valve, causing it to open or close, ensuring the process variable signal follows the set-point command signal. This enables remote control over the electronic control valve operations. The process variable signal would come from a flow meter, pressure sensor or other rapid fluctuating process. The electric solenoid pilot controls will also be combined with hydraulic Relief Override and electronic fail-safe valve closure upon loss of power. Upon receiving the remote setpoint command from the PLC or a local command from the electronic valve controller, the electronic valve shall modulate and maintain the desired setpoint value. When the feedback signal deviates from the setpoint, the appropriate opening or closing solenoid on the valve will pulse. As the feedback signal approaches the setpoint, this on/off pulse time will gradually decrease to smoothly modulate the valve to setpoint. When the feedback signal is within a programmable dead band, the opening and closing solenoids will lock the cover and the electronic valve will maintain position.
  5. Materials:
    - a. Body and Cover: Ductile Iron-ASTM A536.
    - b. Main Valve Trim: Stainless Steel.
    - c. Seat: Stainless Steel.
    - d. Stem, Nut and Spring: Stainless Steel.
    - e. Seal Disc: Buna-N.
    - f. Diaphragm: Nylon Reinforced Buna-N.
    - g. Internal Trim Parts: Stainless Steel, Bronze and Brass.
    - h. Pressure Rating: Class 150 (250 psi max).
    - i. Temperature Range: Water to 180-deg F.
    - j. Any other wetted metallic parts: Stainless Steel, Bronze and Brass.

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- k. Coating and Lining:
  - 1) Fusion Bonded Epoxy (interior and exterior) per AWWA C116-03.
  - 2) For potable water applications, epoxy lining shall be NSF 61 approved.
- 6. Accessories:
  - a. Position Indicator.
  - b. Analog valve position status transmitter, 4-20 mA to indicate 0-100% of open position to PLC.
  - c. Anti-Cavitation Trim Package.
  - d. Externally mounted wye strainer with flush valve on supply line.
  - e. Nameplates:
    - 1) Each Control Valve and associated pilot(s) shall be provided with an identifying nameplate.
    - 2) Nameplates, depending on type and size of control valve, shall be mounted in the most practical position possible, typically on the inlet side of the valve body.
    - 3) Nameplates shall be brass and a minimum of 3/32" thick, 3/4" high and 2-3/4" long, unless otherwise approved by Engineer.
    - 4) Pertinent control valve data shall be etched or stamped into the nameplate. Data shall include control valve Catalog number, function, size, material, pressure rating, end-connection details, type of pilot controls used and control adjustment range.
- 7. Manufacture:
  - 1) Main Valve:
    - a) The main valve shall be hydraulically operated, single diaphragm actuated, globe or angle pattern as shown on the Drawings. The valve shall consist of three major components; the body with seat installed, the cover with bearing installed and the diaphragm assembly. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating the operating pressure from line pressure. Packing glands, stuffing boxes and/or rolling diaphragm technology will not be permitted and there shall be no pistons operating the main valve or pilot controls. No fabrication or welding shall be used in the manufacturing process. Y-pattern valves shall not be permitted. Main valve shall be certified by NSF/ANSI Standard 61 as a safe drinking water system component.
  - 2) End Connections:
    - a) End Connections for control valve shall be flanged per ASME/ANSI B16.42, Class 150.
  - 3) Main Valve Body:
    - a) No separate chamber(s) below the diaphragm shall be allowed between the main valve cover and body. No fabrication or welding shall be used in the manufacturing process.
    - b) The valve shall contain a resilient, synthetic rubber disc with a rectangular cross-section contained on three- and one-half sides by a disc retainer and forming a tight seal against a single removable seat insert. No O-ring type discs (circular, square, or quad type) shall be permitted as the seating surface. The disc guide shall be of the contoured type to permit smooth transition of flow and shall hold the discs firmly in place. The disc retainer shall be of a sturdy one-piece design capable of withstanding opening and closing shocks. It must have straight edge sides and a radius at the top edge to prevent excessive diaphragm wear as the diaphragm flexes across this surface. No hours-glass shaped disc retainers shall be permitted, and no V-type or slotted-type disc guides shall be used.

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- c) The diaphragm assembly containing a non-magnetic stainless-steel stem; of sufficient diameter to withstand high hydraulic pressures and shall be fully guided at both ends by a bearing in the main valve cover and an integral bearing in the valve seat. The valve seat shall be a solid, one-piece design and shall have a minimum five-degree taper on the seating surface for a positive, drip-tight shut off. No center guides shall be permitted. The stem shall be drilled and tapped in the cover end to receive and affix such accessories as may be deemed necessary. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating the operating pressure from the line pressure. No bolts or cap screws shall be permitted for use in the construction of the diaphragm assembly.
  - d) The flexible, non-wicking, FDA approved diaphragm shall consist of nylon fabric bonded with synthetic rubber compatible with the operating fluid. The diaphragm's center hole for the main valve stem must be sealed by the vulcanized process or a rubber grommet sealing the center stem hole from the operating pressure. The diaphragm must withstand a Mullins Burst Test of a minimum of 600 X per layer of nylon fabric and shall be cycled tested 100,000 times to insure longevity. The diaphragm shall not be used as the seating surface. The diaphragm shall be fully supported in the valve body and cover by machined surfaces which support no less than one-half of the total surface area of the diaphragm in either the fully opened or fully closed position. Bellofram type rolling diaphragms shall not be permitted.
  - e) The main valve seat and stem bearing in the valve cover shall be removable. The cover bearing and seat in the 6" and smaller size valve shall be threaded into the cover and body. The valve seat in the 8" and larger size valves shall be retained by flat head machine screws for ease of maintenance. The lower bearing of the valve stem shall be contained concentrically within the seat and shall be exposed to the flow on all sides to avoid deposits. To insure proper alignment of the valve stem, the valve body and cover shall be machined with a locating lip. No "pinned" covers to the valve body shall be permitted. Cover bearing, disc retainer and seat shall be made of the same material. All necessary repairs and/or modifications other than replacement of the main valve body shall be possible without removing the valve from the pipeline. The valve shall be designed such that both the cover assembly and internal diaphragm assembly can be disassembled and lifted vertically straight up from the top of a narrow opening/vault. Y-pattern valves shall not be permitted. The seat shall be of the solid one piece design. Two piece seats or seat inserts shall not be permitted. Packing glands and/or stuffing boxes shall not be permitted.
- 4) Pilot Control System:
- a) The pilot control shall be through two direct acting two-way solenoid pilot valves controlled by an external power source. The pilot control system shall include strainers and solenoid manual by-pass valves. The pilot control system shall utilize Stainless Steel control tubing and fittings. The solenoid pilot valves either add or relieve line pressure from the cover chamber of the main valve, causing it to open or close as directed by the electronic controller. Solenoids shall have NEMA IV enclosures.
  - b) Materials for Solenoid Pilot Controls:
    - 1. Body: Stainless Steel.
    - 2. Pilot Trim: Stainless Steel.

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3. Seals and Disc: NBR.
  4. Core and Plugnut: 430F Stainless Steel.
  5. Core Springs: 302 Stainless Steel.
  6. Shading Coil: Copper.
  7. Disc-Holder: CA.
  8. Core Guide: CA.
  9. Connections: FNPT.
  10. Pressure Rating: 400 psi max.
  11. Temperature Range:
    - AC: Water to 125 deg-F max.
    - DC: Water to 104 deg-F max.
  12. Power Supply: 120 VAC, 60 Hz.
  13. Enclosure: NEMA Type1
  14. Control Tubing: Stainless Steel.
  15. Control Fittings: Stainless Steel.
8. Factory Assembly:
    - a. Each control valve shall be factory assembled.
    - b. For all control valves, the factory assembly shall include the complete main valve, pilot valve(s), and all associated accessories and control equipment.
    - c. During factory assembly the control valve manufacturer shall make all necessary adjustments and correct any defects.
  9. Factory Testing:
    - a. Each control valve shall be factory tested.
    - b. Tests shall conform to approved test procedures.
    - c. The standard factory tests shall include a valve body and cover leakage test, seat leakage test and a stroke test. Control valves and pilot valves, in the partially open position, with both ends closed off with blind flanges (valves) and pipe plugs (pilots), shall be subject to an air test. The applied air pressure shall be 90 psi minimum. All air pressure tests shall be applied for a minimum of 15 minutes. No visible leakage is permitted through the valve seat, the pressure boundary walls of the valve body, valve cover, pilot body, pilot cover or the body-cover joint.
    - d. Control valve manufacturer shall, upon request, offer additional testing, such as high-pressure hydrostatic testing, positive material inspection testing, ferrite testing, liquid penetration inspection testing, magnetic particle examination testing and radiographic examination testing.
  10. Field Testing:
    - a. A direct factory representative shall be made available by the equipment supplier for start-up service, inspection and necessary adjustments.
  11. Manufacturers and Products:
    - a. Cla-Val Company Model 131-17 Electronic Interface Control Valve, Equipped to close on Power Failure and Pressure Relief Override as manufactured by Cla-Val Co., Newport Beach, CA 92659-0325
    - b. Or Equal.

## 2.10 AIR RELIEF AND VACUUM VALVES

- A. **AVV-01:** Air/Vacuum Valve, ½" to 3"
  1. Service: Water.
  2. Features:
    - a. Automatically exhausts large amounts of air during pipeline filling and allows large quantities of air to enter pipeline during pipeline draining to break vacuum.

- b. Once air has been exhausted, uses water pressure to close valve. In CLOSED position, seat against resilient seat to prevent water leakage.
    - c. Rated 200 psi working pressure.
    - d. Provide vent hose or piping and route discharge line to nearest drain/structure.
    - e. Cast iron, ductile iron, or semi-steel body and cover with stainless steel float and trim.
    - f. Model determined by size indicated in Valve Schedule or on Drawings.
  - 3. Manufacturers and Products:
    - a. APCO Valve and Primer Corp.; 140 Series.
    - b. Val-Matic Valve; 104S/38 Series.
    - c. Or equal.
- B. **AVV-02:** Air/Vacuum Valve for Vertical Turbine Pumps
- 1. Service: Water.
  - 2. Features:
    - a. Automatically exhausts large amounts of air when pump starts and allows large quantities of air to re-enter the pump column when pump stops to break vacuum.
    - b. Once air has been exhausted, uses water pressure to close valve. In CLOSED position, seat against resilient seat to prevent water leakage.
    - c. Discharge orifice shall be fitted with a double-acting throttling device to automatically regulate and restrict air venting and to establish pressure loading on rising suction column of water to minimize air surging. On pump stop, throttling device shall automatically open to allow full line unrestricted air re-entry to prevent vacuum from forming in the pump column.
    - d. Rated 200 psi working pressure
    - e. Cast iron, ductile iron, or semi-steel body and cover with stainless steel float and trim.
    - f. Includes butterfly isolation valve, surge check valve, air release valve with ball isolation valve, and mushroom vent.
    - g. Model determined by size as indicated in Valve Schedule or on Drawings.
  - 3. Manufacturers and Products:
    - a. APCO Valve and Primer Corp.; Series 1204 with 200A series air release valve.
    - b. Val-Matic Valve; 100ST Series.
  - 4. Or equal.
- C. **CARV-01:** Combination Air Release and Vacuum Valve, Water Service up to 150 psi:
- 1. Service: Water.
  - 2. Features:
    - a. Combines the operating features of both an air vacuum valve and air release valve, allowing to vent or re-enter system freely in either direction.
    - b. Once air has been exhausted, uses water pressure to close valve. In CLOSED position, seat against resilient seat to prevent water leakage.
    - c. Single-body type
    - d. Rated 150 psi working pressure, orifice size by manufacturer (minimum orifice size 3/32-inch).
    - e. Cast iron, ductile iron, or semi-steel body, cover with stainless steel float and trim.
    - f. 2-inch inlet, 2-inch outlet.
    - g. Provide No. 16 Mesh 316SS screen on inlets and outlets.
    - h. Provide vent hose or piping and route discharge line to nearest drain/structure.
    - i. Coatings and Linings:
      - 1) Liquid epoxy, 12 mil minimum, for valve interior and exterior.
      - 2) For potable water applications, epoxy lining shall be NSF 61 approved.

3. Manufacturers:
  - a. APCO Valve and Primer Corp., Model 145C
  - b. Val-Matic Valve; Model VM-202C.2
  - c. Or equal.

## 2.11 BACKFLOW PREVENTERS

- A. **BFP-01:** Reduced-Pressure Principle Backflow Prevention Assembly:
  1. Service: Water.
  2. Materials:
    - a. Body: lead-free bronze materials or epoxy-coated cast/ductile iron.
    - b. Test cocks: lead-free bronze
    - c. Ball valves: lead-free bronze
    - d. Valve Seats: stainless steel or Noryl
  3. Features:
    - a. Two check valves with an independent relief valve between the valves,
    - b. Two resilient-seated isolation gate valves or ball valves
    - c. Test cocks, in accordance with AWWA C511
    - d. Rated 175 psi maximum working pressure,
    - e. Meets requirements of USC Foundation For Cross-Connection Control and Hydraulic Research.
    - f. Ends: as required for installation as shown on Drawings
    - g. Coatings and Linings (steel and cast iron):
      - 1) Liquid epoxy, 12 mil minimum, for valve interior and exterior.
      - 2) For potable water applications, epoxy lining shall be NSF 61 approved.
  4. Backflow assembly color: Forest Green
  5. Manufacturers and Products:
    - a. Watts; Model 099, 909, 709 DCDA, 909 RPDA
    - b. Wilkins; Model 975, 375ASt, 375 ASTR, 350ASTDA
    - c. Ames; Model 300 DCDA stainless, 4000RP stainless or epoxy, 4000B, 5000 RPDA epoxy
    - d. Conbraco/Appollo: Model 40-200 series
  6. Backflow Assembly Support Stands
    - a. Placer Waterworks Series PW/PS
    - b. Or approved equal
  7. Backflow Assembly Support Stands Saddle
    - a. Placer Waterworks series PW/SDL
    - b. Or approved equal
  8. Blocking for Boxes:
    - a. Slump Block
    - b. Or approved equal

## 2.12 OPERATORS

- A. General:
  1. Operator force not to exceed 40 pounds under any operating condition, including initial breakaway. Gear reduction operator when force exceeds 40 pounds.
  2. Operator self-locking type or equipped with self-locking device.
  3. Provide position indicator on all valves.
  4. Worm and gear operators one-piece design worm-gears of gear bronze material. Worm hardened alloy steel with thread ground and polished. Traveling nut type operators threaded steel reach rods with internally threaded bronze or ductile iron nut.

5. Valve handles, wheels, etc. to be designed to accommodate a padlock.

B. Manual Operator:

1. Galvanized and painted handwheels.
2. Lever operators allowed on quarter-turn valves 8 inches and smaller.
3. Cranks on gear type operators.
4. For all valves above 5'-0" above adjacent working surface (finished floor or finished grade), provide chain wheel operator with tiebacks
5. For all exposed valves below adjacent working surface (finished floor or walkway), provide extension stem, floor stands, and other accessories to permit operation from 2'-6" above adjacent working surface.
6. For all buried valves 3" and larger, provide stem extension, valve bonnet, valve box and 2" AWWA operating nut such that operating nut is within 12" of adjacent finished grade.
  - a. For small-diameter buried valves, provide cross-shaped handle for operating with forked key.
7. Valve Extension Manufacturer:
  - a. Placer Waterworks Extension
  - b. Or approved equal

## 2.13 ACCESSORIES

A. T-Handled Operating Wrench:

1. One each galvanized operating wrench, 4 feet long.
2. Manufacturers and Products:
  - a. Mueller; No. A-24610.
  - b. Clow No.; F-2520.
  - c. Or Equal.

B. Cast Iron Valve Box: Designed for traffic loads, sliding type, with minimum of 6-inch ID shaft.

1. Box: Cast iron with minimum depth of 9 inches.
2. Lid: Cast iron, minimum depth 3 inches, marked WATER.
3. Extensions: Cast iron.
4. Manufacturer:
  - a. Christy (H-20)
  - b. Or approved Equal

## **PART 3 - EXECUTION**

### 3.1 VALVE SCHEDULE

- A. A Valve Schedule has been attached to this Specification and is incorporated herein by reference. Provide valves in accordance with Valve Schedule.
- B. For valves that are not referenced in Valve Schedule, provide the valve type and size called for on the Drawings.

### 3.2 PREPARATION

A. Cleaning:

1. Clean all mating faces of valve (threads, flange faces, etc.) prior to assembly.

2. Remove all debris from valve body prior to assembly.
  3. Take extra care to clean mating faces of existing pipe and fittings which may have corrosion, dirt, debris and mineral build-up which should be removed for a proper fit.
- B. Apply joint compound, lubricant, etc. as recommended by valve manufacturer for proper installation prior to installation.
- C. Install valves in accordance with the following schedule and as noted on the Drawings:

### 3.3 INSTALLATION

- A. Install valves per manufacturer's recommendations.
- B. Install valves so handles operate from fully open to fully closed without encountering obstructions.
- C. Install valves in location and orientation for easy access for routine operation and maintenance. Access should be such that an operator can operate the valve by reaching a handle, chain, etc. at a height between 2'-6" and 5'-0" above adjacent work surface (for buried valves, this is accomplished with a t-handle wrench and the operating nut being within 12" of finished grade).
- D. Install plug valves with the seat side as indicated on the drawings. If manufacturer's recommendations differ from indicated seat direction on the drawings, or if no seat side is indicated, install plug valves with seat side as recommended by the manufacturer after obtaining approval from the ENGINEER.

### 3.4 TESTS AND INSPECTION

- A. Valve may be either tested while testing pipelines, or as a separate step.
- B. Test that valves open and close smoothly under operating pressure conditions. Test that two-way valves open and close smoothly under operating pressure conditions from both directions.
- C. Inspect air release and vacuum valves as pipe is being filled to verify venting and seating is fully functional.
- D. Count and record number of turns to open and close valve; account for any discrepancies with manufacturer's data.
- E. Set, verify, and record set pressures for all relief and regulating valves.
- F. Automatic valves to be tested in conjunction with control system testing. Set all opening and closing speeds, limit switches, as required or recommended by the ENGINEER.

### 3.5 SUPPLEMENTS

- A. The following supplements are attached to this Specification section and incorporated herein by reference:
1. 15200 VS – Valve Schedule

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## SECTION 15200 VS

### VALVE SCHEDULE

#### 1.1 DESCRIPTION

- A. General:
  - 1. This schedule is provided for the convenience of the CONTRACTOR. Some valves may be shown on the drawings, but not listed here.
  - 2. Valve specifications are given in Section 15200, Valves and Operators.
- B. Valve Tag Number:
  - 1. Tag numbers are as noted in the Drawings.
- C. Valve Type:
  - 1. Valve types are as described in 15200, Valves and Operators
- D. Valve Ends:
  - 1. FLG – Flanged
  - 2. GRV – Grooved End
  - 3. LUG - Lugged
  - 4. MJ – Mechanical Joint
    - a. Where the surrounding piping system is installed with restrained joints, MJ valves shall be installed using RMJ (restrained mechanical joint) glands per 15120, Piping Specialties.
  - 5. SLV – Solvent Welded Socket
  - 6. SLD – Soldered Socket
  - 7. THR – Threaded
  - 8. W – Wafer
- E. Installation Codes
  - 1. Ex – Exposed
  - 2. Un – Underground
- F. Valve Actuators, as described in 15200, Valves and Operators
  - 1. HW – Handwheel
  - 2. L – Lever
  - 3. N – 2" Nut
  - 4. T – T Handle Key
  - 5. N/A – Not Applicable

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## 1.2 VALVE SCHEDULE

VALVE TAG NUMBER	VALVE TYPE	ENDS	DIAMETER	INSTALLATION	ACTUATOR
<b>GENERAL/YARD PIPING</b>					
WD00_VALV_54001	GAV-10	MJ	6"	Un	N
<b>BOOSTER PUMP STATION</b>					
<b>General Piping</b>					
WD24_VALV_54001	BFV-10	FLG	30"	Ex	HW
WD24_VALV_54002	CARV-02	THD	2"	Ex	N/A
WD24_VALV_54003	BFV-10	FLG	16"	Ex	HW
WD24_VALV_54004	ALT-01	FLG	16"	Ex	N
WD24_VALV_54005	BFV-10	FLG	16"	Ex	HW
WD24_VALV_54006	BFP-01	THD	2"	Ex	N
<b>Pump No. 1</b>					
WD24_VALV_54101	BFV-10	FLG	24"	Ex	N
WD24_VALV_54102	AVV-01	THD	1"	Ex	N/A
WD24_VALV_54103	AVV-02	FLG	4"	Ex	N/A
WD24_VALV_54104	CKV-10	FLG	16"	Ex	N/A
WD24_VALV_54105	BFV-10	FLG	16"	Ex	HW
<b>Pump No. 2</b>					
WD24_VALV_54201	BFV-10	FLG	24"	Ex	N
WD24_VALV_54202	AVV-01	THD	1"	Ex	N/A
WD24_VALV_54203	AVV-02	FLG	4"	Ex	N/A
WD24_VALV_54204	CKV-10	FLG	16"	Ex	N/A
WD24_VALV_54205	BFV-10	FLG	16"	Ex	HW
<b>Pump No. 3</b>					
WD24_VALV_54301	BFV-10	FLG	24"	Ex	N
WD24_VALV_54302	AVV-01	THD	1"	Ex	N/A
WD24_VALV_54303	AVV-02	FLG	4"	Ex	N/A
WD24_VALV_54304	CKV-10	FLG	16"	Ex	N/A
WD24_VALV_54305	BFV-10	FLG	16"	Ex	HW
<b>Pump No. 4</b>					
WD24_VALV_54401	BFV-10	FLG	24"	Ex	N
WD24_VALV_54402	AVV-01	THD	1"	Ex	N/A
WD24_VALV_54403	AVV-02	FLG	4"	Ex	N/A
WD24_VALV_54404	CKV-10	FLG	16"	Ex	N/A
WD24_VALV_54405	BFV-10	FLG	16"	Ex	HW
<b>Future Pump No. 5</b>					
WD24_VALV_54501	BFV-10	FLG	24"	Ex	N
<b>HYDROPNEUMATIC TANK</b>					
WD25_VALV_54001	BFV-10	FLG	12"	Ex	HW
WD25_VALV_54002	BAV-01	THD	2"	Ex	L
WD25_VALV_54003	HSV-03	THD	1 ½"	Ex	T

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VALVE TAG NUMBER	VALVE TYPE	ENDS	DIAMETER	INSTALLATION	ACTUATOR
<b>TANK VALVE VAULT</b>					
WD44_VALV_54001	HSV-03	THD	1 ½"	Ex	T
WD44_VALV_54101	BFV-10	FLG	24"	Ex	N
WD44_VALV_54102	CKV-30	FLG	24"	Ex	N/A
WD44_VALV_54103	BFV-10	FLG	24"	Ex	N
WD44_VALV_54104	BFV-10	FLG	30"	Ex	N
WD44_VALV_54201	BFV-10	FLG	24"	Ex	N
WD44_VALV_54202	CKV-30	FLG	24"	Ex	N/A
WD44_VALV_54203	BFV-10	FLG	24"	Ex	N
WD44_VALV_54204	BFV-10	FLG	30"	Ex	N
WD44_VALV_54205	BFV-10	FLG	24"	Ex	N
WD44_VALV_54206	BFV-10	FLG	30"	Ex	N
<b>WATER STORAGE TANKS</b>					
WD45_VALV_54101	GAV-10	FLG	8"	Un	N
WD45_VALV_54102	PLV-10	FLG	6"	Ex	HW
WD45_VALV_54201	GAV-10	FLG	8"	Un	N
WD45_VALV_54202	PLV-10	FLG	6"	Ex	HW

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**SECTION 15400**  
**PLUMBING FIXTURES**

**PART 1 - GENERAL**

**1.1 SUBMITTALS**

- A. Shop Drawings:
  - 1. Catalog information and rough-in dimensions for plumbing fixtures, products, and specialties.

**PART 2 - PRODUCTS**

**2.1 PLUMBING FIXTURES**

- A. Tankless Water Heater (**IWH-02**)
  - 1. Type: Instant water heater designed specifically to provide tepid water to emergency shower and eyewash systems.
  - 2. Construction:
    - a. Enclosed in powder-coated, cold rolled steel NEMA 4 rated cabinet.
    - b. Manufactured from NSF-61 listed materials.
    - c. Parabolic heat design tankless water heater.
  - 3. Electrical Requirements:
    - a. 480 volt, 3 phase, 60 hz
    - b. 126 kW
  - 4. 1 ¼" inlet and outlet connections.
  - 5. Rated to 150 psi.
  - 6. ANSI/UL 499 listed.
  - 7. Standard temperature setting: 90-degrees Fahrenheit
  - 8. Maximum Flow Rate: 40 gpm.
  - 9. Manufacturer and Product:
    - a. Haws Model 9326
    - b. Or Equal
    - c.
- B. Emergency Eyewash and Shower (**EWSS**)
  - 1. Deluge Shower:
    - a. ABS plastic shower head.
    - b. Instant action, stay open, self-draining ball valve.
    - c. Pull-rod.
    - d. Steel stanchion.
    - e. Floor flange.
    - f. Interconnecting piping.
  - 2. Eyewash:
    - a. Aerated eye wash with stainless steel receptor.
    - b. Stay open, self-draining ball valve.
    - c. Push handle control.
    - d. Foot treadle control if available.
    - e. Plastic anti-surge eyewash heads.
    - f. Supply line strainer.

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3. Accessories:
  - a. Scald Protection Bleed Valve: Set to open when internal water temperature rises above 95 degrees F and close when internal temperature drops below 87 degrees F.
  - b. Freeze Protection Bleed Valve: Set to open when the internal water temperature drops below 35 degrees F and close when the internal water temperature rises above 42 degrees F.
  - c. Corrosion-resistant coating.
4. Manufacturers and Products:
  - a. Haws; Model 8300 with SP157B and SP158B
  - b. Speakman
  - c. Or Equal.

## 2.2 DRAINAGE PRODUCTS

### A. Floor Drain with Funnel (**FD-02**)

1. Features:
  - a. Cast Iron body and grate
  - b. Funnel top, 4 inch diameter and 4-1/4 inch tall, attached to grate with concealed screws
  - c. Trap primer connection
  - d. Threaded outlet designed for use with PVC drain waste and vent pipe
2. Manufacturers:
  - a. Jay R. Smith Manufacturing Co.; Model 3510T
  - b. Or equal.

### B. Trench Drain (**TD-01**)

1. Design Load Class C, Heavy Duty.
2. Width and length as shown on the Drawings.
3. Features:
  - a. Drain channel shall be constructed of high-density polyethylene composite, polyvinyl chloride, precast polymer concrete, fiberglass reinforced plastic, or equal material.
  - b. Pre-sloped: 0.6% minimum.
  - c. Bottom outlet, designed for use with PVC drain waste and vent pipe.
  - d. Flat grated trench cover.
    - 1) Material shall be cast or ductile iron, galvanized steel, stainless steel, resin composite, pultruded fiberglass, or other suitable material.
    - 2) Ferrous metals shall have corrosion resistant coating.
  - e. Closed-end construction
  - f. Lap joints to connect the sectional units
4. Manufacturer and Product:
  - a. Jay R. Smith Manufacturing Co.
  - b. Or Equal

## **PART 3 - EXECUTION**

### 3.1 DETAILING

- A. Contract Drawings and specifications do not detail all requirements for installation of plumbing fixtures. CONTRACTOR shall provide all required materials to provide a

complete installation of all plumbing fixtures which is fully functional and compliant with all applicable codes and regulations.

### 3.2 PLUMBING FIXTURE INSTALLATION

- A. General:
  - 1. Install all plumbing fixtures plumb, level and per the manufacturer's instructions.
- B. Plumbing Fixtures, Mounting Heights:
  - 1. Standard rough-in catalogued heights, unless shown otherwise on Drawings.
  - 2. Caulk fixtures in contact with finished walls with waterproof, white, non-hardening sealant which will not crack, shrink, or change color with age.
- C. Fixture Trim: Install fixture trim where applicable on fixtures.
- D. Water Heater:
  - 1. Install water heater and all appurtenances in accordance with the local plumbing code.
  - 2. Route the drains from the relief valve, drip pan, and hot water tank drain to the nearest floor drain. Provide an air gap.
- E. Drains and Cleanouts:
  - 1. Install top flush with finished floor elevation.
  - 2. Install PVC p-traps at each floor drain.
  - 3. Provide cleanouts where shown and where required by code.

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## **SECTION 15500**

### **HEATING, VENTILATION AND AIR CONDITIONING EQUIPMENT**

#### **PART 1 - GENERAL**

##### **1.1 SUBMITTALS**

- A. Complete specifications, descriptive drawings, catalog cuts, and descriptive literature that include make, model, dimensions, weight of equipment, horsepower, and electrical schematics for products and control system components specified.
- B. Complete performance data that indicates full compliance with the Specifications.
- C. Recommended procedures for protection and handling of equipment and materials prior to installation.
- D. Manufacturer's standard finish color selection for cabinet finishes.
- E. Operation and maintenance manuals.
  - 1. List of recommended spare parts for equipment and materials specified.
  - 2. Manufacturer's Certificate of Conformance for the heat pumps.

##### **1.2 QUALITY CONTROL**

- A. Furnish 2-year warranty for all equipment.
- B. Furnish special warranty of 5 years for refrigeration section compressor(s).

#### **PART 2 - PRODUCTS**

##### **2.1 HVAC EQUIPMENT**

- A. See equipment schedule shown on the Drawings for evaporative cooler, air conditioning system, and exhaust fan.

##### **2.2 FIXED LOUVERS**

- A. The following described fixed louvers. Owner may prefer louvers with gravity or automatic dampers to close when not in use to minimize dust intrusion when HVAC systems not in use. Coordinate final louver design with Design-Assist Team.
- B. Furnish storm class fixed blade louvers where shown and with the dimensions and shapes shown on Drawings. Louvers shall be designed for intake and exhaust while providing maximum resistance to water penetration due to wind-driven rain.
- C. Fixed Louver Construction:
  - 1. Louver shall be constructed from extruded aluminum, alloy 6063-T5.
  - 2. Louver shall be 7 inches thick.
  - 3. Frame and blades shall be 0.081" thick.
  - 4. Louver shall be shaped and dimensioned as shown on the Drawings.

5. Install aluminum louver screen on interior side of the louver.
  6. Finish: Kynar 500 fluorocarbon coating, dark brown color, or equal.
- D. Fixed Louver Design:
1. Free Area: Minimum 45% net free area. Provide AMCA test data to show a 4'x 4' unit with a minimum of 7.3-square feet free area.
  2. Pressure Loss: AMCA certified rating of no greater than 0.30-inch WC at 750 fpm.
  3. Provide louver supports designed to carry 30 psf wind load.
  4. Louvers to be designed for air flow in either direction.
  5. Louvers to provide protection from water penetration due to wind-driven rain. Provide test results, per AMCA standard 500L, which show that the louver being provided has the following performance characteristics:
    - a. 99% effectiveness at preventing water penetration of 3 inches per hour of wind driven rain at a wind speed of 29.1 miles per hour directed to the face of the louver
- E. Manufacturers and Products:
1. Construction Specialties; Model RS-7315.
  2. Airolite; Model SCH7.
  3. Or equal.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install equipment and systems in accordance with manufacturers' instructions.
- B. Evaporative Coolers:
1. Pipe drain pan connection as recommended by manufacturer.
  2. Locate units to provide access spaces required for filter changing; motor, drive, and bearing servicing; and fan shaft removal.
  3. Lubricate nonsealed bearings prior to startup.
  4. Seismic Restraints:
    - a. Use lateral and vertical motion limiters described in the latest edition of SMACNA "Guidelines For Seismic Restraints of Mechanical Systems."
    - b. Restraint Snubbers: Rubber-faced, securely anchored to the structure, and installed with sufficient clearance so that unit isolators are not restricted for proper free isolation, but do limit movement in all directions.
    - c. Restrain as described in the latest edition of ASHRAE "HVAC Applications," chapter on Seismic Restrain Design.

+ + END OF SECTION + +

## SECTION 15501

### DUCTWORK AND ACCESSORIES

#### **PART 1 - GENERAL**

##### **1.1 SERVICE CONDITIONS**

- A. All ductwork shall be aluminum.

##### **1.2 QUALITY ASSURANCE**

- A. Manufacturer Qualifications:
1. Engage a single firm, with undivided responsibility for performance and other requirements and components of the ductwork.
  2. Engage a firm which can show successful experience in the fabrication and erection of ductwork systems of scope and type similar to the required Work.
- B. Installer Qualifications:
1. Engage a single installer regularly engaged in ductwork installation and with experience in the installation of the types of materials required; and who agrees to employ only tradesmen with specific skill and experience in this type of Work. Submit name and qualifications to ENGINEER
  2. Engage a single installer for the entire ductwork system with undivided responsibility for performance and other requirements.
- C. Requirements of Regulatory Agencies:
1. Building Codes: Comply with the:
    - a. Uniform Building Code, as supplemented by the authorities having jurisdiction.
    - b. Uniform Mechanical Code, as supplemented by the authorities having jurisdiction.
  2. Permits: CONTRACTOR shall obtain and pay for all required permits, fees and inspections by authorities having jurisdiction.
- D. Reference Standards: Comply with applicable provisions and recommendations of the latest editions of the following, except as otherwise shown or specified. Specific provisions of this Contract shall supersede the Standards in case of conflict:
1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
  2. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
    - a. HVAC Duct Construction Standards.
    - b. Round Industrial Duct Construction Standards.
    - c. Rectangular Industrial Duct Construction Standards.
    - d. Fire Damper Guide for Air Handling Systems.
  3. American Conference of Governmental Industrial Hygienists
  4. ASTM A 774, As-Welded Wrought Austenitic Stainless-Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
  5. ASTM A 778, Welded, Unannealed Austenitic Stainless-Steel Tubular Products.
  6. NFPA 91, Blowers and Exhaust Systems for Dust, Stock and Vapor Removal or Conveying.

##### **1.3 SHOP DRAWINGS**

- A. Shop Drawings: Submit for approval the following:

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1. 1/4-inch scale duct layouts.
  2. Dimensions.
  3. Details of construction.
  4. Details of installation.
  5. Manufacturer's literature, illustrations, specifications and engineering data.
  6. Ceiling diffusers and registers. Provide schedule of air outlets indicating location and quantity.
  7. Fire Dampers:
    - a. Closing mechanisms.
    - b. Fusible link operating temperature.
    - c. Installation details.
    - d. Access Doors (UL Listed).
  8. Access doors.
  9. Flexible connections.
  10. Duct sealants.
  11. Deviations from Contract Documents.
- B. Test Reports: Submit the following test reports for approval.
1. UL Label, Fire Dampers.
  2. Damper leakage tests from an AMCA approved testing laboratory.

#### 1.4 OPERATION AND MAINTENANCE MANUALS:

- A. Submit complete manuals including copies of all approved Shop Drawings, test reports, maintenance data and schedules, description of operation and spare parts information.

#### 1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Store equipment and materials so as to keep free from moisture, damage, and deterioration.
- B. Manufacturer shall protect all flange faces and the more fragile appurtenances of the sub-assemblies, with padding between pieces in order to prevent one piece from impacting with another, and by crating or other means for shipment.
- C. Duct sub-assemblies shall be unloaded with care and stored in a location where they will be free from damage. Impact of a tool or other heavy object may result in a fracture of the inner lining and affect the service life of the duct or equipment.
- D. Large sub-assemblies shall be supported during unloading to prevent excessive deflection and overstressing.
- E. Ductwork shall be protected, by padding or bracing, from banding or ropes used in shipment. No chains are to be used to secure any ductwork during transportation.

#### 1.6 GENERAL REQUIREMENTS

- A. The Drawings show general arrangement and extent of Work to be done, but the exact location and arrangement of all parts shall be determined as the Work progresses, to conform in the best possible manner with its surroundings. The exact location of all parts of the Work must be governed by the general building plans and the actual building conditions. Piping, equipment, ducts, etc. found to interfere with the construction of the building, plumbing apparatus and piping, electrical wiring or other obstructions, etc. shall

be located to clear such obstructions. Connections shown to the various units are intended as an indication only. The actual connections shall be made and to best suit each particular case, provide for expansion, circulation and minimize the amount of space required.

- B. Drawings do not show all offsets, fittings, accessories and details which may be required. CONTRACTOR shall field survey all conditions which may affect the installation of the Work, and shall arrange the Work accordingly. Provide all required items to complete the systems to the extent required by the Contract Documents.
- C. If ductwork can be run to better advantage, CONTRACTOR, before proceeding with the Work, shall prepare and submit complete drawings showing all details of the proposed rearrangement for written approval.

## **PART 2 - PRODUCTS**

### **2.1 METALLIC RECTANGULAR DUCTWORK**

- A. Type:
  - 1. Aluminum (Alloy 3003 - H-14).
    - a. All accessories and hardware shall be aluminum, unless otherwise noted.
    - b. All fasteners shall be Type 304L stainless steel, unless otherwise noted.
- B. Construction: Conform to the latest edition of SMACNA (Sheet Metal and Air Conditioning CONTRACTOR's National Association, Inc.) Standards.
  - 1. All sheet metal construction shall conform to a minimum pressure classification of 2-inches of water gauge (positive and negative pressure), unless otherwise shown or specified, and shall be in accordance with the construction details and installation details in the latest edition of the SMACNA HVAC Duct Construction Standards. This standard is hereinafter referred to as HVAC DS.
    - a. All ductwork served by ADM-LEF-1 and ADM-AHU-2 shall conform to a minimum pressure classification of negative and positive 4-inches of water gauge.
  - 2. Duct construction alternatives (duct gage in relation to reinforcement spacing) selected by the CONTRACTOR from HVAC DS tables shall be identified by duct system and shall be submitted in schedule form to the ENGINEER prior to beginning installation of ductwork. CONTRACTOR shall construct ductwork to meet the requirements of the HVAC DS tables in conjunction with the minimum thickness schedule below.
  - 3. Longitudinal seams shall be Pittsburgh type with permanently elasticmatic sealant applied continuously within the seam.
  - 4. Aluminum ductwork minimum thicknesses:

Duct Dimension (maximum side):	Thickness:
Under 12 inches	0.040 in. (No. 18 B&S Gage)
Between 12 and 30	0.050 in. (No. 16 B&S Gage)
Between 31 and 54	0.064 in. (No. 14 B&S Gage)
Between 55 and 84	0.071 in. (No. 13 B&S Gage)
Above 84	0.090 in. (No. 11 B&S Gage)
  - 5. Ductwork shall be connected by a mechanical joining system manufactured by Ductmate Industries, Inc., or equal except where otherwise noted. Manufacturers' installation instructions will be followed, except where otherwise noted.

- a. Rectangular Ductwork: SMACNA T-24 flange type connectors formed from the duct edge will NOT be allowed. All connectors shall meet or exceed the functional criteria outlined in SMACNA.
    - 1) Aluminum Ductwork Connectors:
      - a) Angle: .04-inch thick Type 3003H14 aluminum.
      - b) Corner: .10-inch thick Type 5052H34 aluminum.
      - c) Cleat: .07-inch thick PVC.
      - d) Gasket: Butyl.
  - 6. Stiffener angles shall be constructed of the same material as the duct or transverse connector.
  - 7. Turning Vanes, Splitter Dampers, Transitions, Offsets, Branch Take-offs and Elbows: :
    - a. Reference: SMACNA.
    - b. Construction: Same material as ductwork.
    - c. Vanes: Double thickness.
    - d. Branch Take-offs: 45 degrees, NO straight taps unless specifically shown.
    - e. Elbows shall be the radius type with R'1.5, unless specifically shown otherwise.
    - f. Where space limitations prevent the use of a radius elbow provide a square throat elbow with turning vanes.
- C. Seal Class B.
- D. Leakage:
- 1. Not to exceed 5 percent.
- E. Flexible duct or duct constructed of fiberglass duct board shall not be permitted on the job, except where specifically shown on the Drawings.

## 2.2 METALLIC ROUND DUCTWORK

- A. Type:
  - 1. Aluminum (Alloy 3003 - H-14).
    - a. All accessories and hardware shall be aluminum, unless otherwise noted.
    - b. All fasteners shall be Type 304L stainless steel, unless otherwise noted.
- B. General: Conform to the latest edition of SMACNA (Sheet Metal and Air Conditioning Contractor's National Association, Inc.) Standards.
  - 1. All sheet metal construction shall conform to a minimum pressure classification of 2-inches of water gauge (positive and negative pressure), unless otherwise shown or specified, and shall be in accordance with the construction details and installation details in the latest edition of the SMACNA HVAC Duct Construction Standards. This standard is hereinafter referred to as HVAC DS.
    - a. All ductwork served by ADM-LEF-1 and ADM-AHU-2 shall conform to a minimum pressure classification of positive and negative 4-inches of water gauge.
  - 2. Duct construction alternatives (duct gage in relation to reinforcement spacing) selected by CONTRACTOR from HVAC DS tables shall be identified by duct system and shall be submitted in schedule form to the ENGINEER prior to beginning installation of ductwork. CONTRACTOR shall construct ductwork to meet the requirements of the HVAC DS tables in conjunction with the mini-mum thickness schedule below.
  - 3. Ductwork shall be manufactured by United McGill Corporation series UNI-SEAL or equal.
  - 4. Ductwork fittings shall be manufactured by United McGill Corporation series LOLOSS or equal.

5. Round, single wall, spiral lock seam ductwork.
6. Aluminum Ductwork Minimum Thicknesses:
 

<u>Duct Diameter:</u>	<u>Minimum Thickness:</u>
Under 26 inches:	0.040 inches
27 thru 36 inches:	0.050 inches
37 thru 50 inches:	0.063 inches
7. Ductwork shall be provided in continuous unjoined lengths where ever possible, except when interrupted by fittings and dampers.
8. Fittings: Elbows shall be die-stamped with a bend radius of 1.5 times the elbow diameter. Converging flow fittings shall be constructed with a radiused entrance to all branch taps and with no excess material projecting from the body into the branch tap entrance. Conform to the following requirements:
  - a. All branch entrances shall be by means of factory fabricated fittings or factory fabricated duct tap assemblies.
9. Connections: Ductwork and fittings shall be connected using flanged joints in accordance with the manufacturers installation procedures and duct sealant recommendations.

C. Seal Class: B

D. Leakage: Not to exceed 5 percent.

## 2.3 METALLIC DUCT ACCESSORIES

### A. Hangers:

1. All ductwork shall be supported from trapeze type hangers. Hanger rods shall be minimum 3/8-inch for all ducts with half perimeter up to 72-inches, and 1/2- inch diameter for all ducts with half perimeter larger than 72-inches. A pair of rods shall be provided at each duct support point. Maximum hanger spacing shall be 8 feet for ducts with half perimeter up to 72-inches and 6 feet for ducts with half perimeter larger than 72-inches.
2. Provide structural steel supports as required to mount hangers from building.
3. All hangers, rods, supports, bolts, nuts, washers, inserts, supports, and appurtenances located in corrosive areas shall be Type 316 stainless steel and those located in non-corrosive areas shall be galvanized steel.
4. Hanger Construction and installation shall conform to SMACNA Standards, except as specified. No sheet metal duct hangers or straps will be allowed.

### B. Duct Liner:

1. 2-inch thick, 3-pound density. Minimum .70 NRC, minimum 0.24K at mean temperature of 75 degrees F. NFPA-90A approved black coating on one side.
2. U. L. Ratings:
  - a. Flame Spread Max: 25.
  - b. Fuel Contribution: 50.
  - c. Smoke Developed: 50.
3. Product and Manufacturer: Provide one of the following:
  - a. Mansville Microlite.
  - b. PPG Textrafine.
  - c. Or equal.

### C. Supply Registers:

1. Rectangular aluminum construction.
2. Individually adjustable horizontal face and vertical rear louver fins.

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3. Gang-operated opposed-blade horizontal volume control damper.
4. Continuous sponge rubber gasket at face flange.
5. 1-inch flat aluminum frame.
6. Prime coat finish.
7. Manufacturers and Products:
  - a. Krueger; Model 5880H-OBD.
  - b. Carnes; Type RNDAAH.
  - c. Or equal.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. All ductwork shall conform accurately to the dimensions shown, the ducts shall be straight and smooth inside with joints neatly finished. Ductwork shall be installed so as to preclude the possibility of vibration under all operating conditions.
- B. Tape and seal all joints in accordance with SMACNA Standards.
- C. Fire/Smoke dampers shall be provided and installed where indicated on the Drawings and where required by U.L. and authorities having jurisdiction and shall be approved by local building codes and in accordance with the requirements of the NFPA.
- D. Install all ductwork and accessories to provide a system free from buckling, warping, breathing or vibration.
- E. All ducts at expansion joints and flexible connections shall be suitably supported at each end within 12-inches of joint.
- F. Coordinate all air outlets for compatibility with ceiling system.
- G. Install ductliner in roof mounted supply, return and outside air ductwork stick clip duct liner to inside walls of ductwork.

#### **3.2 ADJUSTMENT**

- A. Set volume control devices for approximate positions in preparation for final testing and balancing.
- B. Start fan system and check for excessive leaks and vibration and correct.

#### **3.3 CLEANING**

- A. Remove all loose materials and obstructions from interior of ducts.
- B. Remove debris and waste materials resulting from installation.

+ + END OF SECTION + +

## SECTION 15600

### TESTING, ADJUSTING AND BALANCING OF HVAC SYSTEMS

#### **PART 1 - GENERAL**

##### **1.1 DESCRIPTION**

A. Scope:

1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to perform the testing, adjusting and balancing of HVAC systems.

##### **1.2 QUALITY ASSURANCE**

A. Balancer's Qualifications:

1. Submit biographical data on employee proposed to directly supervise the testing, adjusting and balancing Work.
2. Submit proof of certification by NEBB (National Environmental Balancing Bureau), AABC (Associated Air Balance Council), or SMACNA (Sheet Metal and Air Conditioning Contractors' National Association), proof of registration in the State of Arizona and a record of at least five years experience in the testing and balancing contracting industry, engaged in heating, ventilating and air conditioning (HVAC) Work.

##### **1.3 SUBMITTALS**

A. Data Forms:

1. Submit data forms on each item of testing equipment required. Include name of device, manufacturer's name, model number, latest date of calibration, and correction factors.
2. All field data pertaining to each item of equipment being tested must be tabulated and submitted on the standard forms of NEBB, AABC, or SMACNA.
3. Testing agency shall sign and date each form in the space provided and proof of certification shall accompany the final report.

B. Report Forms:

1. Submit example copies of report forms for ENGINEER'S approval.
2. Forms shall be 8-1/2 by 11-inch paper for loose-leaf binding, with blanks for listing of the required test ratings and for certification of report.
3. Reports shall be on the organizations approved forms imprinted with the company's name.
4. Certified report outlining procedure used to balance the system and the types of measuring devices used.

C. Test results shall be submitted on approved forms in a typed format.

D. Submit certified copies of required test reports to the ENGINEER for approval.

#### 1.4 JOB CONDITIONS

- A. Heating, ventilating and air conditioning equipment shall be completely installed and in continuous operation as required to accomplish the testing, adjusting and balancing Work specified.
- B. Testing, adjusting and balancing shall be performed when outside conditions approximate design conditions indicated for heating and cooling functions.

#### 1.5 OPERATING INSTRUCTIONS

- A. Reports shall be certified by CONTRACTOR verifying that the methods used and the results achieved are as specified.

#### 1.6 CORRECTIVE ADJUSTMENTS

- A. Should corrective measures caused by faulty installation require retesting, adjusting and balancing, such Work shall be performed by CONTRACTOR, at no additional cost to the OWNER.
- B. Inspections:
  - 1. Fan Belt Deflection: No less than 1/4-inch or more than a 1/2-inch.
  - 2. Finned Coils: Fins shall be combed out with a fin comb for appropriate fin spacing. Helical fins shall be straightened with blunt bladed instrument.

### **PART 2 - PRODUCTS**

#### 2.1 BALANCING INSTRUMENTATION

- A. Provide all necessary instrumentation, tools, ladders, etc. to complete all air balancing, tests and adjustments.
- B. Instrumentation shall be in accordance with NEBB, AABC, or SMACNA requirements and shall be calibrated to the accuracy standards stipulated by these organizations.
- C. Flow-measuring hoods (manufactured, not fabricated) shall be acceptable for measurement of ceiling diffuser performance only.
- D. Assume full responsibility for safe keeping of all instrumentation during the course of the Work.

### **PART 3 - EXECUTION**

#### 3.1 GENERAL

- A. Testing, adjusting, and balancing of air systems shall be performed in compliance with the standard procedure manual published by the testing, adjusting, and balancing organization affiliated with CONTRACTOR. Submit one copy of the standard procedure manual to the ENGINEER for record purposes only.

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- B. Sole responsibility for the protection and safeguarding of the Work and providing every protection against accidents, injury, and damage to persons and property belongs to CONTRACTOR.
- C. Keep dust, dirt, and debris to an absolute minimum and reinstall all removed ceiling components to their original positions at the end of each day.
- D. Full responsibility for removal and reinstallation of ceiling system and replacement of any component damaged belongs to CONTRACTOR.
- E. Install additional access panels, at no additional cost to the OWNER, as required to gain access to equipment concealed above ceilings, behind walls, or any other concealed space.
- F. Air systems shall be tested, adjusted, and balanced with clean filters.
- G. Provide final air balancing report to Maricopa Building Official prior to notifying Maricopa County for final inspection of mechanical work. (IMC, Section 107)

### 3.2 INSPECTION

- A. Pre-Startup Inspection:
  - 1. Verify proper equipment mounting and setting.
  - 2. Verify that control, interlock and power wiring is complete.
  - 3. Verify alignment of motors and drives.
  - 4. Verify proper piping connections and accessories.
  - 5. Verify that lubrication is completed.
- B. First Run Observations:
  - 1. Verify direction of rotation.
  - 2. Verify setting of safety controls.
  - 3. Monitor heat build up in bearings.
  - 4. Check motor loads against manufacturer's nameplate data.
- C. Equipment Check:
  - 1. Verify proper overload heater sizes.
  - 2. Verify function of safety and operating controls.
  - 3. Verify proper operation of equipment.
  - 4. Report on inspection, observation and checking procedures.

### 3.3 AIR SYSTEMS

- A. Preliminary:
  - 1. Identify and list size, type and manufacturer of all equipment to be tested, including air terminals.
- B. Central Systems:
  - 1. Test rpm for all equipment, including adjustment to each fan and air handling unit, and air conditioning unit to design requirements within the limits of mechanical equipment provided.
  - 2. Adjust or change drive sheaves as required to adjust actual cfm to scheduled cfm.

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3. Test and record motor voltages and running amperes, including motor manufacturer's nameplate data, and starter heater ratings for each unit as listed above.
  4. Make Pitot tube traverse of main supply, exhaust and return ducts, determine cfm at all fans and units and adjust fans and units to within five percent of design requirements.
  5. Test and record system suction and discharge static pressure.
  6. Test and adjust system for design outside air, cfm.
  7. Test and adjust system for design recirculated air, cfm.
  8. Test and record heating apparatus outdoor entering air temperatures, dry bulb.
  9. Test and record heating apparatus return air temperatures, dry bulb.
  10. Test and record heating apparatus mixed air temperatures, dry bulb.
  11. Test and record heating apparatus leaving air temperatures, dry bulb.
  12. Test and record cooling apparatus outdoor entering air temperatures, dry bulb and wet bulb.
  13. Test and record cooling apparatus return air temperatures, dry bulb and wet bulb.
  14. Test and record cooling apparatus mixed air temperatures, dry bulb and wet bulb.
  15. Test and record cooling apparatus leaving air temperatures, dry bulb and wet bulb.
  16. Record all fan and air handling unit speeds.
  17. Record air quantity delivered by each fan and air handling unit.
- C. Distribution:
1. Adjust volume dampers, control dampers, splitter dampers, air extractors, etc. to proper design cfm in main ducts, branch ducts, and zones.
- D. Air Terminals:
1. Identify each air terminal as to location and determine required flow reading.
  2. Test and adjust each air terminal to within tolerance of design requirements as listed below:
    - a. Diffusers and Supply Registers: 0 percent to +10 percent.
    - b. Return Registers: 0 percent to -10 percent.
    - c. Exhaust Registers: 0 percent to -10 percent.
  3. Test procedure on air terminals shall include recording comparison of required cfm and observed cfm, adjustment of terminal, and recording of final cfm.
  4. Adjust flow patterns from air terminal units to minimize drafts to extent design and equipment permits.
- E. Verification:
1. Prepare summation of readings of observed cfm for each system, compared with required cfm, and verify that duct losses are within specified allowable range.
  2. Verify design cfm at fans as described above.
  3. If the air systems are not properly balanced, rebalance and recheck all data in the presence of ENGINEER and as approved by the ENGINEER.

### 3.4 AUTOMATIC CONTROL SYSTEM

- A. In cooperation with the control manufacturer's representative, set and adjust automatically operated devices to achieve required sequence of operations.
- B. Verify all controls for proper calibration and operation and list those controls requiring adjustment by control system installer.

### 3.5 MANUFACTURER'S SERVICES

- A. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of 2 visits, minimum 4 hours on-site for each visit, to the site. The first visit shall be for assistance in the installation of equipment. The second visit shall be for checking the completed installation and start-up of the system and instruction of Operations and Maintenance Personnel. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the equipment and controls conform to requirements. Representative shall revisit the job site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.
- B. All costs, including travel, lodging, meals and incidentals, shall be considered as included in CONTRACTOR'S bid price.

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## **SECTION 15990**

### **TESTING OF PRESSURE PIPING SYSTEMS**

#### **PART 1 - SUBMITTALS**

##### **1.1 TESTING PLAN**

- A. Testing Plan: Submit prior to testing and include at least the information that follows.
  - a. Testing dates.
  - b. Piping systems and section(s) to be tested.
  - c. Test type.
  - d. Method of isolation.
  - e. Calculation of maximum allowable leakage for piping section(s) to be tested.
2. Certifications of Calibration: Testing equipment.
3. Certified Test Report.

##### **1.2 REFERENCE**

- A. Reference Section 15100 PS for test pressure.

#### **PART 2 - PRODUCTS (NOT USED)**

#### **PART 3 - EXECUTION**

##### **3.1 NOTIFICATION**

- A. Notify ENGINEER in writing 5 days in advance of testing. Perform testing in presence of ENGINEER.

##### **3.2 PRESSURE TESTING**

- A. General:
  1. Complete installation of piping system, including all thrust restraint, prior to pressure testing.
    - a. If thrust blocking is specified, wait 5 days minimum after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to 2 days.
  2. Prior to test, remove and replace with pipe spools or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
  3. New Piping Connected to Existing Piping: Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to ENGINEER.
  4. Piping to be Pressure Tested and Test Pressure: as indicated on Piping Schedule.
- B. Testing with Water (non-HDPE2 pipe):
  1. Fluid: Clean, potable water.
  2. Pipeline Protection:
    - a. Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.
    - b. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.



3. Exposed Piping:
  - a. Perform testing on insulated piping prior to application of insulation
  - b. Maintain hydrostatic test pressure continuously for 60 minutes, minimum, and for such additional time as necessary to conduct examinations for leakage.
  - c. Examine joints and connections for leakage.
    - 1) Correct visible leakage and retest as specified.
    - 2) Empty pipe of water prior to final cleaning or disinfection.
4. Buried Piping:
  - a. Test after backfilling has been completed.
  - b. Expel air from piping system during filling.
  - c. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
  - d. Maintain hydrostatic test pressure continuously for 2 hours minimum, reopening isolation valve only as necessary to restore test pressure.
  - e. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.
  - f. Maximum Allowable Leakage:

$$L = \frac{SD(P)^{1/2}}{133,200}$$

where:

- L = Allowable leakage, in gallons per hour.
- S = Length of pipe tested, in feet.
- D = Nominal diameter of pipe, in inches.
- P = Test pressure during leakage test, in pounds per square inch.

- g. Correct leakage greater than allowable, and retest as specified.

C. Testing with Water (15100 PSDS HDPE2) per ASTM F2164:

1. Fluid: Clean, potable water.
2. Pipeline Protection:
  - a. Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.
  - b. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.
3. Allow the test section and test liquid to equalize to a common temperature.
4. Pressurizing (initial expansion phase):
  - a. Once test section is completely filled and void of all air pockets, gradually increase pressure in the test section to the specified test pressure.
  - b. Test section shall not exceed 1.5 x design pressure at systems lowest point.
  - c. Should test pressure not be obtainable, examine pipe for leaks, air pockets or other faults prior to continuing test.
  - d. Once test section has achieved stable test pressure, add make-up water as necessary to maintain test pressure for four (4) hours.
5. Test Phase
  - a. Reduce test pressure by 10 psi and monitor pressure for one (1) hour. Do not increase pressure or add make-up water.
  - b. If no visual leakage is observed and pressure during the test phase remains steady (within 5% of the test phase pressure) for the one (1) hour test period, a passing test is achieved.
6. Retesting
  - a. If retesting is necessary, depressurize the test section by releasing test liquid at a controlled rate. Sudden depressurization can cause water hammer.

- b. Do not attempt to correct faults or make repairs while test section is pressurized.
- c. Allow the test section to relax for a period of eight (8) hours before restarting the pressurization step of testing.

### 3.3 PIPE PRESSURE TESTING LOG

- A. All pressure tests shall be witnessed by ENGINEER. CONTRACTOR shall keep a pipe pressure testing log to document the pressure testing and ENGINEER's approval of such.
  - 1. Specific details of the contents and format pipe pressure testing log shall be determined by the CONTRACTOR and approved by the ENGINEER.
  - 2. At a minimum, pipe pressure testing log shall record, on a daily basis for any day when pipe pressure testing is performed:
    - a. Test Report Documentation:
      - 1) Test date.
      - 2) Description and identification of piping tested.
      - 3) Test fluid.
      - 4) Test pressure.
      - 5) Remarks, including:
        - a) Leaks (type, location).
        - b) Repair/replacement performed to remedy excessive leakage.
  - 3. Pipe pressure testing log shall be kept on-site. Pipe pressure testing log shall be signed on a daily basis, for any day when pipe pressure testing log work is performed, by the supervisor of the CONTRACTOR's field crew and by the ENGINEER.
  - 4. Any piping system which was pressure tested, but which was not recorded in the pipe pressure testing log shall be re-tested at the ENGINEER's discretion.

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## **SECTION 15995**

### **DISINFECTION OF POTABLE WATER SYSTEMS**

#### **PART 1 - GENERAL**

##### **1.1 SUBMITTALS**

- A. Informational Submittals:
  - 1. Plan describing and illustrating conformance to appropriate AWWA standards and this Specification.
  - 2. Procedure and plan for cleaning system.
  - 3. Procedures and plans for disinfection and testing.
  - 4. Proposed locations within system where Samples will be taken.
  - 5. Type of disinfecting solution and method of preparation.
  - 6. Certification that employees working with concentrated chlorine solutions or gas have received appropriate safety training.
  - 7. Method of disposal for highly chlorinated disinfecting water.
  - 8. Independent Testing Agency: Certification that testing agency is qualified to perform bacteriological testing in accordance with AWWA standards, agency requirements, and this Specification.
  - 9. Certified Bacteriological Test Results:
    - a. Facility tested is free from coliform bacteria contamination.
    - b. Forward results directly to ENGINEER.

##### **1.2 QUALIFICATIONS**

- A. Independent Testing Agency: Certified in the State of California with 10 years' experience in field of water sampling and testing. Agency shall use calibrated testing instruments and equipment, and documented standard procedures for performing specified testing.

#### **PART 2 - PRODUCTS**

##### **2.1 WATER FOR DISINFECTION**

- A. Clean, uncontaminated, and potable.
- B. CONTRACTOR shall make arrangements for water supply and convey water in disinfected pipelines or containers.

##### **2.2 CONTRACTOR'S EQUIPMENT**

- A. Furnish chemicals and equipment, such as pumps and hoses, to accomplish disinfection.
- B. Water used to fill pipeline may be supplied using a temporary connection to existing distribution system. Provide protection against cross-connections as required by AWWA C651.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Conform to AWWA C651 for pipes and pipelines, C652 for tanks and reservoirs, C653 for water treatment plants and filters, and C654 for wells, except as modified in these Specifications.
- B. Disinfect the following items installed or modified under this Project, intended to hold, transport, or otherwise contact potable water:
  - 1. Pumps.
  - 2. Tanks.
  - 3. Pipelines: Disinfect new pipelines that connect to existing pipelines up to point of connection.
- C. Disinfect surfaces of materials that will contact finished water, both during and following construction, using one of the methods described in AWWA C652 and C653. Disinfect prior to contact with finished water. Take care to avoid recontamination following disinfection.
- D. Prior to application of disinfectants, clean pump, tank, filters, and pipelines of loose and suspended material.
- E. Allow freshwater and disinfectant solution to flow into pipe or vessel at a measured rate so chlorine-water solution is at specified strength. Do not place concentrated liquid commercial disinfectant in pipeline or other facilities to be disinfected before it is filled with water.

### **3.2 PIPING**

- A. Cleaning:
  - 1. Before disinfecting, clean all foreign matter from pipe in accordance with AWWA C651.
- B. If the continuous feed method or the slug method of disinfection, as described in AWWA C651 are used, flush pipelines with potable water until clear of suspended solids and color. Provide hoses, temporary pipes, ditches, and other conduits as needed to dispose of flushing water without damage to adjacent properties.
- C. Flush service connections and hydrants. Flush distribution lines prior to flushing hydrants and service connections. Operate valves during flushing process at least twice during each flush.
- D. Flush pipe through flushing branches and remove branches after flushing is completed.
- E. Disinfecting Procedure: In accordance with AWWA C651, unless herein modified.

### **3.3 PUMPS**

- A. Disinfecting Solutions: Minimum free chlorine concentration of 100 ppm.
- B. Application:

1. Inject disinfecting solution into pump and associated piping and circulate for a minimum 3-hour period of time. At end of 3-hour period, solution shall have a strength of at least 50 ppm free chlorine.
2. Operate valves and pump appurtenances during disinfection to ensure that disinfecting solution is dispersed into all parts of pump and lines.
3. If disinfecting solution contained in pump has a residual free chlorine concentration less than 50 ppm after the 3-hour retention period, reclean pump, reapply disinfecting solution, and retest until a satisfactory test result is obtained.
4. After chlorination, flush water from pump until water through the unit is chemically and bacteriologically equal to permanent source of supply.

### 3.4 TANKS

- A. Potable Water Storage Tanks: Disinfection procedures are described in section 03314.
- B. Cleaning:
  1. Clean interior surfaces using water under pressure before sterilizing. Isolate tanks from system to prevent contaminating materials from entering the distribution system. Cleaning shall:
    - a. Remove all deposits of foreign nature.
    - b. Remove all biological growths.
    - c. Clean the slopes, walls, top, and bottom.
    - d. Avoid damage to the structure.
    - e. Avoid pollution or oil deposits by workers and equipment.
  2. Dispose of water used in cleaning in accordance with applicable regulations before adding disinfecting solution to tank.
- C. Disinfecting Procedure: In accordance with AWWA C652, unless herein modified. Parts of structures, such as ceilings or overflows that cannot be immersed, shall be spray or brush disinfected.

### 3.5 DISPOSAL OF HEAVILY CHLORINATED WATER

- A. Do not allow flow into a waterway without neutralizing disinfectant residual.
- B. See the appendix of AWWA C651, C652, C653, and C654 for acceptable neutralization methods.

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**SECTION 16010**  
**ELECTRICAL GENERAL**

**PART 1: GENERAL**

**1.01 SCOPE OF WORK**

- A. The following list of components and areas of work is a summary of the work required in the drawings and specifications. The list is not comprehensive of the total work required nor is it in any specific order. It is merely being provided as an aid to the bidder. Work not listed herein, but described in the plans or specifications, is also part of the overall scope of work.
1. Outdoor Utility Metering with Main Disconnect, Generator Breaker, and Transition Sections to accommodate rear entry Automatic Transfer Switch in NEMA 3R weatherwrap.
  2. Indoor Automatic Transfer Switch with Transition Section and Power Distribution Sections. Custom ATS rear entry compartment.
  3. VFD Motor Control Panels.
  4. Soft Starter Motor Control Panels.
  5. Generator with sound attenuating enclosure, load bank and remote fuel tank.
  6. SCADA View Node
  7. Site access control and security
  8. PLC Control panel(s).
  9. PLC and SCADA.
    - a. Configuration and programming of the PLC is by Application Programmer – a person or entity further defined in this section.
    - b. Configuration and programming of the SCADA System is by Owner.
  10. Communications system. Contractor to coordinate, configure, test, and place communications system(s) into operation.
  11. Instrumentation
    - a. Mounting supports or other accessories as detailed and as recommended by the instrument manufacturer for the application.

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- b. Contractor shall calibrate, configure and test all instrumentation and document results.
- 12. Coordination and timely installation of critical path equipment and services such that construction may be facilitated. The Electrical Contractor and System Integrator should not assume that submittals, manufacturing, installation, start-up will be based on their own schedule. The Electrical Contractor and System Integrator scope of work is part of a much larger project and will need to be coordinated. Expect that additional cost in time and labor will be required beyond normal optimistic projections.
- 13. Conduit – support systems, wire, and grounding system, for equipment interconnection, and operation.
- 14. All necessary process piping, shut off, sample and calibration valves, drains, pressure reducers and calibration equipment for connection of instrumentation.
- 15. Trenching, backfilling, compaction and resurfacing for all new underground conduit routes, concrete pads, and pull boxes.
- 16. Coordination and equipment for connection of power utility and telephone services per utility drawings and standards.
- 17. Site electrical devices, lights and receptacles.
- 18. Seismic Anchorage Design Calculations and conforming installation.
- 19. System startup, calibration, testing and documentation.
  - a. The Application Programmer (defined in Electrical Specifications [Electrical General].), Owner and/or Construction Manager will be actively engaged in Operational Testing and Commissioning. These efforts shall be combined efforts of the Application-Programmer/Construction-Manager/Engineer, Contractor and Owner.
  - b. The Contractor shall facilitate test as outlined herein such that hardware, software and application programming are tested completely and all applicable test documentation is completed.
  - c. The Contractor shall assume that a minimum of 80 hours will be required to assist in this task.
  - d. Sufficient time shall be allocated in the construction schedule for troubleshooting, testing, startup, and verification of application programming in front of associated construction milestones. For instance, if a pump station is required to be operational prior to a date certain, then the schedule shall allocate time for these activities. The time necessary depends on the system to be started and shall be coordinated with the Owner Representative or Application Programmer during

construction scheduling early in the project.

- B. Electro-mechanical equipment to be installed in this project may be specified in other divisions but will interface to equipment provided under Electrical Specifications. Obtain submittals for those devices, review, coordinate and provide all interfacing equipment, software, communications, I/O, and testing to integrate the equipment to the extent possible and as intended.
- C. Install electrical and control portion of electro-mechanical equipment specified in other sections. Reference those specifications, pertinent details, and follow all manufacturer instructions to erect, install and commission equipment. Furnish all electrical equipment, interconnecting wire, and make connections to place equipment in operation.
- D. All electrical equipment and materials, and methods - including installation, calibration, and testing - shall conform to the applicable codes and standards listed in this and other Sections. All electrical materials and work shall conform to published standards of the National Electric Code (NEC) current issue, Institute of Electrical and Electronic Engineers (IEEE), and Underwriters Laboratories Inc (UL).

## 1.02 RELATED SPECIFICATIONS

- A. The following specification sections are part of the [Electrical Specifications].

Section	Description
16110	Conduit and Boxes
16120	Low Voltage Wire and Data Cable
16210	Engine Generator
16250	Automatic Transfer Switch
16430	Low Voltage Switchboard
16450	Grounding
16470	Panelboard and Power Transformer
16481	Variable Frequency Drive
16482	Solid State Soft Starter
16600	Factory and Field Testing
16905	Control Panels
16910	PLC Hardware
16931	Security System
16932	Access Control System
16933	Video Monitoring System
16940	Instrumentation

- B. Owner, Engineer, Construction Manager, Application Programmer, and City are used within Electrical Specifications and are interchangeable. They are all representatives of the Owner, in this case, the City of Roseville.

## 1.03 QUALIFICATIONS AND REQUIRED WORK SCOPE

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A. Electrical Contractor

1. Management and installation of the entire electrical and control system) required for this project shall be by an Electrical Contractor meeting qualifications as defined herein.
  - a. Contractor shall be capable of looking at electrical equipment submittals, prior to installation, comparing hookup requirements to the drawings, and noting any deficiencies.
2. Electrical Contractor shall select, furnish, and install all commodity electrical materials (conduit, wire, supports, fittings, ductbanks, etc) that are generally not "custom" or uniquely manufactured for this project. Custom electrical panels, controls, and instrumentation shall be furnished by Systems Integrator.
3. Shall be competent in and familiar with management and subcontracting of specialty electrical and instrumentation supply and engineering work as requires of a Systems Integrator as described herein.
4. Electrical Contractor must be competent in performance, supervision and coordination of work required and performed by equipment suppliers and Systems Integrator (Subcontractors).
5. The Electrical Contractor (EC) shall meet the following minimum qualifications:
  - a. Has a current C10 Electrical Contractor's License issued by the State of California Department of Consumer Affairs.
  - b. EC shall be regularly engaged in similar industrial power and controls electrical contracting for the Water and Wastewater Industry.
  - c. EC shall have successfully performed work of similar or greater complexity (as measured in contract value on industrial power and controls projects) on at least three (3) previous projects.
  - d. EC shall carry all insurances as defined and required by the special provisions and as required by law.
  - e. EC shall be competent in methods and materials execution and selection associated in the type of electrical and instrumentation work specified in this Division.
    - 1) EC shall be familiar with and understand codes and requirements from NFPA70, NFPA110, and all other governing national or local codes as required for work scope as described in the drawings and specifications.
    - 2) EC shall know and understand common terms and abbreviations used in this Industry. Not all terms and abbreviations will be defined in the drawings and specifications.

B. System Integrator

1. Systems Integrator shall be a supplier to the Electrical Contractor and

must be competent in performance, supervision and coordination of work required in this contract.

2. This includes, but is not limited to, all work necessary to select, furnish, construct, supervise installation, configure, calibrate, test, and place into operation all transmitters, instruments, programmable controllers, control panels, motor controls, alarm equipment, communications, monitoring equipment, and accessories.
3. The System Integrator shall have on staff a Project Engineer with three years prior experience on similar sized projects. This Project Engineer shall coordinate the technical aspects of this project and prepare the submittals and drawings. The Project Engineer shall attend all coordination meetings when specifically requested by the Engineer.
4. The System Integrator (SI) shall meet the following minimum qualifications:
  - a. SI shall be regularly engaged providing electrical and control systems for the Municipal Water and Wastewater Industry.
  - b. SI shall have an Electrical Engineer on staff registered in the State of California as a Professional Engineer.
  - c. SI shall be capable of labeling all electrical panels as manufactured or customized by the System Integrator with appropriate UL label prior to factory testing or shipment to project site.
  - d. SI shall have successfully completed work of similar or greater complexity and on similar facilities on at least ten previous projects under the present company name.
  - e. SI shall be actively engaged in the following disciplines for the last 5 consecutive years.
    - 1) Design and manufacturing of custom Control Panels, Motor Controls Centers, and associated devices and equipment as specified in this division.
    - 2) Programming and commissioning of SCADA, PLC and Operator Interface hardware.
    - 3) Instrumentation - selection, purchase, calibration, start-up and commissioning.
    - 4) Testing, calibration, start-up, and commissioning of control systems as applied to the Water and Wastewater industry.
  - f. SI shall employ personnel on this project who have successfully completed ISA or equal training courses on general purpose instrumentation.
  - g. SI shall have a permanent, fully staffed and equipped service facility within 200 miles of the project site for a minimum of 1 year prior to bid date with personnel and equipment required to maintain, repair and calibrate the instrumentation system.

C. Application Programmer

1. The Applications Programmer will be a part of the construction management team. The Applications Programmer will be a

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subconsultant of the Owner.

2. The Application Programmer work is limited to programming and configuration, and associated startup and testing services of the PLC and SCADA system. All other work is by Contractor.

#### 1.04 CONTRACT DOCUMENTS

- A. The resolution of conflicting information within the contract electrical documents shall put precedence on electrical drawings over that of electrical specifications.
- B. The Drawings and specifications are intended to be descriptive of the type of electrical system to be provided with sufficient detail to construct. Minor omission of detail shall not relieve a qualified contractor from the obligation to provide a complete operational system if it can be determined that the particular detail is usual and customary for similar systems.
- C. The following specifications may incorporate specific equipment or materials that do not have equal equipment listed. These items are standards because of their familiarity, serviceability, and/or spare parts inventory. However, equal alternate equipment or materials (noted in the submittal cover letter) will be considered for use on this project if submitted. The Engineer may reject said equipment for the purpose of adherence to standards.
- D. Contract drawings are diagrammatic and indicate general arrangement of systems and equipment, except when specifically dimensioned or detailed. Exact locations and layouts of electrical products shall be defined during submittal, assembly, or field fit during construction. Field measurements take precedence over dimensioned drawings. Drawing intent is to show initial size, capacity, approximate location, orientation, and general relationship of equipment in area shown but not exact detail or arrangement. The requirements or descriptions in the drawings shall take precedence in the event of conflict.
- E. The Contractor shall examine the architectural, mechanical, structural, and electrical and instrumentation submittals and equipment furnished under other specifications divisions in order to determine conduit routing, stub-up locations, and final terminations for all conduits and cables. Conduits shall be stubbed up as near as possible to equipment electrical terminals. The exact locations and routing of cables and conduits shall be governed by structural conditions, physical interferences, and the physical location of wire terminations on equipment. If the Contractor installs equipment conflicting with the architectural, mechanical, structural, instrumentation or electrical equipment provided under this and other specifications sections, the Contractor shall replace without additional cost.
- F. All equipment shall be installed and located so that it can be readily accessed for operation and maintenance. If accessibility appears to be compromised, the location of equipment or stub ups shall be modified to the extent possible.
- G. Where conduits are shown on the Drawings, or stated to be furnished but not explicitly shown, as part of the scope of work; the Contractor shall provide all

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fittings, boxes, wiring, etc. as required for completion of the raceway system in compliance with the NEC and the applicable specifications in this Section.

- H. No changes from the Drawings or specifications shall be made without written approval of the Engineer. Should there be a need to deviate from the Contract documents, submit written details and reasons for all changes to the Engineer for review.
- I. The Contractor shall maintain a neatly and accurately marked full size set of Contract Drawings recording the as built locations and layout of all electrical and instrumentation equipment, routing of raceways, junction and pull boxes, and other diagram or drawing changes. Drawings shall be kept current weekly, with all "change orders", submittal modifications, and construction changes shown. Drawings shall be subject to the inspection by the Engineer at all times, progress payments or portions thereof may be withheld if drawings are not accurate or current.
- J. When documents are changed, they shall be marked with erasable colored pencils using the following coloring scheme:  
  
Additions - red  
Deletions - green  
Comments - blue  
Dimensions - black
- K. Prior to acceptance of the work, the Contractor shall deliver to the Engineer one set of record full size drawings neatly marked accurately showing the information required above.

#### 1.05 UTILITY COORDINATION AND FEES

- A. All fees and charges of the Power Utility, Roseville Electric Utility, for design and final connection will be paid by others.
- B. Coordinate all work with the Utility for the work shown on Contract Drawings.
  - 1. Unless already completed, apply for electric service within 10 working days from Notice to Proceed.
  - 2. Coordinate and meet with the Utility's Representative at the project site(s) within 30 days after award of contract.
  - 3. Discuss specific installation and comply with Utility requirements. Contact Engineer in the event that Utility requirements far exceed allowances in the plans and specifications. Provide an itemized list of deviations and potential costs or credits.
  - 4. Coordinate and obtain required inspections prior to backfill. Make corrections to installation as required.
  - 5. Coordinate connection and date of service with Utility. Utility back-charges due to mis-coordination or installation problems will be Contractor responsibility to pay and correct.

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- C. Furnish and install electric service in accordance with the serving Utility's requirements.
  - 1. The contract plans show the preliminary design for the Utility installation. Slight changes required by the Utility do not constitute extra work unless cost impacts in material and labor exceed \$5000. In that event, the agreed excess amount will be allowed as a contract change.
  - 2. The Contractor shall provide and install service entrance equipment, all material, conduits, wiring, pull ropes, pole risers, transformer pads, bollards, etc. as shown on Utility design drawings and standards for new power service. Utility standards are available upon request from the Utility or for download from the Utility's website.
- D. Following award of Contract, schedule all service installations and connections with utilities. Construction or start-up delays as a consequence to lack of documented effort by the Contractor which delay the project completion due to lack of Utility services will not be considered valid and Contract liquidated damages may be assessed.

#### 1.06 PROJECT COORDINATION

- A. Prior to submittal, the Electrical Contractor shall coordinate with equipment suppliers to verify sizes, mounting, connections, storage, and delivery of equipment. If there are any issues whereby the solution will be in conflict with plans and specifications, or that are undefined and need direction, they shall be brought to the attention of the Engineer or Construction Manager via the RFI process.

#### 1.07 SUPERVISION

- A. The Contractor shall schedule all activities, manage all technical aspects of the project, coordinate submittals and drawings, and attend all project meetings associated with this Section. The Contractor shall coordinate and confirm that the project schedule is being adhered to and all work is being completed within the scheduled time frames.
- B. The Contractor shall supervise all work in this Section, including the electrical system general construction work, from the beginning to completion and final acceptance.
- C. The Contractor shall coordinate, obtain, prepare, and/or complete the documentation required within this division. All documentation shall be complete and delivered prior to final acceptance.

#### 1.08 INSPECTIONS

- A. General
  - 1. Contract work or materials shall be subject to inspection at any time by the Engineer. If equipment, material, or installation method does not conform to the Contract documents, or does not have a favorably

reviewed submittal status and has been determined to be unsatisfactory by the Engineer, then the Contractor shall remove said material from the premises; and if said material has been installed, the entire expense of removing and replacing same, including any cutting and patching that may be necessary, shall be borne by the Contractor.

2. The Engineer may inspect and test the fabricated equipment at the factory before shipment to job site. See Electrical Specifications [Factory and Field Testing] for requirements.
3. Work shall not be closed in or covered over before inspection and approval by the Engineer. All costs associated with uncovering and making repairs where non-inspected work has been performed shall be borne by the Contractor.
4. The Contractor shall cooperate with the Engineer and provide assistance at all times for the inspection of the electrical system under this Contract. The Contractor shall remove covers, provide access, operate equipment, and perform other reasonable work which, in the opinion of the Engineer, will be necessary to determine the quality of the work.

B. Milestones requiring inspection and signoff.

1. Underground conduit and grounding system complete. Do not cover any portion of conduit prior to inspection. Conduits must be labeled with temporary tags per Electrical Specifications [Conduit and Boxes] and [Grounding].
2. Factory testing. Coordinate test date with Engineer 2 weeks prior to test scheduled date.
3. Installation of electrical equipment. Equipment is anchored in place, conduit connections are complete, no wire is yet pulled into conduit. Permanent conduit tags must be in place per Electrical Specifications [Conduit and Boxes] and [Grounding].
4. Wire termination complete. Do not energize equipment. All wire tags must be installed and wires terminated per Electrical Specifications [Low Voltage Wire and Data Cable]. Pre-energization testing to commence after inspection.
5. Testing per Electrical Specifications [Factory and Field Testing]. All testing per Electrical Specifications [Factory and Field Testing] shall be witnessed unless specifically declined by the Engineer. Schedule tests with Engineer 2 weeks prior to test date.
6. Start-up per Electrical Specifications [Factory and Field Testing]. Schedule tests with Engineer 2 weeks prior to test date.
7. Punch list – final inspection. Schedule final walkthrough with Engineer one week prior to intended project completion date. All items on punchlist must be complete prior to scheduling walk-through.

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## 1.09 JOB CONDITIONS

### A. Construction Power and Telephone Service

1. The Contractor shall coordinate, furnish and install, temporary utility services required during construction of the project, such as temporary electrical power and telephone service. Temporary services shall be installed in accordance with the applicable codes and regulations of the serving utilities.
2. Upon completion of the project, remove temporary services. All equipment and material shall be the property of the Contractor.

### B. Equipment Storage

1. The Contractor shall provide adequate protection for all equipment and materials during shipment, storage and construction.
2. Equipment and materials shall be completely and sufficiently sealed and covered and set on a pallet above grade so that they are protected from weather, wind, dust, water, or construction operations.
3. Equipment shall not be stored outdoors. Where equipment is stored or installed in an area with susceptibility to moisture, such as unheated buildings, untested piping, etc., provide an acceptable means to prevent moisture damage, such as plastic cover and a uniformly distributed heat source to prevent condensation.

- C. The project site is located where outside temperatures vary between 10 deg F. to 110 deg F. Humidity in this area will range from 10% to 100%.

## 1.10 AREA CLASSIFICATIONS

- A. Area classifications are shown on the site electrical plans. The area enclosed by walls or the entire drawing area shall be classified as shown unless otherwise described in notes.
- B. All electrical equipment, enclosures, conduit, and supports shall be formally rated for or, at minimum, meet the intent of the rating as interpreted by Engineer.
- C. If no area classification rating is shown on the drawings, classification shall default to a NEMA 12 rating for indoors, and NEMA 4 rating for outdoors (non corrosive) and NEMA 4X for corrosive areas both indoors and outdoors.

## 1.11 SUBMITTAL REQUIREMENTS

### A. General

1. Requirements described herein are specific to electrical submittals and are secondary to those described in other general specifications sections. Any additional requirements described here that are beyond those described in those sections shall be provided as described.

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Conflicts shall be resolved by giving priority to general specifications.

2. The Contractor shall ensure that the System Integrator and/or equipment suppliers provide the submittal documentation required in this section. Submittals shall be neat, orderly, complete (without unneeded parsing), and indexed.
  - a. Like equipment shall be submitted complete in a single submittal. For instance, all general electrical materials shall be in a single submittal. All instrumentation, all control panels, or all MCCs and so on shall be submitted complete where possible.
  - b. Submittals that are broken down without sufficient cause will be rejected for future inclusion into a combined submittal.
  - c. Do not separate submittals by area.
  - d. Do not separate submittals by specification division unless agreed to in advance.
  - e. Submittals for work scope covered in this contract are expected to be as follows. This list is intended to be a guideline and not to be specific of all submittals required. Project circumstances or leadtimes or availability will each impact the order and division of submittals.
    - 1) General electrical materials – conduit, wire, labels, etc.
    - 2) Lighting
    - 3) Power Distribution and Motor Controls
    - 4) PLC and Control Panels
    - 5) Engine Generator
    - 6) Seismic Calculations
    - 7) Instrumentation
    - 8) Security System
    - 9) Video Surveillance system
    - 10) Factory and Field Testing forms and procedures
    - 11) Interconnection Diagrams
    - 12) Installation details or procedures
    - 13) O&M Manuals
3. The Contractor shall coordinate submittals with the work so that project will not be delayed. This coordination shall include scheduling the different categories of submittals, so that one will not be delayed for lack of coordination with another. Time extensions will not be allowed due to failure to properly schedule submittals.
4. No material or equipment shall be delivered to the job site until the submittal for such items has been reviewed by the Engineer and marked "no exceptions noted" or "make corrections noted".
5. The equipment specifications have been prepared on the basis of the equipment first named in the Specifications. The Contractor shall note that the second named equipment, if given, is considered acceptable and equal equipment, but in some cases additional design, options, or modifications may be required to meet Specifications or functional

installation.

6. Exceptions to the Specifications or Drawings or equipment or procedures submitted as "equal" to specified equipment shall be clearly identified in a letter at the front of the submittal. Submittal data for "equal" equipment or procedures shall contain sufficient details so a proper evaluation may be made by the Engineer. The Contractor is responsible for verifying proper application/operation of substituted equipment.
  7. The opinion of the Engineer will be the final determination whether a substitution request meets the design intent.
  8. Deviations from the Contract documents shall **not** be incorporated into the work without prior written approval of the Engineer. A "Change Order" directive from the Engineer is required prior to incorporating any deviation from the Contract documents that has costs associated. The cost differential associated with this change order must be negotiated with the Engineer to amend the Contract to reflect the costs or savings.
- B. Electrical Equipment -- Submittal data shall be grouped by equipment type. Each submittal shall be as complete as possible covering the entire project and scope of supply. Drawings or equipment submitted individually that are not on the critical path will not be accepted for individual review. The electrical submittals shall include (as a minimum):
1. Table of Contents
  2. Comment Letter: The Project Engineer of the System Integrator shall note all deviations from Contract Documents and the reason(s) for the deviation. They may use this forum to inform the Engineer or installing Contractor of important information related to the project. RFIs must be submitted separately. Re-submittals shall include written responses to every comment provided by the engineer during the previous review.
  3. Bill of Materials: The Contractor and System Integrator each shall provide Bill of Material for electrical components formatted as shown below. Generic names or part numbers as defined by a distributor or Integrator are not acceptable. Only the originating manufacturer's name and part number shall be listed. Provide separate bill of materials for each panel, MCC, instrument list, etc.

Bill of Material

Item #	Qty	Tag#	Description	Manufacturer	Part #

4. Shop Drawings:
  - a. Equipment elevations with enclosure details drawn to scale or dimensioned with relative scale.

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- b. Electrical One-line, Elementary, and wiring diagrams
  - c. PLC I/O wiring diagrams
  - d. Interconnection diagrams
- 5. Catalog Data shall include the following: (features and options shall be highlighted, circled, or "arrowed.")
  - a. Instrumentation data summary sheets (by Contractor)
  - b. Manufacturer's technical information brochure
  - c. Physical size and mounting details and illustrations
  - d. Calibration Range
  - e. Input/output signals
  - f. Electric power, air, and/or water supply requirements.
  - g. Options selected and available (Cross out items not included)
  - h. Materials of construction of components
- C. Shop Drawings - Shop drawings shall be furnished for each electrical panel even if one was not shown explicitly on the Drawings. Shop drawings shall be numbered in sequence. Blank drawings or drawings that contain no specific project data will not be accepted for review.

All drawings shall be generated with a computer utilizing AutoCAD or similar drafting program. Drawings shall be no smaller than 11" x 17". The lettering shall be legible and no smaller than 0.75 inch in height.

Drawings shall be custom prepared for this project and shall have borders and a title block identifying the project, manufacturer, system or location, drawing number, drawing title, AutoCAD file name, project engineer, date, revisions, and type of drawing. Diagrams shall carry a uniform and coordinated set of wire colors, wire numbers, and terminal block numbers. The shop drawings shall include the following as a minimum:

- 1. Electrical one-line diagrams detailing all devices associated with the power distribution system. The following applicable information or data shall be shown on the one- or three- line diagram: location, size and amperage rating of bus; size and amperage rating of wire or cable; breaker ratings, number of poles, and frame sizes; power fail and other protective devices; fuse size and type.
- 2. Detailed analog and digital I/O diagrams showing the wiring requirements for each instrument or device connection. Reference the Drawings for an example of each I/O card drawing requirements. If one is not included in the Drawings, then one may be obtained from the Engineer upon request.
- 3. Elementary (wiring) diagrams shall be provided for all relay logic, programmable logic controls, motor controls, power supplies, and other wiring. All elementary (wiring) diagrams shall be drawn in JIC EMP/EGP format and standards showing ladder rung numbers and coil and contact cross referencing numbers.
- 4. Equipment exterior and interior scaled drawings of front, side, elevation, deadfront, front panel devices, and backpan components. Show fabrication methods and details; including material of

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construction, paint color, door latch and lock, and ventilation system. Show shipping split locations and offloading information. Submit base plan showing allowed conduit entrance areas and bolt hole locations.

5. Drawings shall show UL required information as needed to UL label the equipment in accordance with UL procedures for label applied.
  6. Submit full size drawing of all nameplates and tags, as specified herein, to be used on project. Submittal to include the following:
    - a. Dimensions of nameplate.
    - b. Exact lettering and font for each nameplate.
    - c. Color of nameplate.
    - d. Color of lettering.
    - e. Materials of construction.
    - f. Method and materials for attachment.
    - g. Drawing showing location of nameplates on each, panel and enclosure.
- D. Interconnection Diagrams - Interconnection diagrams shall be furnished for each electrical and instrumentation system, even if one was not shown explicitly on the Drawings. Reference the Drawings for an example of interconnection drawing requirements. If one is not included in the Drawings, then one may be obtained from the Engineer upon request. Each interconnection diagram shall include the following as a minimum:
1. The diagrams shall show connection point descriptions and field routing only. This includes, but is not limited to, terminal blocks, field wiring with numbers, junction boxes, conduit material with sizes, and conduit numbers.
  2. Each conduit in the Conduit and Wire Schedule shall be shown on at least one interconnection diagram. Multiple conduits may be shown on a single interconnect and a conduit may appear on multiple interconnects.
  3. Interconnect diagrams shall be based on connected equipment, ie. Interconnection diagram for Pump 1. All components connected to the MCC cubicle for Pump 1 shall be shown on a single interconnect.
  4. All terminations points on the diagram shall be shown with the actual equipment identification terminal number or letter.
  5. Interconnections between equipment shall be shown terminal to terminal with conduit lines in between. Wires within the same conduit shall be bundled and shown as a single line and labeled with the conduit name and wire fill. If not all wires within a conduit are used on a particular interconnection diagram, then the fill shall be noted as XX of XXX wires.
  6. Conduit shall be shown as routed through junction boxes and pull boxes. Wire fill leading into a pull box shall be equal to the combined outgoing conduit wire fill.

7. Each wire and color code shall be shown connected to a terminal block. Spare wires may be shown as a list of wire numbers located near the end point of the wire.
8. Schematic symbols shall be used for field devices showing electrical contacts. Circuit polarities shall be shown where applicable.
9. The diagrams shall show all other Contract and shop drawing numbers, for reference, that are associated with each device that is interconnected. Attached with each interconnect, a copy of all the support documents used in preparing interconnects. This includes current issues of panel schematics, connection diagrams, terminal block diagrams, submittals, contract drawings, vendor drawings and all other data used to develop the interconnection diagram as noted in the "Reference Documents" corner of interconnect drawings.
10. Provide a notes section on each interconnect drawing. In the note section list any variances from the Contract conduit schedule necessary for completing the interconnections. Change orders regarding wire fill, conduit schedule and errors in plans regarding conduits and wires may not be processed until interconnect drawings have been received for such work.
11. The interconnection drawings shall be As-Built by the Contractor after start-up and prior to project completion. All deletions and additions of equipment, wire and cables shall be clearly shown. Interconnects shall include list of all applicable field instructions and change orders.
12. The diagrams shall be utilized by the electrician during all phases installation and connection of all conductors to ensure coordination of equipment interconnect.
13. Field wiring shall not start before the interconnection drawing have been submitted by the Contractor and approved by the Engineer.
14. The Contractor shall not pull in any wires into conduits that do not have approved interconnects. If the Contractor pulls and/or terminates wire without approved interconnect drawings, the Contractor will not be reimbursed for labor for re-pulling/replacing wires even if there was an error in wire fill or sizing in the "Wire and Conduit Schedule". If the Contractor pulls and/or terminates wire without approved associated interconnect drawings, then all progress payments for that particular area of work will be withheld until approved interconnect drawings are in use.

E. Seismic Anchor Design Calculations

1. All switchgear, motor controls centers, transformers, cabinets, raceways, supports, and electrical materials shall be so installed as to remain in a secure and captive position when subjected to a horizontal force in accordance with the current, applicable, and more stringent of California Building Code (CBC) or International Building Code (IBC) requirements. Method of securing shall constrain equipment against

both vertical and horizontal forces and overturning forces.

2. Calculations as prepared by a structural engineer registered in the State of California shall be submitted in accordance with code requirements for earthquakes forces on all specified equipment. Calculations shall include wind loading forces for equipment installed outdoors.

## 1.12 OPERATING AND MAINTENANCE INFORMATION

### A. Operations and Maintenance Manuals

1. Provide Operation and Maintenance manuals per specifications as described in "Submittal Requirements" in this section with the following additional requirements:
  - a. A comprehensive index.
  - b. A complete "Record" set of favorably reviewed electrical submittals as provided under subsection "Submittal Requirements" illustrating all components, piping, and electrical connections.
  - c. A complete list of the equipment supplied, including serial numbers, ranges, catalog cuts, and pertinent data.
  - d. Full specifications on each item.
  - e. Detailed service, maintenance and operation instructions for each item supplied. Schematic diagrams of all electronic devices shall be included. A complete parts list with stock numbers shall be provided for the components that make up the assembly. All of these shall be originals, no copies.
  - f. Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.
2. Submit electronic readable PDF file format (CD disk copies (2) or email with attachments or download links) of the proposed O&M manuals for review by the Engineer. Submittals shall be delivered timely to the Engineer to allow for review period, corrections, and re-submissions as necessary.
  - a. General Contractor supervision must not be circumvented by sending submittals direct to Engineer.
  - b. O&M Submittals shall be published 1<sup>st</sup> electronically and 2<sup>nd</sup> on hard copy paper stock.
  - c. Electronic Submittals shall be transmitted with the hard copy submittals and be viewable using a PDF reader.
  - d. Electronic submittals shall be assembled in accordance with the specifications for hard copy submittals with table of contents, bookmarks, tabs, subtabs, etc. utilizing the electronic

bookmarks feature available in the PDF assembler.

- e. Electronic (PDF) submittals must follow all applicable requirements for hard copy submittals including indexing, item selection indication, bookmarks, etc.
- 3. Provide four (4) hard copy O&M manuals per specifications as described in SUBMITTALS REQUIREMENTS in this section.
  - a. Deliver approved hard-copy O&M manuals to the project site and Owner prior to pre-operational testing or equipment start-up.
- B. At the end of the project hard copy and soft copy electronic PDF files, shall be updated to "as-built" conditions.
- C. Provide two (2) sets of compact disk (CD) containing all shop drawings, application programs, configurations, calculations, documents or other computer electronic files prepared for this project in native file format and updated to reflect as-built conditions.

## **PART 2: PRODUCTS**

### **2.01 QUALITY**

- A. All equipment and materials shall be new, in current production, and the products of reputable suppliers having adequate experience in the manufacture of these particular items. For uniformity, only one manufacturer will be accepted for each type of product.
- B. Products specified that have become obsolete (out of current manufacturing, or have been superseded by another product) shall be cross-referenced to a replacement product(s) and provided in lieu of the specified product(s) for no additional cost. Under no conditions, shall products be submitted or furnished that are known (on manufacturer's list of obsolescence) and expected to be removed from current production within 12 months after project submittal. Products found to have been furnished this way will be removed and replaced at Contractor's expense.
- C. All equipment shall be designed for the service intended and shall be of rugged construction, of ample strength for all stresses which may occur during fabrication, transportation, erection, and continuous or intermittent operation. All equipment shall be adequately braced and anchored and shall be installed in a neat and workmanlike manner. Appearance and safety, as well as utility, shall be given consideration in the design of details. All components and devices installed shall be standard items of industrial grade, unless otherwise noted, and shall be of sturdy and durable construction suitable for long, trouble free service. Light duty, fragile and competitive grade devices of questionable durability shall not be used.
- D. The Contractor should expect that there will be occasional freezing conditions at the project site in outdoor locations. Instrument valves, tubing, instrumentation, and other components, etc. which are outdoors and



susceptible to damage if frozen, must be provided with internal or external protection. Freeze protection can consist of internal or external active heaters with thermostats and/or passive insulation systems. Active systems can be powered from a nearby receptacle or via the conduit intended for the device.

- E. Products that are specified and include a manufacturer, trade name or catalog number are intended to establish a standard of quality, performance, warranty and service. Products that are specified "or equal," do not prohibit the use of equal products of other manufacturers provided they are submitted, identified and promoted as equal, and favorably reviewed by the Engineer prior to procurement and installation.
- F. Products submitted as "equal" to the named products will be reviewed for conformance with the specifications and in comparison with the first named product. If the equal product meets specifications, but does not have a feature or performance characteristic that is available with the first named product, and that feature or performance is required for this project, then the submitted equal product may be rejected on those grounds.
- G. In the event that some claims of the manufacturer of submitted "equal" product are called into question by the Engineer, the Contractor, may be required to prove those claims either prior to installation or during startup of product. If the product does not meet the claims made or specifications, the product may be rejected by the Engineer and a replacement product must be submitted by the Contractor in its place. All cost for the rejected product, installation, testing, and removal will be the responsibility of the Contractor.
- H. Underwriters Laboratories (UL) listing is required for all substituted equipment when such a listing is available for the first named equipment. Extra parts, labor, panel space, power supplies, GFIC devices shall be provided as necessary for incorporation of specified non-UL components.
- I. When required herein or requested by the Engineer, the Contractor shall submit equipment or material samples for test or evaluation. The samples shall be furnished with information as to their source and prepared in such quantities and sizes as may be required for proper examination and tests, with all freight and charges prepaid. All samples shall be submitted before shipment of the equipment or material to the job site and in ample time to permit the making of proper tests, analyses, examinations, rejections, and resubmissions before incorporated into the work.

## 2.02 NAMEPLATES & TAGS

- A. Equipment exterior nameplates - Nameplate material shall be rigid laminated black plastic with beveled edges and white lettering; except for caution, warning, and danger nameplates the color shall be red with white lettering. The size of the nameplate shall be as shown on the drawings. No letters are allowed smaller than 3/16". All nameplates located outdoors shall be UV resistant. Securely fasten nameplates in place using two stainless steel screws type, 316L, if the nameplate is not an integral part of the device. Epoxy cement or glued on nameplates will not be acceptable. Engrave the nameplates with the inscriptions as approved by the Engineer in the

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submittal.

1. For each major piece of electrical equipment provide a manufacturer's nameplate showing the Contract specified name and number designation, and pertinent ratings such as voltage, # of phases, ratings, etc.
  2. For each device with a specific identity (pushbutton, indicator, instrument, etc.) mounted on the exterior or deadfront of a piece of equipment provide a nameplate with the inscription as shown on the Drawings and described herein.
  3. Where no inscription is indicated on the Drawings or described herein, furnish nameplates with an appropriate inscription providing the name and number of device.
  4. Install Safety Signs in accordance with the latest OSHA requirements.
    - a. Entrances to electrical rooms and stations: Danger Sign requirements, ELECTRICAL ROOM, HIGH VOLTAGE (define voltage, example 480 VAC) KEEP OUT, AUTHORIZED PERSONNEL ONLY.
    - b. Equipment enclosures, cable tray and wireway where 120 VAC or higher and 50 V DC and higher exist: Danger Sign requirements, HIGH VOLTAGE (define voltage, example 480 VAC) AUTHORIZED PERSONNEL ONLY.
    - c. Equipment such as motor control centers, control panels, etc., where more than one source may be present in an enclosure or cubicle: Danger Sign requirements, VOLTAGE (define voltage, example 120 VAC control voltage or 480 VAC power) FROM MULTIPLE SOURCES IN THIS ENCLOSURE.
    - d. Equipment such as switchboards, switchgear, panelboards and motor control centers: Warning Sign requirements, WARNING, SERVICE ENTRANCE DISCONNECT FOR 1 OF \_\_\_\_ (define quantity) SERVICES TO THIS BUILDING. OTHER SERVICE ENTRANCE DISCONNECTS ARE LOCATED AT (define locations).
  5. Caution, warning and danger nameplates shall be red with white lettering
- B. Equipment Interior Nameplates - Nameplate material shall be clear plastic with black machine printed lettering as produced by a KROY or similar machine; except caution, warning, and danger nameplates shall have red lettering. The size of the nameplate tape shall be no smaller than 1/2" in height with 3/8" lettering unless otherwise approved by the Engineer. Securely fasten nameplates in place on a clean surface using the adhesion of the tape. For each device with a specific identity (relay, module, power supply, fuse, terminal block, etc.) mounted in the interior of a piece of equipment provide a nameplate with the inscription as shown on the Drawings and described herein. Where no inscription is indicated on the

Drawings or described herein, furnish nameplates with an appropriate inscription providing the name and number of device used on the submittal drawings. Stamp the nameplates with the inscriptions as approved by the Engineer in the submittal.

- C. Equipment Tags - When there is no space or it is impractical to attach an engraved plastic nameplate with screws, as is the case with most field devices and instruments, the Contractor shall attach a tag to the equipment with the same inscriptions as specified above in paragraph A. The tag shall be made from stainless steel material and the size of the nameplate shall be no smaller than 3/8"h x 2"w with 3/16" machine printed or engraved lettering unless otherwise approved by the Engineer. The tag shall be attached to the equipment with stainless steel wire of the type normally used for this purpose.

## 2.03 FASTENERS

- A. Fasteners for securing equipment to walls, floors, or ceilings, shall be stainless steel. The minimum size fastener shall be 3/8 inch diameter.

## 2.04 COMPONENTS

### A. Switches and Pushbuttons

1. Switches (HS) and pushbuttons (HC) for general purpose applications shall be water and oil tight as defined by NEMA 4X, corrosion resistant as defined by NEMA ICS 6-110.58, U.L. listed, standard 30 mm diameter, with plastic holding nut.
2. Switches and pushbuttons shall have contacts rated NEMA A600 or 10 amperes continuous and 600 VAC. Provide NO and NC contacts as required.
3. Engraved black legend plates shall be provided to define each switch and pushbutton function.
4. Selector switch handles and pushbutton caps shall be black unless otherwise noted on drawing. Emergency Stop caps shall be red.
5. Selector switches for hand-off-auto (HOA) applications shall have the hand position to the left, off in center, and auto in the right position.
6. Pushbuttons and selector switches in hazardous locations shall have hermetically sealed contacts or explosion proof enclosures.
7. Lockout stop pushbuttons shall include padlocking attachment. Pushbutton type shall be coordinated with padlock attachment type.
8. Switches and pushbuttons shall be Allen-Bradley 800H, or equal.

### B. Indicating Lights

1. Indicating Lights for general purpose applications shall be NEMA 4X,

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corrosion resistant as defined by NEMA ICS 6-110.58, U.L. listed, 30 mm diameter, with plastic lens, plastic holding nut, and miniature bayonet lamp base.

2. Lamp shall be full voltage 120 VAC with 28 chip (min) High Intensity LED.
3. Indicating lights shall have contacts rated NEMA A600 or 10 amperes continuous and 600 VAC. Provide NO and NC contacts as required.
4. Engraved black legend plates shall be provided to define each lights function.
5. Indicating light type and color of lens shall as follows or as otherwise shown on the Drawings:
  - a. Open/On Red
  - b. Closed/Off Green
  - c. Alarm Amber or Blue
  - d. Power On White
6. Indicating lights designated "PTT" on wiring diagram or shown with push-to-test wiring shall be provided with a push-to-test switch and wiring.
7. Indication lights shall be Allen-Bradley 800H, or equal.

C. Relays and Timers

1. General: Relays and timers shall be provided with N.O. or N.C. contacts as shown on the Drawings. All spare contacts shown shall be provided. Contacts shall be rated 10 amps minimum at 120 VAC, 60 Hz unless otherwise shown on the Drawings. Coil voltage shall be 120 VAC unless otherwise described or shown on the Drawings. Relays and timers shall be designed for continuous duty. All relays shall be U.L. listed. All relays and sockets shall be the product of a single manufacturer. The following is a summary of abbreviations associated with relays and timers:

CR	– Control relay
TR	– Timing relay
TDOE	– Time delay on energization
TDOD	– Time delay on de-energization
PR	– Power Relay

2. Sockets for plug-in relays and timers shall be standard industrial type din rail mount with barrier type pressure plate screw terminals. Sockets shall be rated 300 VAC, 10 amps minimum.
  - a. Blade 8 or 11 pin for coil voltage above 90 volts AC or DC.
  - b. Octal 8 or 11 pin for coil voltage below 90 volts AC or DC.

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3. Control relays (CR) shall be plug-in type with neon indicating lights and clear see-through sealed housing to exclude dust. Provide IDEC Type RR, or equal. Two form-C contacts (minimum) shall be provided on each relay.
4. Time delay relays on energization (TR-TDOE) shall be solid state plug-in relays with adjustable timer ranges from 1 second to 10 hours selectable unless other ranges are shown. Provide LED timer energized indicator lamp. Time delay relays shall be IDEC RTE, or equal.
5. Time Delay Relays (TR-TDOD)
  - a. Time delay relays on de-energization (TR-TDOD) (continuous power control input) shall be solid state plug-in relays with a timer adjustable range from 1 second to 10 hours selectable unless other ranges are shown. Provide LED timer energized indicator lamp. Time delay relays shall be IDEC RTE, or equal.
  - b. Time delay relays on de-energization (TR-TDOD) (true off) shall be solid state plug-in relays with a timer adjustable range from 1 second to 10 minutes unless other ranges are shown. True off time delay relays shall be IDEC GT3F-2, or equal.
6. Power relays (PR) shall be plug-in type and clear see-through sealed housing to exclude dust. Provide Magnecraft Type 389FXCXC-120A, or equal. 3PDT contacts rated 20A or 1 HP at 240 VAC (minimum) shall be provided on each relay. Furnish compatible blade type relay socket model 70-788EL11-1 or equal.

D. Amperage Transducer:

1. Amperage transducer shall produce 4-20mA DC output directly proportional to measured current (utilizing integral CT) of the power feed. Transducer range shall be selected for the load to be measured with expected load current between 50% and 75% of available measurement range. Transducer shall measure true RMS current and have an accuracy of 5% and repeatability of 1/2% of full scale (minimum). Operating temperature range shall be -20 deg C to 50 deg C. Transducer shall have separate zero and span adjustments. Insulation between output and case shall be rated at 1000VAC. Amperage transducer shall be as manufactured by Neilsen-Kuljian (NK technologies) ATR series or equal.

## 2.05 MOLDED CASE CIRCUIT BREAKERS

A. GENERAL

1. Circuit breakers and motor circuit protectors shall be manufactured by Eaton Cutler-Hammer, Square D, G.E., Siemens, or equal.
2. Circuit breakers shall be the bolt-on type.

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3. Multiple-pole circuit breakers shall be designed so that an overload on one pole automatically causes all poles to open. The use of tandem or dual circuit breakers in a normal single-pole space to provide the number of poles or spaces specified are not acceptable.
4. Molded case circuit breakers shall be operated by a single toggle-type handle and shall have a quick-make, quick-break switching mechanism. An automatic trip of the breaker shall be clearly indicated by the handle position. Contacts shall be non-welding silver alloy and have flash reduction arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.
5. Minimum interrupting capacity:
  - a. 480 volt circuit breaker shall have a minimum interrupting capacity of 42,000 amperes.
  - b. 120 or 208 or 240 volt breaker shall have a minimum interrupting capacity of 22,000 amperes
6. Circuit breakers shall be UL listed for series application.
7. Where indicated circuit breakers shall be current limiting.
8. Where indicated on drawings, provide UL listed circuit breakers for continuous duty at 100% of their ampere rating in the intended enclosure.
9. Furnish add-on features such as auxilliary position status contacts, trip indication contacts, shunt trip coils, etc, as shown in the drawings.

**B. TRIP UNIT – Molded Case Circuit Breakers**

1. Circuit Breakers less than 400 volt shall have thermal-magnetic (TM) trip units and inverse time-current characteristics. All other circuit breakers shall have trip units as defined herein.
2. The trip unit shall be Eaton type Digitrip 310+ or equal.
3. Each molded case circuit breaker microprocessor-based tripping system shall consist of three (3) current sensors, a trip unit and a flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors, and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time-delay settings are reached.
4. Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall non-adjustable. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.
5. Furnish 24VDC power supply with terminal blocks and 0.5A miniature circuit breakers to distribute power to each circuit breaker trip unit

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that requires it. Circuit breaker trip units shall be operable and adjustable with zero current flowing through the circuit breaker. The power supply shall be connected after the main breaker and above any feeder circuit breakers.

6. System coordination shall be provided by the following microprocessor-based time-current curve shaping adjustments:
  - a. Adjustable long-time setting (set by adjusting the trip setting dial to an amount not to exceed rating plug)
  - b. Adjustable short-time setting and delay with selective flat or  $I^2t$  curve shaping,
  - c. Adjustable instantaneous setting
  - d. Adjustable ground fault setting and delay with selective flat or  $I^2t$  curve shaping.
7. The microprocessor-based trip unit shall have both powered and unpowered thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession.
8. Furnish internal ground fault protection with adjustable settings. Provide neutral ground fault sensor for four-wire loads.
9. Breakers shall have built-in test points for testing the long-time delay, instantaneous, and ground fault functions of the breaker by means of a test set.

## 2.06 MOTOR CONTROL ACCESSORIES

### A. Control Power Transformer:

1. Control power transformer shall be epoxy encapsulated for dust and moisture protection. The internal wiring shall be copper and have 105 deg. C insulation rating. The unit shall feature barriered screw terminals for connection to electrical circuits. Provide with time-delay, slow-blow secondary fuse rated to protect the transformer and interrupt 10,000 amperes at 120VAC. Two primary fuses rated for 480 VAC and AIC as shown in the drawings shall be provided. Transformer minimum size and voltage ratings shall be as shown on Contract drawings. Control power transformer shall be Micron Impervitran, Cutler Hammer MTE or equal.

### B. Motor Starter:

1. Motor starters shall be NEMA rated of size shown on the Drawings. Coil voltage shall be 120 volts AC or as shown otherwise in elementary drawings. Provide auxiliary contacts as required per the elementary diagrams and/or as shown in the P&IDs. Motor starters shall include contactor and overload relay as a package unit or as separate pieces to accommodate for special switching requirements. Motor starters shall be Cutler Hammer Freedom, Square D, GE or equal.

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C. Motor Overload:

1. External motor overload protection shall be required per drawings. External overload shall use bimetallic heating strips and provide +/- 15% adjustment for full load amperage. Provide Cutler Hammer Freedom or equal.

D. Voltage monitor Relay (VMR)

1. The voltage monitor relay (VMR) shall continuously monitor the three phases for power loss, low voltage, phase loss, and phase reversal. The VMR shall interface to the control circuit with DPDT contacts rated for 4 Amps at 120 VAC. The VMR shall have a drop-out voltage adjustment, time delay adjustment, and status indicating LEDs. Voltage monitor relay shall be Time Mark 2652, or equal.

## 2.07 DEVICES

A. Switches

1. General purpose commercial grade switches shall be manufactured in accordance with UL 20. Switches shall be one pole, brown, 20 amps at 277 VAC, 1HP at 120 VAC, 2 HP at 240 VAC. Switches shall have copper alloy contact arm with silver cadmium oxide contacts. Switches shall have slotted terminal screws and a separate green grounding screw. Provide Leviton 1221, or equal.
2. Wall mount commercial grade motion detector switches (denoted with M next to switch symbol in drawings) shall utilize passive infrared detection with 180 deg field of view to determine if the space is occupied by personnel. The device shall be capable of switching incandescent (800W at 120V) and fluorescent (1200VA at 120V) lamps with electronic ballasts. The device shall feature a manual-off-auto switch. A delay off time adjustment shall be settable from 30 seconds to 30 minutes. The device shall incorporate a photocell with light intensity adjustment to keep the switch from activating when light levels are above setting. Provide Leviton ODS10, or equal.
3. Timer Switches (denoted with T next to switch symbol in drawings) shall provide a variable time range countdown of lighting circuit. Depressing touchplate turns lights on for the dial setting located behind the touchplate. Dial setting ranges of 1 minute to 18 hours shall be attainable. An illuminated LED indicates the load is on and blinking LED accompanied by annunciator sound indicates end of time cycle. Device shall be capable of switching incandescent (600W at 120V) and fluorescent (900W at 120V) lamps with electronic ballasts. Timer Switch shall be Leviton 6652, or equal.

B. Receptacles

1. General purpose receptacles shall be commercial grade, duplex and rated 20 amps, 120 VAC, 2 pole, 3 wire grounding, NEMA 5-20R configuration, specification grade, and side wired to screw terminals.

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Face color shall be brown when paired with stainless steel covers. General purpose receptacles shall be specification grade Leviton 5362-B or equal.

2. Ground fault circuit interrupter receptacles (denoted by GFI next to receptacle symbol on plan) shall be used where noted as GFI and in all boxes shown as weatherproof (WP). GFI receptacles shall be commercial grade, duplex, brown, 20A, 120V, back and side wired, with "test" and "reset" buttons. "Daisy Chain" connecting multiple receptacles from one GFI unit is not acceptable. GFI receptacles shall be Leviton 8898, Leviton MGNF2-B, Leviton 7899, or equal.

## 2.08 DISCONNECTS

### A. Disconnect Switch:

1. Disconnect Switch shall be heavy duty, horsepower rated, three pole, single throw, fusible/non-fusible with quick make/break operating mechanism. The enclosure shall be 316 stainless steel and rated NEMA 4X. The enclosed switch shall be rated for 480 Volt, and 10HP (minimum) unless otherwise shown on the drawings. Provide fuses, auxiliary contacts, or indicators as required by the motor control or one-line diagram. The operator shall actuate the switch side mounted handle and have provisions for up to 3 padlocks. Disconnect switch shall be Cutler Hammer DH series, Square D or equal.

## 2.09 SPARE PARTS

- A. The Contractor shall supply all spare parts prior to start of field tests. All parts shall be sealed in plastic bags and delivered to the site in a heavy duty plastic storage bag. Bag shall be clearly labeled with part name & number and the corresponding equipment tagname.
- B. The Contractor shall make available any replacement parts that are not manufacturer's normal stock items for immediate service and repair of all the instrumentation equipment throughout the warranty period.
- C. The following spare parts shall be provided as part of this Contract:
  1. Ten fuses for each type of fuse below 31 amps, 3 of each type above
  2. Ten lamps for each type of light, two lamps per color if LED type.
  3. Two relays for each type of control, and time delay relay.
  4. One voltage monitoring relay or power fail relay.

## PART 3: EXECUTION

### 3.01 CONSTRUCTION METHODS

- A. Equipment shall be assembled and wired by the manufacturer prior to shipment. Field modifications or changes are not allowed without a written "change order" to the Contract. Field changes, however large or small, shall be executed using the components, materials, wiring, labeling, and assembly methods identical to that of the original supplied equipment.

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- B. Electrical plugs, receptacles, cords, and connectors required to power or interface the equipment and panels shall be furnished and installed by the Contractor.
- C. Factory as-built drawings for each custom manufactured control panel or MCC shall be shipped with the equipment and placed inside in waterproof envelopes.

### 3.02 EQUIPMENT FABRICATION

- A. All electrical equipment, including custom manufactured equipment, shall meet the requirements of Underwriters Laboratories (UL) and bear the appropriate label. Panels shall be affixed with UL label prior to shipment and be built in accordance with the UL guidelines and procedure that corresponds to the UL label. Custom control equipment shall bear a UL-508 label, minimum, with additional UL labels as required per intended service.
- B. Panel cutouts for devices (i.e. indicating lights, switches) shall be cut, punched, or drilled and smoothly finished with rounded edges. Exposed metal from cutouts that are made after the final paint finish has been applied shall be touched up with a matching paint prior to installing device.
- C. Equipment doors shall swing freely and close and latch with proper alignment.
- D. Component within the electrical equipment shall be securely mounted on an interior subpanel or backpan and arranged for easy servicing. Mounting bolts and screws shall be front mounted for device removal without special tools or removal of entire mounting panel.
- E. A ground bus shall be provided in each enclosure or cabinet. It shall have provisions for connecting a minimum of ten grounding conductors. Screw type lugs shall be provided for connection of grounding conductors. All grounding conductors shall be sized as shown on plans or in accordance with NEC Table 250-95, whichever is larger.
- F. Bolts and screws for mounting devices on doors shall have a flush head which blends into the device or door surface. No fastening devices shall project through the outer surfaces of equipment.

### 3.03 WORKMANSHIP

- A. All work in this division shall conform to the codes and standards outlined herein.
- B. Installation shall be performed by qualified personnel providing first class workmanship per Electrical Specifications [Electrical General, Qualifications].
- C. Maintain equipment installed (or to be installed) in new condition. Protect equipment from damage while in Contractor care from dust, water, or mishaps that are typical to construction sites
- D. Confirm that equipment and materials are correct for their intended duty and will be installed per manufacturer guidelines. Equipment and components

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found to be installed inconsistent with manufacturer guidelines and/or these specifications will not be acceptable and subject to removal and replacement.

- E. Upon completion of daily work, remove excess materials, scraps, and debris from the work area and from the inside of equipment.
- F. Upon notification, stop work on any portion of the installation that is determined to be non-compliant with contract or being installed by unqualified personnel.
- G. Perform all work to correct improper installations at no additional cost to the owner.
- H. Equipment furnished under this contract or provided to Contractor for installation shall be installed in accordance with manufacturer's instructions, installation calculations, and contract documents.

#### 3.04 EQUIPMENT SHIPMENT AND STORAGE

- A. Shipment -- Any equipment whose destination (jobsite) is more than 25 miles from the factory shall be carefully protected for shipping. All openings shall be protected by plywood securely fastened to the framework of the equipment. Equipment shall be adequately covered during local delivery.
- B. Storage -- From the time of receipt until the equipment is installed and energized, the equipment shall be considered in storage. While in storage, a 120V, 1 phase source of power shall be made available and connected to space heaters in all items of equipment so equipped. Equipment not provided with space heaters shall be provided with a light bulb or electric heater while in storage to prevent moisture condensation. Unless stored indoors, it shall be at least 1 foot above grade covered with at least 2 layers of heavy polyethylene plastic sheets and anchored to prevent damage by high winds. All equipment shall be protected from dust and moisture prior to and during construction.

#### 3.05 DAMAGED PRODUCTS

- A. Damaged products that cannot be repaired to new condition shall be replaced with new products. All equipment and materials shall be in like-new condition at start-up and commissioning.
- B. Any equipment furnished outside of contract to the Contractor shall be repaired or replaced if damaged while in the Contractor's care. The Contractor shall pay for the parts and/or services of the original equipment manufacturer (OEM) to troubleshoot, assess, and repair damaged equipment.
- C. Minor cosmetic damage shall be repaired by spray painting, after properly preparing the surface, all scratches or defects in the finish of the equipment. Only identical paint furnished by the equipment manufacturer shall be used for such purposes.

#### 3.06 INSTALLATION

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A. General

1. Install all products per manufacturer's recommendations and the Drawings.
2. Provide all necessary hardware, conduit, wiring, fittings, and devices to connect the electrical equipment provided under other Sections.
3. Protect wiring insulation from wear by installing rubber cushions, bushings, or strip insulation, or by fastening the wiring to a rigid surface with zip ties and anchors.
4. Provide additional devices, wiring, conduits, relays, signal converters, isolators to complete interfaces of the electrical and instrumentation system.
5. Changing normally open contacts to normally closed contacts or vice versa
6. Adding additional relays to provide more contacts as necessary.
7. All programmable devices (not specifically excluded herein) shall be programmed, set-up and tested by the Contractor prior to startup. Programming and set-up parameters shall be adjusted or changed as directed by the Engineer during start-up and throughout the warranty period.
8. Coordinate with the Engineer and setup all alarm, process, and operation setpoints.
9. Keep a copy of the manufacturer's installation instructions on the jobsite available for review at all times prior to and during the installation of the associated equipment.

B. Panels and enclosures:

1. Install panels and enclosures at the location shown on the Plans or approved by the Engineer.
2. Install level and plumb.
3. Seal all enclosure openings to prevent entrance of insects and rodents.
4. Clearance about electrical equipment shall meet the minimum requirements of NEC 110.26

C. Conduits and Ducts:

1. Install all conduits and ducts per Electrical Specifications [Conduit and Boxes] and [Grounding].
2. Minimum wire bending space at terminals and minimum width of wiring gutters shall comply with NEC tables 312-6 (a) & (b).

D. Wiring, Grounding, and Shielding:

1. Observe proper grounding and shielding practices as this application environment is generally noisy. The shield of shielded cables shall be terminated to ground at one end only, the origination end. The shield at the other end shall be encased in an insulated material to isolate it from ground.

E. Cutting and Patching:

1. The Contractor shall do all cutting and patching required for installing his work. Any cutting which may impair the structure shall require prior approval by the Engineer. Cutting and patching shall be done only by skilled labor of the respective trades. All surfaces shall be restored to their original condition after cutting and patching.

F. Cleaning and Touch up:

1. At the completion of the work, all parts of the installation, including all equipment, exposed conduit, and fittings, shall be thoroughly cleaned of grease and metal cuttings. Any discoloration or other damage to parts of the building, the finish, or the furnishings, due to the Contractor's failure to properly clean the system, shall be repaired by the Contractor.
2. The Contractor shall thoroughly clean any of his exposed work requiring same.
3. Vacuum and clean the inside of all electrical and instrumentation enclosures prior to applying power.
4. The Contractor shall paint scratched or blemished surfaces with the necessary coats of quick drying paint to match existing color, texture and thickness. This shall include all prime painted electrical equipment including but not limited to enclosures, poles, boxes, devices etc.

### 3.07 APPLICATION OF POWER

A. The Engineer will direct the energization and de-energization of all existing and new equipment. The Contractor is not authorized to energize or de-energize any equipment unless they have been given written permission to do so or while in the presence of the Engineer.

1. Any equipment that is under repair, demolition or installation shall be locked off and tagged out of service with Contractor supplied padlocks and tags.
2. The Contractor is required to comply with NFPA 70E and specifically in regards to safety when working on live equipment. Obtain work permits when needed to do live work.

B. The Contractor is responsible for grounding of high and medium voltage cabling and/or bus during installation and removal of equipment. The

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contractor is responsible for complying with all California Electrical Safety Orders (ESO) and Occupational Safety and Health Act (OSHA) safety requirements and procedures while working in or near medium voltage equipment.

### 3.08 WARRANTY

- A. The Contractor shall warrant all electrical and instrumentation equipment & software for a period of 1 year from date of final acceptance. Standard published warranties of equipment which exceed the preceding specified length of time shall be honored by the manufacturer or supplier.
- B. The Contractor shall have a staff of experienced personnel available to provide on-site warranty service on 2 working days notice during the warranty period. Such personnel shall be capable of fully testing and diagnosing hardware & software and implementing corrective measures.

### 3.09 FINAL ACCEPTANCE

- A. Final acceptance will be given by the Engineer after the equipment testing is complete, each deficiency has been corrected, final documentation has been provided, and all the requirements of Contract documents have been fulfilled.
- B. At the end of the project, following the completion of the field tests, and prior to final acceptance, the Contractor shall provide the following:
  - 1. Each "operation and maintenance" manual shall be modified or supplemented to reflect all field changes and as-built conditions.
  - 2. Two (2) disk copies of all final documentation to reflect as-built conditions.
- C. Keys: Submit two sets of all keys for locks supplied on this project. Wire all keys for each lock securely together. Tag and plainly mark with lock number or equipment identification, and indicate physical location, such as panel or switch number.

**END OF SECTION**

## **SECTION 16110**

### **CONDUIT AND BOXES**

#### **PART 1: GENERAL**

##### **1.01 SCOPE OF WORK**

- A. Labor, materials, equipment, tools, safety gear, test equipment, incidentals, services, and transportation for a complete electro-mechanical installation as shown on the Drawings, included in these Specifications, or as can be reasonably implied from project descriptions.
- B. The scope of work includes:
  - 1. Furnish and install conduits, junction boxes, pull boxes, and associated hardware. Provide hardware, conduit, fittings, and other parts for a complete raceway installation.
  - 2. Furnish and install grounding system required by drawings, or if not shown or defined, as required by Article 250 of the NEC.
  - 3. Installations shall be designed and installed with components meeting the NEMA area designation.
- C. Work includes that specified in Electrical Specifications [Electrical General].

##### **1.02 REFERENCES**

- A. Electrical Specifications [Electrical General]
- B. Electrical Specifications [Low Voltage Wire & Data Cable]
- C. Electrical Specifications [Grounding]
- D. Project Drawings

##### **1.03 QUALIFICATIONS**

- A. Material furnished under this specification shall be installed by qualified installers meeting requirements specified in Electrical Specifications [Electrical General, Qualifications].

##### **1.04 SUBMITTAL REQUIREMENTS**

- A. Provide submittals and drawings as specified in Electrical Specifications [Electrical General, Submittal Requirements].

## **PART 2: PRODUCTS**

### **2.01 CONDUIT, RACEWAYS AND WIREWAYS**

- A. GENERAL - Conduit, raceways, and wireways, wiring methods, materials, installation shall meet all requirements of the NEC, be UL labeled for the application, and meet the minimum following specifications.
1. All wiring shall be installed in conduits, raceways, or wireways when interconnecting equipment and devices.
    - a. The minimum size conduit shall be 3/4-inch unless indicated otherwise on the Drawings or for special connections to equipment.
    - b. Provide cords and cord seals for devices or instrumentation requiring waterproof seal to maintain NEMA 4 or 4X ratings. Example devices include lighting and pipe mounted instruments that are located below grade.
  2. Conduits may connect into junction boxes or wireways as shown in the drawings or as requested by Contractor and approved by Engineer. Junction boxes (circle with J in drawings) can be as simple as a conduit or JIC box, or larger box as determined by contractor and needed for the installation. Drawing may depict junction box requirements. Wireways or junction boxes shall be rated for area (as noted in the drawings), or furnish minimum NEMA 4 if not noted.
  3. The Contractor shall use conduit material types (SPEC per conduit schedule) as defined below or as otherwise shown in the contract drawings or as specifically called out in the conduit schedule.
    - a. Non-exposed underground portions of conduit run shall be PVC-40 for all signals and voltages unless otherwise shown in the conduit schedule.



- b. Exposed conduit material (not underground and beyond transition) shall be per the following table unless specifically noted otherwise in the plan drawings. The conduit schedule denotes the conduit type for non-exposed (under-ground, in-concrete, etc.) and does not apply or coordinate with this table. Exposed condulets, elbows, fittings, device boxes, and hardware shall be of the same material and finish as the adjacent conduit.

<u>Location</u>	<u>Material</u>
NEMA 1 or 12	Galvanized rigid steel (GRS)
NEMA 3R	PVC-Coated Steel (GRS-PVC)
NEMA 4	PVC-Coated Steel (GRS-PVC)
NEMA4X	PVC-Coated Steel (GRS-PVC)
Class 1 Div 1 or 2 hazardous	PVC-Coated Steel (GRS-PVC)

4. Conduit stubs and transitions:

- a. Conduit transitions shall be GRS-PVC for 6" on either side of the transition point (minimum) or as shown in drawing details. Conduit transition is defined as conduit sections emerging from or through concrete or earth or from below to above grade or through walls or vaults, non-exposed to exposed.
- b. Beneath pad mounted electrical equipment, where not exposed, shall be installed or trimmed to 2" or less above slab and have bushing or end bell installed. Overall height of conduit entering into the base of equipment shall be enough for bushings/bells to be installed but be high enough for conduit tags to be installed.
- c. Uniform in height for each panel or section. Conduits end bushings/bells shall not vary in height above slab more than 1/2" from lowest to highest.
- d. Conduits shall be spaced apart such that bushings and end bells may be installed without interfering with the adjacent conduits.
- e. Transitions to PVC shall include PVC coated locknuts to shield exposed steel pipe threads.
- f. Through walls – shall protrude approximately 2" and include end bell or bushing. Pack space around conduit with non-shrink grout if the thru-hole was core drilled.
- g. Conduits for future use shall be capped with coupling and plug. Identify each end with conduit labels.
- h. Existing conduits that are no longer able to be used due to removal of a section or shown demolished and that protrude above graded shall be cut flush and filled with grout.

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5. Conduit Tags

- a. All conduits listed in the "Conduit and Wire Routing Schedule" shall have conduit tags at both ends of each conduit run and within 3 feet of any pull box, panel board, switchgear or control panel with tag number from schedule identified. This shall include ends within underground pull boxes.
- b. All conduits shall have temporary tags during construction. Temporary tags may be made from duct tape with hand written ink marking or suitable equivalent. Temporary tags shall be removed by Contractor at time of installation of permanent tags.
- c. Conduit labels shall be stainless steel tape with pressure stamped letters and numbers. Stamped text shall not be less than ¼ inch high. Conduit labels shall be a minimum of 2 inches long and 1/2 inch wide and shall be attached with #18 304 stainless steel wire

6. Supports

- a. Cross section of a single channel shall be 1-5/8" x 1-5/8" and cross-section of a double channel shall be 1-5/8" x 3-1/4". The channel wall thickness shall be 12 gauge as applicable.
- b. One-Hole clamps shall be intended for pipe mounting on support channels and equipped with clamp-backs. The clamps shall be Efcor, Thomas and Betts, Appleton or equal
- c. Spacers, provided to support underground conduits in concrete encasements, shall be plastic. The spacers shall be Carlon, Johns-Manville, Underground Products or equal
- d. Anchors shall be expansion type for securing equipment to concrete foundations, floors and walls. Anchors shall have length identification mark on the exposed end of the bolt. Provide Hilti Kwik Bolt 3, or equal.
- e. Stanchions shall be provided as needed to mount equipment and electrical components. Stanchions shall be shop fabricated from welded 4" c-channel, 12" x 12" x ¼" steel base plate, coated with a rust inhibiting primer and top coat of gray polyurethane gloss paint. Attach equipment to the stanchion direct or on a ¼" aluminum sheet sized for the equipment supported.
- f. Conduit Hangers shall be trapeze construction, with double channel, 3/8-inch rods and nuts. Suspend from suitable structural support.
- g. Support material and finish shall be per the following table unless otherwise noted in the drawings. Brackets, fittings and

hardware shall be of the same material and finish.

<u>Location</u>	<u>Material</u>
Indoors NEMA 12	Galvanized steel
Outdoors NEMA 3R	Galvanized steel
Outdoors NEMA 4	Stainless Steel type 316
Corrosive areas NEMA4X	PVC bonded, 40 mil, factory applied

- h. Equipment mounting racks shall be designed by installer for rigid equipment and conduit mounting. Racks shall be bolted or welded construction and sized for equipment or as shown on the drawings.
- i. Strut channels shall be used for mounting equipment to walls and for supporting conduit runs. Double strut channel type shall be used for fabricating equipment mounting racks as required and/or as detailed on the drawings. Add additional supports to rigid mounting locations as needed to prevent wobbling and to meet seismic requirements. All field cut surfaces of the strut channels shall be deburred and coated to prevent rust.

B. GALVANIZED RIGID STEEL CONDUIT - (GRS)

- 1. Manufactured from high-strength steel and hot dipped zinc galvanized inside and out. Conduit and fittings shall meet UL 514B, UL 6, and conform to NEMA RN 2. Conduit shall be capable of being used as an equipment grounding conductor per NEC 250.
- 2. Provide galvanized rigid steel factory sweeps and elbows for 90 degree transitions.
- 3. Cast fittings and device boxes shall be malleable iron or aluminum. Appleton type FS/FD or equal.
- 4. In hazardous locations, fittings shall meet and be listed UL 886.
- 5. All fittings, hubs, couplings, pulling elbows and connectors shall be threaded-type. Set-screw type and compression-type are not acceptable. All thread conduit is not allowed over 1/2" exposed length. Cover plates shall be cast iron with sealing gasket in NEMA 3R locations.
- 6. Conduits entering enclosures shall be fitted with insulated grounding bushing; O-Z "HBLG", Appleton "GIB", or approved equal. All grounding bushings shall be tied to the grounding system with properly sized bonding conductors per the NEC code.
- 7. Combination expansion-deflection fittings installed exposed shall be Type XD as manufactured by Crouse-Hinds Co.; Type DX as manufactured by O.Z. Gedney Co.; Type DF as manufactured by Appleton Electric Co., or equal

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C. GALVANIZED RIGID STEEL CONDUIT - PVC COATED (GRS-PVC)

1. Galvanized Rigid Steel conduit with a 40-mil thick polyvinylchloride exterior coating and a 2-mil urethane interior coating meeting NEMA RN-1, UL-6 and ETL PVC-001. The bond of the PVC to the zinc coated pipe must be stronger than the tensile strength of the PVC.
2. Provide PVC coated galvanized rigid steel factory sweeps and elbows for 90 degree transitions.
3. Cast fittings and device boxes shall be malleable iron or aluminum with a 40-mil thick PVC coating meeting the same
4. In hazardous locations, fittings shall meet and be listed UL 886.
5. Provide PVC coated threaded-type fittings, hubs, pulling elbows, couplings, and connectors; set-screw type and compression-type are not acceptable. Form 8 conduit fittings, ½" through 4", must have a tongue-in-groove gasket to effectively seal out the corrosive elements. Covers shall be supplied with plastic encapsulated stainless steel cover screws. Form 8 fittings shall be UL and type 4X and IP69 listed.
6. A "PVC Coated Sealing Locknut" shall be used on all exposed male threads transitioning into female NPT threads which do not have sealing sleeves, including transitions from PVC couplings/female adapters to PVC Coated GRC elbows in direct burial applications. "PVC Coated Sealing Locknuts" are not to be used in place of a myers hub
7. A PVC sleeve extending one pipe diameter or two inches, whichever is less, shall be formed at every female fitting opening except unions. The inside sleeve diameter shall be matched to the outside diameter of the conduit.
8. All junction and metal pull boxes shall be galvanized with exterior surfaces PVC coated to 40 mils thickness.
9. Unistrut, strut clamps, pipe straps, and clamp back spacers, shall have 40 mil thick PVC coating. All mounting anchors shall be stainless steel.
10. Conduits entering enclosures shall be fitted with insulated grounding bushing. All grounding bushings shall be tied to the grounding system with properly sized bonding conductors per the NEC code.
11. Installers of PVC Coated Conduit must be certified by the manufacturer and be able to present a valid, unexpired certified installer card.
12. GRS-PVC conduit to be Robroy Plasti-bond, Perma-Cote, KorKap, T&B OCAL or equal.

D. PVC CONDUIT, SCHEDULE 40 or 80 (PVC-40, PVC-80)

1. Shall be high impact schedule 40 or 80 polyvinylchloride suitable for use underground, direct burial and for use with 90 C wires, and shall

conform to UL 651. Shall be UL listed and labeled for "direct" burial.

2. A copper bonding conductor shall be pulled in each raceway and bonded to equipment at each end with approved lugs.
3. Each underground run shall be placed in a trench with a five (5) inch sand bed evenly compacted on all sides, top and bottom unless otherwise noted.
4. Elbows, and risers shall be per exposed conduit transition detail. PVC conduit is not allowed above ground.
5. PVC fittings shall have solvent-weld-type conduit connections. Fittings and device boxes shall be PVC with factory fabricated conduit connections. Provide Carlon or equal.
6. Conduits entering enclosures shall be fitted with a glued male adapter, lock ring and bushing to prevent wire chafing. Conduits entering panels through concrete to an open bottom or entering a pull box shall have a glued end bell fitting.
7. PVC conduit shall be stored on a flat surface and shielded from the sun.

E. LIQUID TIGHT FLEXIBLE METAL CONDUIT (up to 2") - (FLEX)

1. Liquid Tight Flexible Metal conduit shall be highly flexible, moisture and oil-proof with black thermoplastic rubber cover that is extruded over a galvanized flexible steel conduit.
2. Liquid tight Flexible Metallic Conduit shall be sunlight, oil, and flame resistant and be manufactured for extreme temperature environments (-75 deg F to +302 deg F). Conduit shall be approved for the installation of electrical conductors in indoor and outdoor applications.
3. Liquid tight Flexible Nonmetallic Conduit shall be listed to UL standard UL 360.
4. Liquid tight flexible metallic conduit shall be installed in accordance with Article 351, Part B of the National Electrical Code (NEC) and other applicable sections of the NEC and/or local electrical codes.
5. Liquid tight Fittings shall be listed for the use with Liquid tight Flexible Metallic Conduit and conform to UL514B.
  - a. Outdoors when extension of GRS-PVC: PVC coated galvanized steel with insulated bushings.
  - b. Outdoors when extension of GRS: Galvanized steel with insulated bushings
  - c. Indoors: Galvanized steel with insulated bushings.

6. Flexible Metallic Conduit shall be Anaconda HCX or equal.

F. LIQUID TIGHT FLEXIBLE METAL CONDUIT (above 2-1/2") - (FLEX)

1. Liquid Tight Flexible Metal conduit shall be moisture and oil-proof with PVC jacket extruded over a galvanized flexible steel conduit.
2. Liquid tight Flexible Metallic Conduit shall be sunlight, oil, and flame resistant and approved for the installation of electrical conductors in indoor and outdoor applications.
3. Liquid tight Flexible Nonmetallic Conduit shall be listed to UL standard UL 360.
4. Liquid tight flexible metallic conduit shall be installed in accordance with Article 351, Part B of the National Electrical Code (NEC) and other applicable sections of the NEC and/or local electrical codes.
5. Liquid tight Fittings shall be listed for the use with Liquid tight Flexible Metallic Conduit and conform to UL514B.
  - a. Outdoors when extension of GRS-PVC: PVC coated galvanized steel with insulated bushings.
  - b. Outdoors when extension of GRS: Galvanized steel with insulated bushings.
  - c. Indoors or outdoors when extension of stainless steel: 316 stainless steel with sealing ring and insulated bushing.
  - d. Indoors: Galvanized steel with insulated bushings.
6. Flexible Metallic Conduit shall be Amer-Tite type GP or equal.

2.02 DEVICE BOXES

A. BOXES

1. Device boxes shall be of zinc-galvanized malleable iron or cast aluminum with shape and size best suited for the particular application, rated for the location installed, and shall be supported directly to structure by means of screws, anchors, or bolts.
2. Box dimensions shall be in accordance with size, quantity of conductors, and conduit clearances per NEC articles 314 requirements.
3. Boxes exposed to the weather or in moist locations shall be weatherproof (WP) by means of gasketing under a weatherproof cover.
4. Boxes connected to GRS-PVC conduit runs shall be PVC coated with 40 mil coating.

B. DEVICE PLATES and COVERS

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1. Indoor general purpose device plates and covers shall be stainless steel. Plates or covers shall be attached with stainless steel screws. An engraved plastic label denoting circuit breaker number and panelboard name shall be affixed to each cover with #4 stainless steel screws.
2. Weatherproof switch, outlet, and receptacle boxes shall be fitted with gasketed covers rated for wet locations. Each access cover shall have a padlockable cover to maintain security and weatherproof integrity even when a plug is connected to the receptacle. Screws and hinge springs shall be stainless steel. Weatherproof access covers shall be Leviton 5977-CL, Cooper 4966, or equal.

## 2.03 PULL BOXES

### A. JUNCTION BOXES

1. Where required for best installation or where specifically called out in the drawings, junction boxes shall have JIC type construction with hinged door, NEMA 4X rating, manufactured of type 304 stainless steel or as otherwise shown. Door shall be fastened with clamps and stainless steel screws. No devices, screws, rivets, or bolts shall protrude through the exterior surface unless specifically shown on the drawings. Boxes shall be Hoffman, Circle AW, or equal.

### B. UNDERGROUND BOXES

1. Underground pull boxes shall be prefabricated "Christy Box" size and type as noted in the drawings or equal. Size shall be as shown or dimensioned on the Drawings. Provide larger boxes as needed to meet code or as determined in field to allow for adequate pull area at Contractor discretion. Extension sections shall be provided as necessary to reach the depth of underground conduits with maximum depth of 48". All boxes shall have galvanized steel hold down bolts and hardware. Boxes shall be H/20 loading rated and have traffic rated covers. Steel covers or lids shall be galvanized and grounded with bonding jumper to the local grounding circuit per NEC. Pull box covers shall be labeled electrical, signal, utility, and telephone, whichever applies. Pull boxes shall be Christy Concrete Products, Brooks or equal.

### C. UNDERGROUND VAULTS:

1. BOX: Underground vaults shall be prefabricated 6" thick reinforced concrete (4000PSI), H/20 load rating, with the interior size (minimum) as shown on the Drawings.
  - a. Provide larger pull boxes when necessary to allow for adequate pull area or to accommodate the number of conduits entering box.
  - b. Vaults shall include 2" thinwall section knock out area for conduit entry on 4 sides. Provide hole in bottom corner for ground rod.

- c. Extension sections shall be provided as necessary to reach the depth of underground conduits.
  - d. Provide sloped bottom with 4" drain hole knockout in bottom center of vault.
- 2. LID: Provide hinged, torsion spring assist, traffic rated H/20, lid cover assemblies. Provide single leaf for 3 by 3 feet pull boxes. Provide double leaf for vaults with openings larger than 3 by 3 feet.
- 3. GROUND BUS: Provide a ¼" x 12" copper ground bus in each vault. Provide 8 - 3/8" diameter holes for multiple #4/0 terminal compression or crimp connectors. Connect ground conductors from duct banks to the ground bus. Connect ground terminals to ground bus using bronze or stainless steel hardware.
- 4. CABLE SUPPORTS: Provide heavy-duty, nonmetallic cable racks for support of wire and cable in vaults. Racks shall be UL listed glass-reinforced nylon consisting of slotted wall brackets supporting cable support arms. Arms shall be designed to support a 400-pound load, minimum. Arms shall be adjustable by moving up and down the bracket. Each support bracket shall extend all the way from the bottom of the handhole to the top of the handhole. Provide 1/2-inch stainless steel bolts, washers, and anchors to secure racks to handhole wall. Cable racks shall be Underground Devices Incorporated type RA arms with CR36 support brackets; Uni-strut Power-Rack F20N-STA33 Stanchions with F20N-ARM14 Arms; or equal. Provide racks to support conductors on 18-inch centers.
- 5. Underground vaults shall be Oldcastle Precast, Brooks, or equal.

**D. PULL BOX AND VAULT IDENTIFICATION**

- 1. Engrave or bead weld box covers with minimum thickness of ¼" x 1" lettering with pullbox name (i.e. PBX-XXX) and purpose (electrical, signal, fiber, telephone, etc.). Provide an additional identifier "high voltage" for boxes with 600 volts or higher.
- 2. Utility pull boxes shall be labeled per Utility Company standards.

**PART 3: EXECUTION**

**3.01 WORKMANSHIP**

- A. All work in this Section shall conform to the codes and standards specified in specified in Electrical Specifications [Electrical General, Workmanship].

**3.02 INSTALLATION**

- A. System:
  - 1. Install all products per Electrical Specifications [Electrical General,



Installation].

B. Rigid Conduits and Ducts:

1. Exposed conduits shall be neatly arranged with runs perpendicular or level and parallel to walls. Bends shall be concentric.
2. Except as expressly indicated or approved, all conduits shall be surface mount on block walls, concealed behind gypsum walls, and buried to required depth below floor slabs.
3. Pipe threads shall be treated with conductive thread compound.
4. Installation of the GRS-PVC conduits must be in accordance with the manufacturer's installation procedures using recommended tools.
  - a. Apply touch up compound at each fitting sealing sleeve edge to improve watertight seal.
  - b. To ensure compliance, the installer(s) must be "manufacturer certified" before installation can proceed.
  - c. Certification available by contacting manufacturer's representative and attending a brief instructional course. Valid and unexpired certification card shall be available for review per installer.
5. Repair GRS-PVC coating utilizing a touch-up compound as provided by the manufacturer of the conduit of the same material as the coating. Overlap beyond the damaged area to cover the PVC coating. Contact from touchup compound to PVC is required to maintain integrity. The entire conduit shall be replaced if the repair exceeds 1" combined length.
6. A maximum of three equivalent 90 degree elbows are allowed in any continuous run. Install pull boxes where required to limit bends in conduit runs to not more than 270 degrees or where pulling tension would exceed the maximum allowable for the cable.
7. Route all above grade conduits parallel or perpendicular to structure lines and/or piping. Conduits installed above grade shall be braced in place with stanchions. Expansion joints shall be installed every 100 feet. Bends shall be concentric.
  - a. Combination expansion-deflection fittings installed exposed shall be Type XD as manufactured by Crouse-Hinds Co.; Type DX as manufactured by O.Z. Gedney Co.; Type DF as manufactured by Appleton Electric Co., or equal
8. Care shall be exercised to avoid interference with the work of other trades. This work shall be planned and coordinated with the other trades to prevent such interference. Process Pipe, mechanical and HVAC shall have precedence over conduits for routing and space

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requirements.

9. Seal each bottom entrance conduit into the MCC and other electrical enclosures with plugging compound sealant to prevent the entrance of gasses, insects and rodents. Plugging compound sealant shall be Gardner Bender Duct Seal or equal.
10. Exposed conduit stubs for future use shall be capped with coupling and plugged. Drill hole in plug for pull rope as necessary.
11. Explosion proof seal-off fittings shall be provided on all conduits that enter or leave hazardous areas per requirements of the National Electrical Code, Chapter 5 and UL 886. The seal-off fitting shall prevent hazardous gases and/or flames from passing from one type area to another through the conduit system. Ceramic or other non-asbestos fiber material and sealing compound shall be placed in the fitting to complete the seal.
12. Hazardous location conduit outlet boxes shall be used in hazardous locations for change in direction, access to conductors and as pull and splice boxes.
13. All spare conduits shall have 1/8" nylon pull ropes installed.

C. Flexible Conduit and Cords

1. Final connections to vibrating equipment such as motors, heaters and fans shall be made with liquid tight flexible conduit.
2. Flexible conduit lengths shall not be greater than 36 inches for sizes up to 2 1/2" and 48 inches for 3" and larger conduit.
3. Flexible conduit shall include a ground conductor for equipment bonding in circuits over 30 VDC or as shown in the conduit schedule.
4. Flexible conduit shall only be installed in exposed or accessible locations.
5. Where equipment is cord connected, submersible rated, and conduit connections are not possible without modification, devices and equipment may be free-air cord connected in lieu of flexible conduit. Connection to adjacent rigid conduit shall be through liquid-tight cord connector fitting specifically designed for the purpose and sized appropriately for the cord. Cord connectors shall be rated similar to the adjacent conduit they are connected to: Stainless steel, galvanized or plastic.

D. Excavation and Back Filling:

1. Trenches for conduit below floor slabs and other underground electrical conduit shall be excavated to the required depths per utility requirements or specific detail. Conduits under floor slabs shall have minimum trench depth to contain bends without any portion of the

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radius visible at finished grade.

2. Underground conduits outside of structures, excluding utility conduits, shall have a minimum cover of 24 inches except under roadways where minimum cover shall be 30 inches or as otherwise shown in the Contract Drawings. Back filling shall be done only after conduits have been inspected. Excavation and back fill of conduits shall conform to the requirements of other applicable Specifications sections unless modified on plans, and to other entities (Utilities, etc.) as required.
3. Install spacers to support underground conduits. Horizontal and vertical separation shall be maintained by plastic spacers set every four feet. Spacers shall be Carlon Snap-Loc or equal.
4. At all times during the installation of the electrical system, the Contractor shall provide barricades, fences, guard rails, etc., to safeguard all personnel, including small children, from excavated trenches.

E. Underground pullboxes:

1. Pullboxes shall be located in areas that will experience the least traffic loading and in the general vicinity as shown in the contract drawings. Boxes in pavement shall be set at final grade and boxes in planter areas shall be set 1" above final grade. Boxes shall not be buried by landscape material.
2. Steel pull box lids shall be grounded per NEC 250.4(A)(5) and 314.4.
3. Boxes shall be set on compacted base and base rock to minimize settling of the box over time. If the box is located in a paved traffic area, a 6" x 6" concrete ring shall be poured around the box below the pavement.

F. Device Mounting Heights:

1. Mounting heights of fixtures and devices shall be as follows unless otherwise indicated or when height has to be adjusted to be over or under counter tops.

Wall switches	=>	48 inches
Convenience outlets	=>	18 inches
Telephone outlets	=>	18 inches
Bracket fixtures	=>	7 feet 6 inches

G. Cutting, Coring, Patching and Repairing:

1. The Contractor shall do all cutting and patching required to install his work. Any cutting which may impair the structure will require prior approval. Cutting and patching shall be done only by skilled labor of the respective trades. Where it is becomes necessary to cut into existing work for the purpose of making electrical installations, locate existing post tension cables, rebar and electrical services prior to core

drilling using ground penetrating radar or similar technologies. All surfaces shall be restored to their original condition after cutting and patching.

### 3.03 FIELD ASSISTANCE

- A. General: Provide all equipment and supplies necessary to perform all testing. The Owner Representative shall have the option to witness and participate in the on-site tests performed by the installer.
- B. Per Electrical Specifications [Factory and Field Testing].

### 3.04 WARRANTY

- A. Provide warranty as specified in Electrical Specifications [Electrical General, Warranty].

**END OF SECTION**

## **SECTION 16120**

### **LOW VOLTAGE WIRE & DATA CABLE**

#### **PART 1: GENERAL**

##### **1.01 SCOPE OF WORK**

- A. Labor, materials, equipment, tools, safety gear, test equipment, incidentals, services, and transportation for a complete electro-mechanical installation as shown on the Drawings, included in these Specifications, or as can be reasonably implied from project descriptions.
- B. The scope of work includes:
  - 1. Furnish and install wire, splices, lugs, or other miscellaneous devices as defined in this specification.
  - 2. Testing of conductors and completed wired systems.
  - 3. Installations shall be designed and installed with components meeting the NEMA area designation.
- C. Work includes that specified in Electrical Specifications [Electrical General].

##### **1.02 REFERENCES**

- A. Electrical Specifications [Electrical General]
- B. Electrical Specifications [Conduit and Boxes]
- C. Electrical Specifications [Grounding]
- D. Project Drawings

##### **1.03 QUALIFICATIONS**

- A. Material furnished under this specification shall be installed by qualified installers meeting requirements specified in Electrical Specifications [Electrical General, Qualifications].

##### **1.04 SUBMITTALS AND DRAWINGS**

- A. Provide submittals and drawings as specified in Electrical Specifications [Electrical General, Submittal Requirements].

## **PART 2: PRODUCTS**

### **2.01 WIRING AND ELECTRICAL DEVICES**

#### **A. GENERAL**

##### **1. General**

- a. Provide wiring and electrical devices specified herein and install field and internal panel wiring as shown on the Contract Drawings.
- b. This section applies to all wires or conductors used internal (non-field) to electrical equipment or external for field wiring.
- c. Field wire quantity and size shall be per "Conduit and Wire Routing Schedule."

##### **2. Analog Signals**

- a. Analog signal transmission between electric or electronic instruments shall be 4-20 milliamperes and shall operate at 24 volts DC unless otherwise specified. Milliampere signals shall be current regulated and shall not be affected by changes in load resistance within the unit's rating.
- b. Provide powered current isolators wherever the loops' load resistance exceeds the originating current signal transmitter's rating. Associated shunt resistors shall be located on rail-mounted terminal blocks. Exposed resistor leads shall be insulated with heat-shrink tubing.

#### **B. LOW VOLTAGE WIRE AND CABLE (through 600V except instrument signals)**

1. General: Low voltage conductors shall be used for power, control, lighting and miscellaneous circuits. This Section applies to all wires or conductors used internal for all electrical equipment or external for field wiring. Wire shall be new, plainly marked with UL label, gauge, voltage, type of insulation, and manufacturer's name.
  - a. Conductors shall be copper with a minimum of 98% conductivity.
  - b. Class C stranding. Solid conductors may be used for lighting and receptacle circuits.
  - c. Wire shall be rated 600 volt (min).
  - d. Size all conductors per NEC minimum or as shown on the drawings.
    - 1) Minimum #12 AWG for wires used in power transmission

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circuits or as defined on the drawings.

- 2) Minimum #14 AWG for wires used in signal transmission circuits or as defined on the drawings.
2. Wire colors and sizes shall not change within the circuit.
3. Wire shall be properly fused or breaker protected at or below the maximum amperage rating allowed by the NEC.
4. Control and Power Wiring:
  - a. Field wire in conduit:
    - 1) Type XHHW-2, XLPE insulation, rated 90 °C in wet or dry locations, oil resistant.
      - i Use for power circuits carrying voltages higher than 200 volts phase to ground.
    - 2) Type THHN / THWN, PVC with nylon jacket insulation, rated 90 °C in dry locations and 75 °C in wet locations, oil resistant, UL83.
      - i Use for power circuits with voltages below 200 volts phase to ground, or control circuits.
    - 3) Minimum #12 AWG for wires used in power transmission circuits or as defined on the drawings.
      - i Minimum #14 AWG for wires used to power instrumentation.
    - 4) Minimum #14 AWG for wires used in signal transmission circuits or as defined on the drawings.
      - i Minimum #16 AWG for wires used to power instrumentation discrete signals.
  - b. Power cord
    - 1) Flexible wire cord shall be type SOW, SOOW, or G and be provided in 2, 3, or 4 conductor plus ground as required for connected load.
    - 2) EPR insulation, 90 deg C rating, oil and abrasion resistant, overall jacket plus individual conductor jackets. 600V rated
    - 3) Conductors shall be stranded copper.
    - 4) Cord shall be installed with cord grips on each end where it enters termination enclosures.

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c. VFD Motor Supply Cable

- 1) VFD motor supply cable shall be shielded and designed for use with AC variable frequency drives. The cable shall be used to interconnect a variable frequency drive to the controlled motor.
- 2) The VFD cable insulation shall disperse voltage spikes, harmonics, and power distortions associated with variable frequency drives. Cable shall be plainly marked with UL label, gauge, voltage, type of insulation, and manufacturer's name.
- 3) Conduits requiring VFD supply cable shall be specifically listed in the conduit schedule in "NOTES" column designation defined as VFD CABLE.
- 4) Power conductor size shall be as listed in the conduit schedule. Length shall be as required to extend from VFD to motor connection terminals. Conductor stranding shall be fine wire, three black conductors with white numbers and one green/yellow ground. Conductor stranding shall be class C or finer.
- 5) Insulation for conductors shall be rated for 1000 volts (min). Insulation shall be oil and UV resistant rated - 25°C to 90°C.
- 6) For Cable sizes 12 AWG to 2 AWG the cable construction shall be tinned copper with XLPE insulation under dual shielding of foil tape and copper braid construction, and outer PVC jacket. The VFD motor supply cable shall be Olflex/Lapp USA Wire and Cable Inc. OLFLEX Slim series, Belden 295xx or equal.
- 7) For cable sizes above 2AWG to 500MCM the cable construction shall utilize 3 symmetrical grounds next to 3 power conductors with XLPE insulation and foil and braid shield. The VFD motor supply cable shall be Olflex/Lapp USA Wire and Cable Inc. OLFLEX VFD Symmetrical series or equal.

d. Nonfield control panel or factory installed equipment internal wiring:

- 1) Insulation - Type MTW, NFPA standard 79, UL 1063 with tinned copper.
- 2) Minimum #16 AWG for wires used for individual conductor circuits 100 volts and above.
- 3) Minimum #18 AWG for wires used for individual conductor circuits below 100 volts.

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5. Instrument wiring:

- a. Field: Instrument cables shall have 600V tray cable rated insulation and 100% individual shielded twisted pair #16 conductors with drain wire. Single twisted shielded pair (TSPR) cables shall be Belden 9342, or approved equal. Three wire twisted shielded cables (#18 TS3W) shall be Belden 1119A or equal.
- b. Non-Field: Instrument cables shall have 300V rated insulation and 100% individual shielded twisted pair #18 conductors with drain wire. Single twisted shielded pair (TSPR.) cables shall be Belden 8760, or approved equal. Three wire shielded cable shall be Belden 8770 or equal.
- c. Field multi-pair instrument cable as required per conduit schedule shall have 300V rated insulation and 100% individual shielded twisted pair #18 conductors with drain wire. Multiple twisted shielded pair (T.S.PR.) cables shall be Belden 9773 thru 9777, or equal.
- d. Multi-pair cable is not allowed (unless specifically called out in conduit schedule or on plans) for use in field or non-field applications. One T.S.PR cable is required for each signal.

6. Manufacturer Supplied Cables

- a. Cables and wiring for special systems provided by the manufacturer with the equipment shall be installed per the manufacturer's recommendations.

7. Data Cable

- a. Data network category 6 cable (indoor) shall consist of 4 pair unshielded twisted pair #24 awg solid copper conductors. The cable shall be rated by IEEE for service intended – plenum and dry.
  - 1) Cable: IEEE Category 6, various manufacturers.
  - 2) Connectors: Standard RJ-45 with boot.
- b. Data network cable (outdoor) shall consist of 4 pair foil and braid shielded twisted pair #24 awg solid copper conductors with anti-crosstalk divider, and drain wire. Rated Level 2 Category 5e Outdoor Carrier by IEEE for use in plenum, conduit, wet or dry.
  - 1) Cable: IEEE Category 5e, Ubiquiti Tough Carrier, Belden, or equal
  - 2) Connectors: Grounded RJ-45 with drain wire crimp.

8. Fiber Optic Cable

- a. Each fiber continuous with no factory splices.
- b. Single-mode, graded index, solid glass wave guides with the following characteristics:
  - 1) Maximum attenuation (1310 nm) 0.4 dB/Km.
  - 2) Maximum attenuation (1550 nm) 0.3 dB/Km.
- c. FDDI compatible and meets requirements of ANSI X3T9.5 for FDDI cable.
- d. Attenuation tested, all fibers, with results provided on reel. Fiber attenuation, connector and splice losses shall not exceed 20% loss deviation between strands.
- e. All splices shall be fusion splices, mechanical splices are not allowed.
- f. Connector type shall match the installed equipment or patch panels. Single mode fibers shall be LC ceramic. Connectors shall be attached using heat cured epoxy. Crimp-on or UV-cured connectors are not acceptable.
- g. All fiber cables shall be terminated in an approved fiber patch panel, "wic", or other approved termination enclosure. The fiber run shall then be connected to electronic equipment using fiber patch cords.
- h. Spider fan out kit shall be used for field termination and pull out protection of fiber optic cables. The spider fan out shall consist to 24 buffer tubes for individual break out and connector installation. Provide Corning SFK, or equal.
- i. All strands of new fiber cables shall be terminated and tested without regard to designated use. Spare strands shall be terminated and tested equally with strands designated for active use on a project.
- j. When fiber optic cable is delivered to a project site, a test should be performed to verify the condition of the cable prior to installation. The cable and reel shall be physically inspected for damage and all the fibers shall be tested with an Optical Time Domain Reflectometer (OTDR) for fiber integrity. The results of these tests shall be submitted for review and approval.
- k. Smaller fiber runs, such as runs within the same cabinet, short runs in a building, etc. may not require pre-installation testing of cable. Waiver of this testing requirement shall not be done without approval
- l. After the fiber optic cable has been pulled, but before breakout and termination, all the fibers shall be tested with an OTDR for fiber integrity. Test results shall be submitted for review and approval.

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- m. When outdoor splices are performed at one location, all splices shall be tested with OTDR at the optimal wavelengths (1310 and 1550 for single-mode), in both directions. These tests shall be performed prior to enclosing and sealing the splices. These tests be witnessed by the Designer, and/or an Owner Representative. The splices shall be tested for integrity as well as attenuation. Individual fusion splice losses shall not exceed 0.1 dB. The test results shall be recorded, and submitted for approval.
  - n. When all fiber links have been completely installed, each link shall be tested with an OTDR and an Optical Loss Test Set with appropriate launch cable. All tests shall be conducted in the presence of the Designer and/or an Owner Representative. OTDR traces shall be from both directions on each fiber at the two optimal wavelengths, 1310 and 1550 for single mode fibers. Optical loss testing shall be done with handheld test sets in one direction at the two optimal wavelengths for the appropriate fiber type. Final testing shall include patch cords.
  - o. During any fiber testing, each tested fiber should exhibit similar results to the other fibers within the same cable. For example, each fiber within a cable may meet the minimum loss standards, but may vary greatly throughout the acceptable range. This could indicate splicing issues, or that minor physical cable damage had occurred during installation. Loss deviations of 20% or greater are not acceptable and will cause a test to fail, even though all fiber results were within the acceptable loss range.
  - p. Each results of each test perform shall be recorded and submitted to the Design Engineer and Owner. Test forms shall be produced, submitted, and approved prior to commencement of any testing. These forms should include the test type, the test location, test date, wavelength, index of refraction, origination/destination cable designation, fiber type, fiber number, fiber color, and the result of the value of the tested parameter. Hardcopy OTDR traces shall be attached to the completed test forms. Electronic versions of OTDR traces shall be submitted.
9. Temporary motor or panel hook-up
- a. Temporary cable may be cord without conduit or PVC conduit with wiring. In either case, the cabling must be protected from damage during construction. Sections may be located out of harms way, buried, or sleeved in steel conduit as needed.
  - b. Power Circuits: Provide 2, 3, or 4 conductor plus ground power supply cable(s) for temporary pump connections or electrical power circuits. Cables shall be sized for breaker rating amperage, (minimum).

- c. Provide multi-conductor (TC) cables for digital control circuits. Provide quantity of conductors as needed.
- d. Provide instrument wiring for 4-20 ma instrumentation.
- e. Voltage drop in power circuits shall not exceed 15% during motor start and 5% during operation.

C. COLOR CODE

- 1. All wires #8 and below shall have wire insulation the color specified. Wires #6 and larger may be black with color electrical tape at termination points.
- 2. No other colors shall be used without prior approval.
- 3. Color code - color code of all wire shall conform with the following table:

**WIRES COLOR CODE TABLE**

Description	Phase/Cod e Letter	Field wire or tape color	Non-Field Wire Color
480V, 3 Ph	A	Brown	Brown
	B	Orange	Orange
	C	Yellow	Yellow
	Neutral	Gray	Gray
240V or 208V, 3 Ph	A	Black	-
	B	Red (Orange if high leg)	-
	C	Blue	-
240 / 120 V, 1 Ph	L1	Black	Black
	L2	Black	Black
24V Positive	24+	Red	Red
24V Negative	24-	Gray	Gray
AC Control		Violet	Violet
DC Control Pos.		Red	Red
DC Control Neg.		Gray	Gray
Neutral	N	White	White
Ground	G	Green	Green
Shielded Pair	+	Black	Black
	-	Clear	Clear

2.02 WIRE MARKING

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- A. All panel, enclosure and field wiring shall have wire labels on both ends of each wire. Labeling shall be neatly installed for visibility and shall be clearly legible. Each conductor of instrument shielded signal wiring shall be labeled. Wire labels shall be machine printed with on white heat shrinkable tubing. Each label shall fit a minimum 23 characters, 3/16" in height before shrink. Tubing shall be oversized for the wire and shrunk into place using an electric heat gun. The "shrunk" label shall have just enough give to allow the label to be rotated. Hand lettered wire labels are not acceptable and shall be replaced at the Contractor's expense. Provide Brady "PermaSleeve" or equal.
1. **Source/Destination Wire Identification** - all wires, field and interior to equipment, shall be identified with wire labels.
- a. Wire labels shall be made up using "origination/destination" style numbering system. Consequently, each wire will have a unique set of wire labels that have their origin/destination numbers inverted on each end of wire.
  - b. Wire labels shall be exactly per interconnection submittal and/or control panel drawings -- abbreviations determined in the field are not allowed. Abbreviations may be used in the wire label as submitted and approved in the interconnection drawings submittal.
  - c. Wire labels shall provide a complete description of the origination and destination panel/device and terminal number.
  - d. Wire labels may be omitted on "neutral jumpers" less than 8" in length.
  - e. Wire labels for lighting and receptacle circuits shall consist of the panel board and circuit number and a unique node number. (I.E. LP#3-A, LP#3-B, LP#3-N) Wire labels for lighting and receptacle circuits are not origination/destination.

## 2.03 ELECTRICAL TAPE / SHRINKABLE INSULATORS

- A. Vinyl tape shall be 7 mil, 600 volt rated, flame retardant, hot and cold weather resistant conforming to UL510. Provide 3M Scotch Super 33+ vinyl tape or equal
1. Vinyl tape for color coding shall be 7 mil, 3/4" width, vinyl tape conforming to UL 510. Provide 3M Scotch 35 vinyl tape or equal.
- B. Rubber Tape: EPR rubber, 90 deg C continuous rated. Provide 3M 130C rubber tape or equal.
- C. Varnished Cambric Tape: Adhesive backed, 7 mil, bias cut cotton tape, coated with yellow insulating varnish. Provide 3M Scotch 2510 or equal.
- D. Shrinkable insulators shall be heat shrinkable, polyolefin thick wall sleeves, end caps and cable repair sleeves are designed for use in splicing, sealing and re-jacketing of direct bury secondary cables. The insulators shall comply with

UL 486D and be rated up to 1000 Volts. They shall provide long-term reliable performance overhead, underground or submerged with mechanical and environmental protection. Shrinkable insulators shall be 3M ITCSN or 3M IMCSN per manufacturer instructions for the application or equal.

### **PART 3: EXECUTION**

#### **3.01 WORKMANSHIP**

- A. All work in this Section shall conform to the codes and standards specified in Electrical Specifications [Electrical General, Workmanship].
- B. Perform work to remedy non-compliant installations after inspection.
- C. Upon notification, stop work on any portion of the installation that is determined to be substandard or being installed by unqualified personnel.

#### **3.02 FABRICATION AND INSTALLATION**

- A. System:
  - 1. Install all products specified in Electrical Specifications [Electrical General, Installation].
  - 2. Panels shall be completely factory wired and tested before shipment.
  - 3. All spare PLC input / output points shall be wired to terminal blocks.
  - 4. A minimum of 20% spare unwired terminals shall be provided in each panel.
- B. Wiring Methods:
  - 1. Wiring Separation: Wires carrying 100 volts and above shall be physically separated from lower voltage wiring by using separate bundles or wire ways with sufficient distance to minimize the introduction of noise, crossing only at 90 degree angles.
  - 2. Harness: All wiring shall be neatly bundled and laced with plastic tie-wraps, anchored in place by screw attached retainer. Where space is available, wiring shall be run in slotted plastic wireways with dust covers. Wireways shall be sized such that the wire fill does not exceed 60%. Tie-wraps shall be T&B TY-RAP or equal.
  - 3. Retainers: Wireways, retainers, and other devices shall be screw mounted with round-head 316 stainless steel screws or mechanically mounted by push-in or snap-in attachments. Glue or sticky back attachment of any type or style shall not be used. Retainers shall be T&B TC series or equal.
  - 4. Hinge Loops: Where wiring crosses hinged surfaces, provide a "U" shaped hinge loop protected by clear nylon spiral wrap. The hinge loop shall be of sufficient length to permit opening and closing the door without stressing any of the terminations or connections. Spiral wrap shall be Graybar T25N or equal.

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5. Routing: Wires and cable shall be routed such as to maintain separation between 100 Volt or higher from 100 volt or lower wiring being run in the same duct or bundle. Wires and cables shall have sufficient length to allow slack and to avoid any strain or tension in the wire or cable.
  - a. Wires shall be routed in slotted plastic wireways with snap covers. Wires carrying 120 VAC shall be separated as much as possible from other wires and signal cables, and shall be routed only in ducts for 120 VAC. If the power wiring has to cross the signal wiring, the crossing shall be as close to a right angle as possible. Wireways for 24 VDC wiring shall be used for all other wires and cables. Routing of 120 VAC in combined wireways shall be minimized. Wires and cables shall be placed in the wireways in a straight, neat and organized fashion and shall not be kinked, tangled or twisted together. Additional wire ducting shall be provided for use by the electrical subcontractor for routing field wires to their landing points in the each electrical and instrumentation panel.
  - b. Provide 2" minimum separation between wireway and terminal blocks.
  - c. Wiring not routed in wireways shall be neatly bundled, treed, and laced with plastic ties.

C. Wire Terminations

1. Single wire and cable conductors shall be terminated according to the requirements of the terminal device as follows:
  - a. Crimp-on terminals: shall be UL listed, self-insulating sleeve type, with ring or rectangular type tongue, suitable for the size and material of the wire to be terminated, and for use with either solid or stranded conductors.
  - b. Terminal Blocks: Remove the last +/- 0.25 inches insulation from of the conductor and insert it under the pressure plate to full length of the bare portion of the conductor. Tighten the screw to close the pressure plate onto the conductor. No more than two conductors shall be installed in a single terminal. All strands of the conductor shall be captured under the pressure plate.
  - c. Screw-less terminals: wire shall be stripped back and inserted per the terminal manufacturer's instructions.
  - d. Motors with pigtail leads: Install unmounted power terminal blocks on the motor pigtails and the cable(s) to be connected. Terminals shall be non-insulated set screw type applied with an allen wrench. Only one wire allowed per terminal. Install plugs in unused terminal spaces.

2. When stripping insulation from conductors, do not score or damage conductor.
3. The drain wire and stripped end of outer jacket of shielded cables shall be covered with heat shrink insulating tubing. The drain wire shall be covered along its full bare length between the cable jacket cover and the terminal lug and placed on end outer jacket to cover foil.
4. Condulets with wire nut connections shall be supplied for wire termination to devices with leads instead of terminals (i.e. solenoid valves, level probe, etc.).

D. Wire Splicing

1. No wires shall be spliced without prior approval.
2. Where splices are allowed or approved they shall conform to the following:
  - a. Wire splicing devices shall be sized according to manufacturer's recommendations.
  - b. Splices of #10 and smaller, including fixture taps, shall be made with nylon self-insulated twist on wire nuts; T & B "Piggys", Ideal "Wing-Nut" or equal.
  - c. Splices of #8 and larger shall be hex key screw, two way connectors, insulated with molded high-dielectric strength plastic; NSI Polaris IPL or IPLD Series terminal blocks or equal.
  - d. Non-Motor Splices #6 and smaller in underground pullboxes shall have wire-nut connections which are sealed with non-hardening silicone based sealant that protects the connection from moisture and corrosion. The wire nuts shall be factory filled with sealant and UL listed for waterproof connections. Provide Ideal Model 60 or equal.
  - e. Non-Motor Splices #4 and larger in underground pullboxes shall have double hex crimp barrel connections applied with adhesive/sealant filled heat shrinkable rubber insulation applied over the exposed connection. The cross-linked polyolefin shrink tube shall extend 4" on each side of the exposed connection minimum. Heat shrink tubing shall be 3M ITCSN or equal.
  - f. Motor lead Splices in underground pullboxes shall have terminal connectors on the motor leads and the cable to be connected. Terminals shall be non-insulated crimp-on type applied with a ratchet-type crimping tool. The terminals shall be bolted together with a nut, bolt and lock washer combination. The connection shall be wrapped with four (4) layers varnished cambric tape, six (6) layers of rubber tape and six (6) layers of vinyl electrical tape, each half lapped. Seal the connection with epoxy resin coating.



E. Wire Installation

1. Exercise care in pulling wires and cables into conduit or wireways so as to avoid kinking, stressing the cables, or damaging the insulation. Use a UL listed pulling compound for lubrication within conduits as necessary. The raceway construction shall be complete and protected from weather before cable is pulled in. Swab conduits before installing cables and exercise care in pulling, to avoid damage to the insulation or conductors.
2. All wire and cables (with the exception of coaxial antenna cable) shall be installed within UL listed raceways or enclosures. Install all wires and cables in one continuous length unless splices are per contract drawings, required to connect equipment or submitted and favorably reviewed.
3. Bundle incoming wire and cables in panels. Zip-tie at intervals of 2" and neatly spread into trees and connect to their respective terminals. Allow sufficient slack in cables for alterations in terminal connections. Do not bundle, tape or tie wires within conduits.

3.03 WARRANTY

- A. Provide warranty as specified in Electrical Specifications [Electrical General, Warranty].

**END OF SECTION**

## SECTION 16210

### ENGINE GENERATOR

#### PART 1: GENERAL

##### 1.01 SCOPE OF WORK

- A. These specifications describe the minimum requirements for a STANDBY duty three phase engine driven generator. The "Generator Data Sheet" at the end of this specification lists the minimum sizing for the generator and accessories. A larger generator shall be supplied when necessary to meet the requirements of this section. The Contractor shall complete this form with proposed generator values and include it with the generator submittal.
- B. The generator shall be provided as described in the following specification and as shown on the Contract drawings, herein designated as the design documents. The generator shall comply with all applicable sections of NFPA 30, 37, 70, 72 and 110, California Fire Code Articles 79 and 80 as well as State Statutes.
- C. The equipment furnished under these specifications shall meet the requirements of NEC Article 702, "Optional Standby Systems" and any other applicable articles of the NEC.
- D. The system shall meet the requirements of NFPA 704 Hazard Identification System Diamond indicating the hazards associated with the fuel being stored.
- E. The generator shall be delivered as a skid mounted unit, completely assembled to the extent possible and factory tested.
- F. Only new models in current production by a U.S. firm that meet the requirements of these specifications and which are cataloged by the manufacturer and for which manufacturer's published literature and printed specifications are currently available, will be considered. Special options may be included only when recommended by the manufacturer of the unit approved.
- G. All equipment/options are to be factory installed. If the equipment/options are not available factory installed, dealer installed equipment/accessories may be acceptable. The bidder is to specify those items which will be dealer installed in the submitted bid document.
- H. The manufacturer's local representative shall be an authorized distributor who maintains a stock of spare parts for the supplied generator and has a service facility with factory-trained service personnel. The manufacturer's local representative shall be located within a radius of 200 miles of the project.
- I. The Contractor shall perform complete startup, training and testing services for the generator per Electrical Specifications [Factory and Field Testing] and as detailed herein.
- J. Generator system shall be EPA Certified and meet all current Local, State and

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Federal air emissions requirements at time and location of installation.

- K. Generator system shall be coordinated and compliant with all current Local and State building and Fire Protection codes and requirements at time and location of installation. Furnish alarms, signage, fuel containment, shutdowns, and other devices and systems as required.
- L. The Contractor shall supply the generator, labor, testing and associated documentation as specified herein. This document describes the materials and intended operation, but does not necessarily describe all devices necessary for a functional system. All components and devices shall be furnished and installed as required to provide a complete, operable and reliable system for accomplishing the functions and meeting the performance set forth hereinafter.
- M. The generator scope of work includes:
  - 1. Engine driven electric generator
  - 2. Remote fuel tank with fuel pump.
    - a. Generator supplier has fuel system responsibility for safe and functional system.
    - b. Fuel line piping meeting local code requirements and drawings.
  - 3. Sub-base fuel tank with fuel pump and associated piping.
  - 4. Battery charger (120 VAC operated) mounted to generator frame.
  - 5. Weatherproof housing.
  - 6. Sound attenuating housing.
  - 7. Noise attenuating system.
  - 8. All auxiliary apparatus and accessories shall be provided as required for a fully functional generator and to meet local code requirements.
  - 9. Install a steel reinforced concrete pad, adequately sized to support the specified generator and fuel tank.
  - 10. All piping associated with exhaust system.
  - 11. Trenching, back filling, compaction and paving of each underground conduit route and fuel line piping.
  - 12. Field installation, startup, testing and training for the generator and associated equipment as part of this scope of work.
  - 13. Fuel for use during testing and full tank top off upon testing acceptance.

## 1.02 REFERENCES

- A. Electrical Specifications [Electrical General]
- B. Project Drawings
- C. The following manufacturing and installation standards apply to this section:
  - 1. ASTM International (ASTM): A335/A335M, Specification for Seamless Ferritic Alloy-Steel Pipe for High-Temperature Service.
  - 2. Best Available Control Technology Standards (BACT)
  - 3. Code of Federal Regulations (CRF): Title 40 Volume 18, Control of

Emissions from New and In-Use Non-road Compression-Ignition Engines.

4. National Fire Protection Association (NFPA):
    - a. 37, Installation and Use of Stationary Combustion Engines and Gas Turbines.
    - b. 70, National Electric Code.
    - c. 110, Emergency and Standby Power Systems.
  5. SAE International (SAE): J1074, Engine Sound Level Measurement.
  6. Underwriters Laboratories, Inc. (UL):
    - a. 142, Steel Aboveground Tanks for Flammable and Combustible Liquids.
    - b. 2085, Protected Aboveground Tanks for Flammable and Combustible Liquids.
    - c. 508, Industrial Control Equipment.
    - d. 1236, Battery Chargers for Charging Engine-Starter Batteries.
    - e. 2200, Stationary Engine Generator.
- D. The bidder shall carefully examine the plans and specifications, and be familiar with the conditions of the location of installation.

#### 1.03 QUALIFICATIONS

- A. Equipment manufacturers shall be represented by a company capable of servicing and testing the generator unit from a mobile service vehicle dispatched from within a 100 mile radius.

#### 1.04 SUBMITTAL REQUIREMENTS

- A. Submit shop documents and drawings for approval in accordance with this subsection and as specified in Electrical Specifications [Electrical General, Submittal Requirements]. All non-relevant items not provided on this project shall be crossed-off or deleted from all submitted documents and drawings.
- B. Submit a specification compliance statement, describing differences between specified and proposed equipment. Note equipment provided specifically to meet local agency or authority having jurisdiction requirements.
- C. Complete "Generator Data Sheet" at the end of this section and submit this form with the generator submittal.
- D. Submit data sheets and catalog information detailing:
  1. Engine:
    - a. Make and model.

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- b. Fuel type.
- c. Number of cylinders and cylinder arrangement.
- d. Bore and stroke.
- e. Compression ratio.
- f. Piston speed, Feet per Minute, at rated RPM.
- g. Cylinder head, piston, valve, and block material.
- h. Crankshaft material.
- i. Main bearings, quantity and type.
- j. Rated RPM and HP at rated RPM.
- k. Governor type.

2. Generator:

- a. Make and model.
- b. Generator full load electrical rating, KVA, KW, Voltage, Amperage, Frequency (Hz), # of Phases, # of Wires, Power Factor.
- c. Generator and Exciter type.
- d. Insulation material, class, and temperature rise.
- e. Bearings, quantity and type.
- f. Peak motor starting, KVA.
- g. Voltage regulator type and regulation % from no load to full load.
- h. Frequency regulator type and regulation %, from no-load to full load.
- i. One step load acceptance.
- j. Unbalanced load capability.
- k. Number of leads.
- l. Generator transient ( $x'd$ ) and subtransient ( $x''d$ ) reactance in per unit.
- m. Ambient temperature range.

3. Electrical

- a. Control and instrument panel.
- b. Generator main breaker.
- c. Batteries and battery charger.

4. Cooling System

- a. Maximum ambient temperature.
- b. Capacity (gallons).
- c. Coolant flow (gpm).
- d. Fan diameter (in).
- e. Fan HP requirement at rated RPM.

5. Accessories:

- a. Exhaust silencer, stack, and piping system.
- b. Fuel tank and piping system.
- c. Vibration isolation system.
- d. Block Heater system.
- e. Weatherproof/Soundproof Housing as specified herein.

f. Paint Finish.

E. Submit electrical schematics and wiring diagrams for:

1. Generator control panel.
2. Battery charging system.
3. Main generator.
4. Voltage regulator.
5. Governing system.
6. Generator main breaker.

F. Submit dimension drawings for:

1. Engine generator side, front, and top.
2. Pad construction (minimum) size, anchor details.
3. Enclosure (if required).
4. Fuel tank and containment basin.
5. Exhaust muffler and air intake baffle.
6. Conduit stub-up areas under generator frame and/or sub-base fuel tank.

G. Submit reports, calculations, and curves for:

1. Generator sizing calculation (computer generated report acceptable) showing that the unit is sized adequately to start all loads as shown on Contract Drawings "Load Calculation" without exceeding the maximum voltage dip specified.
2. Generator air emissions data, prototype or actual, suitable for submission to governing air quality management agency where generator is to be installed. Emissions data shall be for fuel type as required by local air quality agency.
3. Sound level data showing that the complete generator package meets the sound level requirements stated herein.
4. Engine generator fuel consumption data at 25%, 50%, 75% and 100% electrical loading.
5. Proposed concrete pad dimensions, reinforcement method and isolation material (as necessary) for submitted generator.
6. Seismic calculations for bolt down anchorage for seismic site class D. Calculation shall be signed by a California Registered Professional Structural Engineer. Generator installation shall meet applicable CBC or IBC requirements for stand-by power systems.
  - a. Calculations shall include calculations for wind loading on equipment to be mounted outdoors.
  - b. The Contractor shall submit a copy of the current ICBO anchor evaluation report for each type of anchor submitted.

- c. The Contractor shall submit a copy of the concrete mix design to include the concrete design strength.
- d. The Contractor shall submit Near Fault Vicinity and Location maps.

H. Air Quality Management Applications and Permits

- 1. The Contractor shall obtain the correct ATC application from the AQMD and preliminarily complete the application by inserting the project specific generator technical information. Submit preliminary partially completed application to the Engineer for use by the Owner in preparation of the final completed ATC application.
  - 2. The Contractor shall submit all generator specific information required to complete the ATC permit application. The Owner will not submit the application until all the information is received and the submittal receives a status of "make corrections noted" or "approved." Submit information in sufficient time for application processing and submittal review as to not delay project completion. The generator will not be considered approved until the ATC permit is obtained.
  - 3. The Owner shall complete and apply for the "Authority to Construct" (ATC) permit from the Air Quality Management District or Board with jurisdiction for this generator system. Fees for permit and application will be paid by the Owner. The Owner will submit the permit application within 14 days of submittal approval. Allocate 12 weeks for Owner to obtain ATC permit once application has been submitted.
  - 4. The Contractor shall confirm that the submitted generator meets all AQMD guidelines prior to submittal of the generator unit or preliminary application. Failure to do so will delay the ATC permitting and submittal approval.
- I. Descriptive literature shall be provided that describes the generator and all accessories. This literature shall provide sufficient detail to determine that the generator has all the accessories, options, features, and characteristics specified herein. Items that are not provided shall be neatly lined out.
- J. Deviations from the Contract documents shall not be incorporated into the work without prior written approval. A "Change Order" directive is required prior to incorporating any deviation from the Contract documents that has costs associated. The cost differential associated with this change order must be negotiated to amend the Contract to reflect the costs or savings.
- K. Exceptions to the Specifications or Drawings or equipment or procedures submitted as "equal" to specified equipment shall be clearly identified by the equipment supplier in a letter at the front of the submittal. Submittal data for "equal" equipment or procedures shall contain sufficient details so a proper evaluation may be made. The Contractor is responsible for verifying proper application/operation of substituted equipment.
- L. The Owner will not accept any ownership for material or equipment until the

corresponding submittals have been reviewed by the Owner and approved.

- M. Submit complete and specific information with regard to equipment representatives and service facilities.

#### 1.05 OPERATION AND MAINTENANCE INFORMATION

- A. Provide six (6) sets of operating, maintenance & parts instructions in original manuals (no copies allowed).

### **PART 2: PRODUCTS**

#### 2.01 QUALITY

- A. The generator shall be as manufactured by Caterpillar, Cummins, Generac, Kohler or equal with accessories as defined herein.
- B. The equipment supplied and installed shall meet the requirements of the National Fire Protection Association (NFPA 70 and NFPA 110) and all applicable local codes and regulations.
- C. The generator system shall be designed as a "black start" unit capable of starting and operating without any external power.
- D. Provide all of the features, options, and accessories specified herein and shown on the design drawings. Finished equipment shall be complete and site tested as an installed unit with all accessories functioning.
- E. All rotating parts shall have guards to protect against accidental contact in accordance with Federal OSHA and Cal-OSHA requirements.

#### 2.02 RATING

- A. The engine generator shall have a minimum continuous standby rating as listed in "Generator Data Sheet" at the end of this section. Standby rated shall mean that generator starts within 60 seconds upon being called and operates continuously for the total duration of the generator call or fuel supply. Rating of the generator shall be based on operation when equipped with all necessary operating accessories such as radiator, fan, air cleaners, lubricating oil pump, governor, exhaust silencer, etc.
- B. No derating from the ratings specified shall occur for ambient temperatures below 122°F or installation elevation below 1,000 feet.
- C. The generator will be installed at approximately 1000 feet above sea level. The generator shall operate as specified at ambient temperatures between 0 degrees Fahrenheit and 122 degrees Fahrenheit.
- D. The engine/generator shall accept 100% of its nameplate rating at 0.8 PF in one step, in compliance with NFPA 110, Paragraph 5-13.2.6.
- E. The generator shall be capable of successfully providing three phase, four wire, 60 hertz power to start and continuously operate at the specified KW

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rating and below for loads shown in the drawing and/or with power factors between 0.5 lag to 0.9 lead. It shall be capable of operating in noisy electrical environments that are typical of variable frequency drive motor loads. The nominal voltage and maximum step voltage dip shall be per the "Generator Data Sheet," as measured line to line at the generator terminals, during start of any of the station loads.

- F. Generator set mean time between failures shall be a minimum of 5,000 hours.

## 2.03 ENGINE

- A. The engine shall be a turbocharged compression ignition engine type, water cooled, four cycle, with vertical inline or V-type cylinders and an overhead valve configuration.
- B. The engine shall utilize only NO. 2 diesel fuel. Generator shall operate per manufacturer's specifications using fuel approved by local air quality authorities.
- C. The engine shall be of direct injection design, i.e. pre-combustion chambers shall not be incorporated in the cylinder heads. Glow plugs shall not be used for engine starting.
- D. The engine shall have sufficient power to produce the specified ratings when operating with all accessories including exhaust, fuel, cooling, and battery charging systems, etc.
- E. The engine shall be equipped with:
  - 1. Engine driven or electric fuel transfer pump, fuel filters, and electric fuel shutoff valve. The fuel transfer pump shall be capable of lifting the fuel from the sub-base fuel tank. Primary and secondary fuel filters shall be provided. The fuel filters shall be replaceable and conveniently located for servicing.
  - 2. Electrical governor; consisting of a magnetic pickup speed sensor, adjustable electronic control, and an electrical actuator mounted integrally with the fuel pump. The governor shall provide automatic engine generator set frequency regulation adjustable from isochronous to 5% droop. Governors using external throttle linkages are not acceptable.
  - 3. An electric starting system complete with batteries, battery charger, battery rack, connector cables, and any other equipment required to start the standby generator. The starting system shall not require an auxiliary AC power supply to start, fully load, and operate the standby generator. The batteries shall be sized to provide five starts with 30 seconds cranking for each start attempt. The battery charger shall be sized to fully recharge the batteries within 12 hours. If required to maintain the above criteria, an electrical heat pad for the batteries shall be provided to keep the batteries in a ready state at the specified minimum ambient temperature. The charger shall be furnished with

charger trouble alarm and an automatic equalize timer for fast recharge. The charger shall alarm on loss of power and cause a generator common alarm output.

4. Positive engagement solenoid shift-starting electric starter with DC voltage as listed in "Generator Data Sheet."
5. Battery charging alternator with a minimum ampere output as listed in "Generator Data Sheet."
6. Positive displacement, full pressure lubrication oil pump, cartridge oil filters, dipstick, and oil drain. The oil pump shall be capable of supplying adequate lubricating oil under pressure to the main bearings, crankshaft bearings, pistons, piston pins, timing gears, camshaft bearings, and valve rocker mechanism. The cartridge oil filters shall be full flow type, conveniently located for servicing. Filters shall be equipped with a spring loaded bypass valve to ensure oil circulation if filters are clogged.
7. An electric DC motor-driven pre-lube oil pump shall be provided if required by the engine manufacturer's design for "black start" of the standby generator.
8. Dry type replaceable air cleaner elements. The dry-type air cleaner shall be equipped with a self-cleaning dust and water evacuator and a vacuum restriction gauge to indicate maximum allowable restriction of the air cleaner system according to the engine manufacturer's recommendations. The air cleaner elements shall be conveniently located for servicing. Unit mounted radiator, blower fan, water pump, and thermostat. The radiator with blower type fan shall be sized to maintain safe operation at 122° F ambient temperature. The engine cooling system shall be filled with a solution of 50/50 ethylene glycol/water antifreeze or equivalent as recommended by the manufacturer.
9. Replaceable type cylinder liners.
10. Replaceable insert main bearings.

## 2.04 GENERATOR

- A. The generator shall be a synchronous wye-connected generator designed for direct connection to the engine. It shall be salient-pole, brushless, 12-lead reconnectable, self-ventilated, drip-proof construction, with amortisseur rotor or damper windings and skewed stator for smooth voltage waveform. The unit shall conform to the applicable standards for synchronous generators, salient pole type.
- B. The generator shall have the following features:
  1. Temperature rise of the rotor and stator shall be limited to 125° C for the specified KW and KVA ratings.

2. Steady state voltage regulation from no load to full load within +/- 0.25% for electronic governors, +/- 0.8% for mechanical governors.
  3. Steady state regulation from no load to full load within +/- 0.25%.
  4. The insulation material shall meet the NEMA standard (MG1-22.40 and 16.40) for class H and be vacuum impregnated with epoxy varnish to be fungus resistant per MIL I-24092.
  5. The excitation system shall be of brushless construction controlled by a solid state voltage regulator with adjustable volts-per-hertz operation capable of maintaining voltage within +/- 2% at any constant load from 0 to 100% of rating. The regulator isolated from the load to prevent tracking when connected to SCR loads. The regulator shall be protected from the environment by conformal coating and provide individual adjustments for voltage range, stability and volts-per-hertz operations. Provide permanent magnet (PM) excitation for generators above 150KW or AREP excitation for generators smaller than 150KW.
  6. The generator shall have a single maintenance-free bearing and be connected to the flywheel housing with a semi-flexible coupling between the rotor and the flywheel.
  7. Radio interference suppression to meet the BS.800 and VDE Class G and N standards.
  8. Telephone interference factor of less than 50 per NEMA MG1-22.43.
  9. AC voltage waveform total harmonic distortion of less than 5% total from no load to full load. Any individual harmonic shall have less than 3% THD.
- C. The generator shall be inherently capable of sustaining at least 300% of rated current for at least 10 seconds under a 3-phase symmetrical short circuit without the addition of separate current support devices.
- D. On starting each listed load, the instantaneous voltage dip shall not exceed that listed in "Generator Data Sheet" and shall recover to +/- 1% of rated voltage within one second.

## 2.05 CONTROLLER & INSTRUMENT PANEL

- A. Provide a generator-set mounted controller & instrument panel. The controller top shall be mounted no higher than 6 feet above finished grade. Controller mounting shall be vibration isolated from the rest of the engine / generator set.
- B. Emergency stop maintained pushbutton located at maximum 6 feet above grade.
- C. Remote mounted emergency stop glass covered pull switch located as shown in the drawings at maximum 54 inches above grade.

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D. Controller Features

1. All solid state construction, except for interface relays. The controller shall utilize a microcomputer based logic with a ROM based control algorithm. Circuit boards shall be coated to protect from environmental damage.
2. Graphical display with preconfigured screens for parameter and alarm viewing and setpoint changes.
3. Voltage, current and power metering, engine and generator parameter viewing.
4. Real time clock for time stamping of diagnostic events and maintenance reminders.
5. Non-volatile memory for setpoint storage through power failures.
6. Security through password access.
7. Control of generator output circuit breaker for generator protection and synchronizing functions.
  - a. Paralleling functions to including automatic and manual synchronizing, dead bus arbitration, load sharing, and load sense/load demand.
  - b. Protective relaying functions – phase sequence, over/under voltage, over/under frequency, reverse power, overcurrent, current balance.
8. Communications to SCADA systems through included Ethernet Modbus TCP port.

E. Control circuitry shall be of plug-in design for quick replacement. The controller shall be equipped to accept a plug-in device capable of allowing maintenance personnel to test controller performance without operating the engine. The controller shall be capable of operation from –40°C to 85°C.

F. Input circuitry from fuel tank devices such as fuel level switches and level transmitters, shall be designed to be suitable for the application and consist of current limiting circuitry and/or non-sparking devices.

G. Control must meet NFPA-110 Level 1 requirements (2005 version) and meet NFPA-70.

H. The panel display shall include as a minimum:

1. AC voltmeter.
2. AC ammeter.
3. Frequency meter.
4. Water temperature gauge.
5. Oil pressure gauge.

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6. Battery voltmeter gauge.
7. Engine running time meter (non-resettable)
8. Voltage adjustment.
9. Pre-alarms:
  - a. Auxiliary fault.
  - b. Battery Charger Fault.
  - c. Fuel low level/pressure.
  - d. Low oil pressure.
  - e. Low engine temperature
  - f. High engine temperature.
  - g. High battery voltage
  - h. Low battery voltage
  - i. Fuel leak alarm
10. Engine shutdowns:
  - a. Auxiliary Shutdown.
  - b. Emergency Stop.
  - c. Low coolant level
  - d. Overcrank.
  - e. Overspeed.
  - f. Low oil pressure.
  - g. Low fuel level.
  - h. High engine temperature.
11. Audible Alarm:
  - a. Generator switch not-in-auto.
12. Functions:
  - a. Three position (RUN-OFF-AUTO) function: In the RUN position the engine shall start and run regardless of the position of the remote starting contact. In the AUTO position, the engine shall start when contacts in the remote control circuit close and stop five minutes after those contacts open following the engine cooldown sequence. In the OFF position the engine shall not start even though the remote start contact closes. This position shall also shutdown engine immediately.
- I. Wiring – The manufacturer shall furnish, install at the factory, and test all wiring required between devices mounted within or on the standby generator unit base. All wiring shall be neatly and carefully installed in wiring gutters, wire looms, or raceway. All power supply circuits shall be provided with suitable isolation/electrical protection means consisting of either fuses or circuit breakers. All internal wiring shall be marked at both ends of the conductor.
- J. Operation:
  1. Two-wire generator start/stop control from an automatic transfer switch (normal start and stop with cooldown) and from a remote

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emergency stop (immediate stop with fuel shutoff).

2. Engine starter control for:
  - a. Cranking cyler with 15 second ON and OFF cranking periods or as recommended by the manufacturer. Cranking shall cease upon engine starting and running.
  - b. Two methods of cranking termination shall be provided:
    - 1) After three 15 second cranking cycles.
    - 2) After 75 seconds if the engine fails to start or as recommended by the manufacturer
    - 3) Each condition shall lockout the engine, and visually indicate an overcrank alarm.
  - c. Starting system shall be designed for restarting in event of a false engine start. It shall permit the engine to completely stop rotating before reengaging the starter.
3. Provide wiring circuitry and sensing devices as required for emergency shutdown of the engine on any occurrence of the following conditions.
  - a. Low coolant level.
  - b. Over speed.
  - c. Over-crank.
  - d. High engine temperature.
  - e. Low oil pressure.
  - f. Low fuel
  - g. Emergency stop
  - h. Auxiliary shutdown
  - i. High enclosure temp (360 °F)
    - 1) Temperature switch shall be roof or ceiling mounted above engine air intake and connected via ½" EMT conduit to control panel. Provide Fenwal Detect-a-Fire model 12-X27121-000.
4. Engine cool down timer factory set at five (5) minutes to permit unloaded running of the generator set after the call to operate is dropped.
5. Programmable I/O contacts to be provided and brought out to terminals for connection to remote monitoring equipment:
  - a. A common alarm dry contact, normally open which closes on any alarm condition.
  - b. A generator running dry contact, normally open which closes when the engine is running.
  - c. A generator in cool-down dry contact, normally open which closes when the engine is running but opens when the engine enters cool-down.
  - d. Low fuel level dry contact, normally open which closes on low fuel alarm condition.

- e. Auto switch position dry contact that closes when the three position (RUN-OFF-AUTO) selector switch is in the "AUTO" switch position.
- f. Remote emergency shutdown from normally closed switch.

## 2.06 ACCESSORIES

- A. Engine block heater. Thermostatically controlled and sized to maintain manufacturers recommended engine coolant temperature to meet the start-up requirements of NFPA-99 and NFPA-110, Level 1. Wattage and voltage shall be per "Generator Data Sheet."
- B. Exhaust System:
  - 1. The complete exhaust system (silencer, stack, and exhaust piping) shall be sized to ensure that exhaust back pressure falls within the manufacturer's minimum and maximum limitations under all operating conditions.
  - 2. Exhaust Silencer: Provide exhaust silencer including flexible piping & fittings properly sized and installed according to the manufacturer's requirements. The silencer shall be critical type (30dB attenuation minimum) and coated to be temperature and rust resistant. The flexible connector section(s) shall be seamless, stainless steel and the ends shall be pipe thread (2" maximum) or SAE flanged. Support for exhaust silencer shall be from overhead or side supports or as shown and shall not be carried by the exhaust manifold.
  - 3. Exhaust Stack and Piping: Provide thin-gauge steel pipes with flange connections, high temperature gaskets, elbows and straight runs to complete the exhaust system. The exhaust system shall extend vertically above roof to direct exhaust and heat away from building or enclosure or as shown on the drawings. Provide wall thimble and roof penetrations designed for high heat applications and a gravity actuated steel rain cap at end of exhaust pipe. Exhaust system shall be supported from side or above utilizing galvanized steel channel trapeze hangars, gusseted wall brackets or custom welded brackets per manufacturer's recommendations to meet the specified seismic design conditions. Design system to accommodate engine vibration and not loosen or break exhaust system mounts.
  - 4. Provide threaded welded half coupling on exhaust piping, 3/4" copper drop pipe and ball valve to drain condensate from muffler and exhaust stack. Mount piping on wall with channel supports. Drain outlet shall be plumbed down the nearest wall such that a 5 gallon bucket may be slid beneath to catch discharge. Exhaust piping and muffler shall be sloped 2% such that drains are at the low points.
  - 5. Insulation system: The non-outdoor portion of the exhaust pipe, stack and silencer shall be covered with fiberglass insulation and soft outer cover. The outer cover shall be constructed of heat and fire resistant canvas material with snap buttons.

C. Vibration Isolation

1. Engine Generator: Vibration isolation dampeners between the engine and steel mounting skid.
2. Exhaust Silencer: Mount with vibration isolators and/or flexible exhaust piping.
3. Enclosures shall be mounted with vibration isolators and/or steel structural stiffeners to minimize added noise due to vibration.
4. The generator shall have provisions for shipping/transit such that expected shocks will not damage the vibration isolators or generator.

D. Remote Fuel Tank:

1. Fuel tanks shall be sized to provide fuel for a minimum run time in hours at full load or gallons as listed in "Generator Data Form."
2. The remote fuel tank shall be listed under UL 142, for above ground steel tanks for flammable and combustible liquids, and UL 2085, furnace fire tests. The tank will be labeled with UL Approvals according to their particular classification.
3. The fuel tank shall meet all local safety and code requirements for secondary containment, leak monitoring, and spill protection. Provide any required information to aid in the permitting process. All necessary information shall be included in the submittal to avoid delays in project completion.
4. Fuel tank shall include accessories including, emergency vent, pressure/vacuum vent, Fill adaptor and cap, test wellcap and adaptor, gauge stick, fill limiter, decal package for tank size and product, and any specialized pipe fittings and caps to accommodate generator service.
5. The fuel tank construction shall have the following features:
  - a. Primary tank constructed of 1/8" (min) sheet steel with continuous welds on all exterior seams. Rectangular in shape and top penetrations only. The outer surface of the primary steel tank shall be covered by a minimum of 1/4" thick insulation panels. Exposed metal shall be powder coated to prevent corrosion.
  - b. Secondary containment shall consist of 30 Mil thick High Density Polyethylene membrane enclosing the steel tank and insulation material.
  - c. The primary and secondary containment shall be encased in 6 inches of monolithic reinforced concrete, with minimum design strength of 4000 psi at 28 days. Concrete encasement shall not have seams. The concrete exterior shall be painted with



two-part water based epoxy paint.

- d. 5-15 gallon spill containment around fill port with normally closed valve to release spilled fuel into the primary steel tank. Provide rain cover for spill containment area.
  - e. 2" locking fill cap
  - f. Emergency vent system per NFPA 30. Provide vent extension to 12 ft (min) height or as required per local codes.
  - g. 30 year warranty by manufacturer.
  - h. Lugs for grounding per NEC 780.
  - i. 1" fuel suction and return connections (minimum). Provide normally closed solenoid shutoff valve at fuel tank outlet that will energize/de-energize with generator run command.
6. 1-1/4" mechanical fuel level gauge. Readout shall be fraction of full tank with indicators at 25%, 50%, 75%, 85%, 90%, and 100% full. Provide Krueger Sentry Gauge or equal.
7. Fuel Tank Control Panel
- a. Control panel shall monitor tank level, and provide alarm contact outputs for low level, low shutoff level, and high filling level. High alarm shall sound alarm horn on front of unit.
  - b. Control panel shall monitor leakage status from secondary containment tank.
  - c. Enclosure shall be suitable for outdoor installation on fuel tank in direct sunlight. Padlockable NEMA 4 or better. Provide sunshade as necessary.
  - d. 120 VAC with alarm follower relays for all alarms, 4-20ma output of tank level, and 0.5" LED display.
  - e. Push buttons for programming, mode, test, and others as required.
  - f. Shall include magnetostrictive level sensor to measure tank level with 0.1" accuracy.
  - g. Digital display shall show level in feet, gallons remaining, available room in gallons, and all setpoint alarm information.
  - h. Fuel tank control panel shall be Pneumercator TMS 2000 or equal.
8. Fuel level switches that are rated for use in fuel or fuel vapor atmosphere that are non-sparking. Switches shall actuate on a float

- mechanism which operates a sealed switch for connection to the generator control panel. Provide the following independent or combination switches:
- a. High High (90% full) level audible alarm.
  - b. High (85% full) level audible alarm.
  - c. Low (25% full) level for low fuel alarm indication.
  - d. Low Low (5% full) for low fuel engine shutdown and indication.
  - e. Secondary Containment Leak for fuel tank leak alarm.
9. Seismic Restraint to comply with Seismic area requirements. Provide anchorage and seats for tank legs as required.
- E. Batteries: Support tray with plastic battery enclosure, tie downs, battery cables, and 12-volt batteries all mounted to the engine/generator skid. The batteries shall be capable of delivering the cold-cranking amps required at zero degrees Fahrenheit per SAE Standard J-537.
- F. Signage:
1. Signage shall be posted on the sides of the generator enclosure facing the main approaches to the system.
  2. Provide an engraved placard with fuel filling procedure, tank capacity, fuel type, and maximum fill guidelines.
  3. Provide signage 0.08" thick white painted/silk-screened aluminum with 1-1/2" red lettering to read "No Smoking". Signs shall be posted on all sides of generator enclosure.
  4. Provide signage 4" x 6" x 0.08" white painted aluminum with red lettering to read "Generator Emergency Stop" for installation at a remote emergency stop switch as shown on the drawings.
- G. Automatic Battery Charger suitable for continuous operation to maintain the battery charge voltage with no manual intervention. Battery charger features shall be as follows:
1. Solid state circuitry with charging modes as described to automatically recharge the starting batteries. When battery voltage drops below the specified value the battery charger shall operate at the high rate constant current mode until the battery voltage rises to the preset equalize level. The equalize mode will continue until the current required to maintain this voltage drops to 50% of the high rate level.
  2. A current limiting circuitry to prevent charger overload under low battery voltage conditions. Provide minimum DC voltage and amp ratings (minimum) as listed in "Generator Data Sheet."
  3. The battery charger shall provide temperature compensation of -2 mv/°C per cell over the ambient temperature of -40°C up to 60°C. This shall automatically adjust the "float" and "equalize" voltage settings to prevent the batteries from overcharging at high temperature and under charging at low ambient temperatures.

4. The complete charger unit shall be U.L. listed.
  5. The charger shall be mounted to the engine/ generator skid. The charger shall be operational through an ambient temperature range of -40°F to 140°F. It shall include the following features:
    - a. Fused AC input and DC output overload & short circuit protection.
    - b. DC ammeter and voltmeter, 5% full scale accuracy, to indicate battery charging amps and volts.
    - c. "Power on" lamp to indicate when the charger is operating.
    - d. DC voltage regulation +/- 1% from no load to full load and over AC input line variations of +/- 10%.
    - e. Reverse polarity protection to prevent the charger from energizing outputs if improperly connected.
    - f. Current limiting. Current limiting circuitry shall be provided to prevent damage to the charger from being overloaded at low battery voltage such as occurs during short circuit conditions or during engine starter cranking.
    - g. The battery charger shall be powered from 120 VAC.
- H. Sound Attenuating Weatherproof Housing for the generator shall be as follows:
1. Manufactured from heavy-gauge aluminum or galvanized sheet steel and painted with the manufacturer's standard finish. Paint color shall be submitted to Owner for approval. Color choices shall include but not be limited to autumn white and beige. All surfaces shall be painted inside and out.
  2. The interior of housing shall have a heat resistant thermo-acoustic insulation system designed to meet sound attenuation requirements for the life of the generator. The placement, type, thickness and weight of the attenuator panels shall provide sound dampening to the specified level of allowable noise outside the generator. The air intake and exhaust shall have similar dampening and allow ample air flow for proper engine cooling, without having to remove side panels. The insulation shall be mechanically held against walls, ceiling and doors behind full sheets of perforated galvanized sheet steel. All insulation shall be covered with the exception of the exhaust piping.
  3. The enclosure shall house the engine, generator, control & instrument panel, battery charger, generator breaker, and all accessories.
  4. The radiator discharge shall be directed upwards through the use of a vertical duct mounted to the enclosure. The duct shall include drip holes to allow rain water to drain out the bottom.
  5. All exterior panels shall have lockable latches to prevent unauthorized entry.

6. The specified exhaust silencer shall be mounted in or on the roof of the enclosure with vibration isolators.
7. Pressure drops through the enclosure openings shall not exceed limits set by the manufacturer of the generator.
8. The enclosure shall be free standing and anchored to the concrete pad (or trailer) supporting the engine generator. The enclosure may be mounted to the generator skid only if a skid mounted enclosure can meet the sound attenuation requirements specified.
9. The enclosure shall be designed so that sound levels measured at a 25 feet radius from any side of the enclosure (free field) and 5 feet above ground level, noise levels shall not exceed (Generator Data Sheet) dB with the engine generator running at full load and full speed inclusive of exhaust noise.

#### I. CIRCUIT BREAKER DISCONNECT

##### 1. GENERAL

- a. Circuit breakers and motor circuit protectors shall be manufactured by Eaton Cutler-Hammer, Square D, G.E., Siemens, or equal.
- b. Sized by Generator manufacturer to meet UL standards, cabling requirements per plans, and "Generator Data Sheet."
- c. Multiple-pole circuit breakers shall be designed so that an overload on one pole automatically causes all poles to open. The use of tandem or dual circuit breakers in a normal single-pole space to provide the number of poles or spaces specified are not acceptable.
- d. Molded case circuit breakers shall be operated by a single toggle-type handle and shall have a quick-make, quick-break switching mechanism. An automatic trip of the breaker shall be clearly indicated by the handle position. Contacts shall be non-welding silver alloy and have flash reduction arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.
- e. Minimum interrupting capacity:
  - 1) 480 volt circuit breaker shall have a minimum interrupting capacity of 42,000 amperes.
  - 2) 120 or 208 or 240 volt breaker shall have a minimum interrupting capacity of 22,000 amperes
- f. Circuit Breakers less than 400 volt and below 100-ampere trip or less shall have thermal-magnetic (TM) trip units and inverse time-current characteristics unless protecting full voltage or solid state reduced voltage motor starters, 15kva or larger transformer secondary, or as specifically shown on drawings.

- g. Circuit Breakers protecting full voltage or solid state reduced voltage motor starters shall be motor circuit protector (MCP) breakers with adjustable magnetic trip unless otherwise noted on the drawings.
- h. Circuit breakers shall be UL listed for series application.
- i. Where indicated circuit breakers shall be current limiting.
- j. Where indicated on drawings, provide UL listed circuit breakers for continuous duty at 100% of their ampere rating in the intended enclosure.

## 2. TRIP UNIT

- a. The trip unit shall be Eaton type Digitrip OPTIM 550 – Programmable or approved equal.
- b. Each circuit breaker microprocessor-based tripping system shall consist of three (3) current sensors, a trip unit and a flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time-delay settings are reached.
- c. Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be fixed-type. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.
- d. System coordination shall be provided by the following microprocessor-based programmable time/current curve shaping adjustments:
  - 1) Protection - Fixed rating plug, interchangeable (In setting)
  - 2) Adjustable long delay pickup setting  $0.4-1.0 \times I_n = I_r$
  - 3) Programmable long-time delay with selectable  $I^2t$  (2-24 seconds) and/or  $I^4t$  (1-5 seconds) curve shaping
  - 4) Programmable short-time settings,  $150-800\% \times I_r$  in 1% increments, with  $\pm 5\%$  band tolerance
  - 5) Programmable short-time delay, 100-500ms, with selectable flat or  $I^2t$  curve shaping
  - 6) Programmable instantaneous pickup settings,  $200-800\% \times I_n$  in 1% increments
  - 7) Programmable ground fault pickup settings trip, 20-100%  $I_s$ , in 1% increments
  - 8) Programmable ground fault delay, 0-500ms, with selectable flat or  $I^2t$  curve shaping

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- e. The microprocessor-based trip unit shall have a powered/unpowered selectable thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession.
- f. When the instantaneous setting has been deselected, a selectable discriminator circuit shall be provided to prevent the breaker being closed and latched on to a faulted circuit.
- g. Provide neutral ground fault sensor for four-wire loads.
- h. The trip unit shall have an information system that utilizes battery backed-up LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. The LEDs shall be complemented by trip event information stored in non-volatile memory after a trip event. A trip reset button shall be provided to turn off the LED indication and reset the memory after an automatic trip. A test pushbutton shall energize an LED to indicate battery status.
- i. The microprocessor-based trip units shall be capable of monitoring the following data:
  - 1) Instantaneous value of phase, neutral and ground current
  - 2) Minimum and maximum current values
  - 3) Average demand current
  - 4) System diagnostic information such as alarms and cause of trip
  - 5) Approximate level of fault current that initiated an automatic trip operation
- j. The trip unit shall contain test capability. Testing shall be carried out by using a hand-held programmer, a breaker interface module or a remote computer to select the values of test current within a range of available settings. The basic protection functions shall not be affected during test operations. The breaker may be tested in either the "Trip" or "No Trip" test mode. Provide an auxiliary power module to allow the breaker trip unit to be tested with a 120-volt external power source.
- k. A hand-held programming unit shall be provided to set/change the network communication breaker address for each device, set the system baud rate, distribution frequency, display breaker information, and display monitored values. In addition, provide password protection for programming time/current set points and to perform functional testing of phase and ground trip characteristics. The programmer shall be self-powered by an internal battery. Provide as a minimum one (1) hand-held programming unit per assembly.
- l. The monitored data shall be displayed by a hand-held programmer, a breaker interface module or a remote computer.

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- m. Provide auxiliary position indication switch for closed and tripped, each with Form C contacts. Provide additional auxiliary switches, bell alarms, shunt trips, and undervoltage releases where indicated on the drawings.

J. Load Bank

1. The load bank shall be pad mounted and self contained.
2. Load bank shall be rated for minimum percentage of generator full load as defined in the Generator Data Sheet at 1.0 power factor. Acceptable KW total tolerance shall be not more than  $\pm 5\%$  of nameplate full load, and  $\pm 2\%$  phase to phase.
3. Load Bank Control Panel
  - a. Manual Mode load control loads the generator to value set by manual toggle switches whenever the generator is operating for routine exercise. The transfer switch shall be in normal position and generator is running but not in cool-down mode.. Load shall be applied to a running generator after a settable time delay.
  - b. Automatic Mode load control automatically adds and removes loads the generator as needed to maintain optimum loading of the generator to prevent "wet stacking". The transfer switch shall be in normal position and generator is running but not in cool-down mode. Load shall be applied to a running generator after a settable time delay.
  - c. Automatically disconnects load from the generator if the transfer switch is in the emergency position or if the generator is in its cool down mode.
  - d. Provide minimum six (6) load steps, with independent switches and indicator lights.
  - e. Automatic overheat thermostat to prevent damage.
  - f. Mounted in accessible location with generator in operation and no more than 72" above grade, inclusive of sub-base fuel tank.
  - g. Outdoor load bank control panels shall be NEMA 3R rated. Verify location of load bank control panel(s) with installation contractor.
4. The pad mounted load bank shall be Load-Tec Model OSM2, Avtron with optional control panel, or equal.

2.07 STAIR AND PLATFORM SYSTEM

A. General

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1. Non-skid walking surface shall be used for safety: steel pre-galvanized grip strut planking, 12 gauge thickness.
  2. Steel welding shall be in accordance with the ANSI/AWS D1.1-02 gas metal arc welding process and shall be performed by experienced operators.
  3. All exposed surfaces shall be smooth and free of sharp or jagged edges.
- B. Stairways
1. Stair treads, and stringers shall be designed for a uniform live load of 100 pounds per square foot and a concentrated vertical load of 300 pounds over an area of 4 square inches.
  2. Stair treads, stringers and risers shall be constructed using steel alloys for structural components.
  3. The walking surface of the stairs shall be steel pre galvanized grip strut planking slip resistant surface.
- C. Landings
1. Landings shall be designed for a uniform live load of 100 pounds per square foot and a concentrated vertical load of 300 pounds over an area of 4 square inches.
  2. Landings shall be level and have a dimension in the direction of travel not less than the width of the stairway. Landings shall be constructed using steel alloys for structural components.
  3. The walking surface of the landing shall be continuous, without gaps, shall be steel pre-galvanized grip strut planking slip resistant surface. Sizes shall be fabricated as required by local codes and/or for specific applications as indicated on drawings.
- D. Legs
1. The legs shall be designed to support the landing sections. The legs shall be designed so that they will be perpendicular to the ground and vertical loads are transmitted axially through them regardless of the slope. All legs shall have 6"x 6"x 1/4" anchor plate pads.
- E. The stair system shall be Amer-Fab, or equal.

### **PART 3: EXECUTION**

#### **3.01 WORKMANSHIP**

- A. The construction methods specified herein shall be followed by the manufacturer of the generator. If the manufacturer fails to comply, the Contractor shall pay all costs required to make the changes to the equipment



to conform to these construction methods.

- B. Screw type solderless terminals or lugs shall be provided for all field connected power cables, control and instrument wiring. All connections shall be accessible from a designated connection panel without removal of internal components.
- C. A terminal strip shall be provided for control and instrument wiring. Number all terminals with machine printed lettering.
- D. All internal and external control and instrument wiring shall have permanent identification at each point of connection. Wire identification shall be by machine printed numbered "shrink-tube" wiring sleeves. Internal wire numbers shall be per generator manufacturer's wiring diagram. External wire numbers shall be determined by the connected control panel(s).
- E. Control and instrument wiring shall be neatly bundled and secured in place with screw down anchors and plastic cable ties. Wiring shall be protected with plastic spiral wrap where it is subject to mechanical damage or crosses over to a hinged door.
- F. The generator and any accessories shall be a product of excellent workmanship and shall be free from any defects or imperfections that will affect their appearance or serviceability.
- G. The generator's neutral shall be grounded per generator manufacturer's installation instructions for 3 wire distribution systems.

### 3.02 INSTALLATION

- A. The generator shall not be delivered to the job site until the manufacturer's certified factory test report has been submitted, reviewed and accepted. A non-existent or non-reviewed certified factory test report shall be sufficient cause for the unit to be rejected.
- B. The Contractor shall remove rejected equipment immediately from the jobsite at his expense until the generator submittal and/or factory test report is approved.

### 3.03 FACTORY INSPECTION AND TESTS

- A. Factory or Factory Authorized Dealer shall be considered one in the same for the purposes of inspection, testing, service facility and herein after may be referred to as "factory" or "manufacturer."
- B. Factory Tests: Each generator to be supplied shall be tested by the manufacturer prior to shipment. All tests shall be made with all accessories installed. The factory tests shall be made under varying loads (30% to 100%) for a minimum of one hour total.

The factory testing shall include the following tests:

1. Single step load pickup.

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2. Transient and steady state governing.
  3. Safety shutdown device testing.
  4. Voltage regulation.
  5. Rated power.
  6. Maximum power.
  7. Test all generator control panel alarms, status lights & indicators.
  8. Test all remote connection status and alarm points (dry contacts).
  9. Simulate remote ATS start/stop of generator utilizing a wire jumper.
- C. A typewritten factory test report shall be provided which lists the factory tests performed. The results of the each test, name & phone number of person who performed the tests, date(s) when tests were performed, serial & part number of equipment tested, setting values, failures encountered, and repairs made during testing.

### 3.04 FIELD ASSISTANCE

- A. The Contractor shall take all precautions necessary to ensure the safety of all personnel during the tests. Absolutely no tests shall be run that could potentially cause injury or jeopardize personnel safety.
- B. The initial setup of each generator shall be performed by a factory-trained service person of the manufacturer's local representative. Fill the engine fuel, lubricants, and cooling system and make all preliminary tests and checks required before engine start-up the day prior to witness field testing.
- C. The Contractor shall be responsible for and pay the costs for the necessary fuel to fill each generator tank prior to the start of the field tests. The fuel shall include a fuel conditioner as recommended by the manufacturer.
- D. The Contractor shall pay for a factory-trained service representative to perform one (1) 8-hour day of field tests for each generator, beginning at 8:00 a.m. any weekday, except Friday.
  1. Each failure mode, alarm, and control function shall be demonstrated to Owner by the Contractor's factory-trained service representative prior to performing any other field tests.
  2. The generator manufacturer representative shall furnish a temporary 1.0 PF load bank and connection cabling rated for a load equal to no less than 100 percent of the generator nameplate KW. The load bank shall be connected to the generator output terminals for a four (4) hour, full-load test. The Owner Representative shall be allowed to change loads during the tests to simulate normal operating conditions. The factory-trained service person shall be responsible for running the generator during the load tests. Any defects or failures discovered during these tests shall be corrected or adjusted by the factory-trained service person. The engine generator load test shall be restarted after each repair or adjustment that requires shutdown of the generator. The test shall be restarted as many times as necessary until the generator runs for four (4) continuous hours without shutdown or failure.

3. The temporary load bank shall be set-up the day before testing. Under no circumstances shall the testing be allowed to extend beyond 5:30 p.m.
  4. All field tests shall be witnessed by Owner. Written notice shall be provided to the Owner Representative seven (7) days prior to the date for the field test.
- E. The Generator Field Checklist (GCL per Electrical Specifications [Factory and Field Testing]) shall be completed by the generator manufacturer representative prior to beginning of operational testing. The checklist shall be signed by the representative submitted prior to the start of operational load bank testing.
  - F. The Generator Performance Test Report (GPT per Electrical Specifications [Factory and Field Testing].) shall be completed by the generator manufacturer representative during operational testing. The forms shall be signed by the representative and given to the Owner Representative prior to completion of operational load bank testing.
  - G. The Generator Sound Level Data Form (GSLD Electrical Specifications [Factory and Field Testing]) shall be completed by the generator manufacturer representative during operational testing. The forms shall be signed by the representative and given to the Owner Representative prior to completion of operational load bank testing.
  - H. Training
    1. The local representative's factory-trained service person shall instruct in the proper operating and maintenance procedures for all components of the generator. This instruction shall be given for a minimum length of two (2) hours. The training shall cover "operation" and "maintenance". Training shall not begin until Operation and Maintenance manuals are approved and field tests have been completed.

### 3.05 WARRANTY

- A. The Generator System Supplier shall have a staff of experienced personnel available to provide service on two (2) working days notice during the warranty period. Such personnel shall be capable of fully testing and diagnosing the equipment delivered; and of implementing corrective measures.
- B. If the Generator System Supplier fails to respond in two (2) working days, the Owner at its option will proceed to have the warranty work completed by other resources; the total cost for these other resources shall be reimbursed in full by the Contractor. The use of other resources, as stated above, shall not change or relieve the Contractor from fulfilling the remainder of the warranty requirements.
- C. Prior to final acceptance, the Contractor shall furnish a listing of warranty information for all manufacturers of materials and equipment supplied under

the scope of work covered in these design documents. The listing shall include the following:

1. Manufacturer's name, service contact person, phone number, and address.
2. Material and equipment description, equipment number, part number, serial number, and model number.
3. Warranty expiration date.

D. Hardware support:

1. The Contractor shall provide warranty of all equipment for a period of one (1) year from date of final acceptance. Standard published warranties of equipment which exceed the preceding specified length of time shall be honored by the manufacturer.
2. The Contractor shall provide all labor and material to replace or repair any hardware that fails during the warranty period, at no additional cost to the Owner.

### 3.06 FINAL ACCEPTANCE

- A. Final acceptance will be given by the Owner after the equipment has been field tested satisfactorily, each deficiency has been corrected, documentation has been provided, and all the requirements of design documents have been fulfilled.
- B. At the end of the project, following the completion of the field tests, and prior to final acceptance, the Contractor shall provide the following to the Owner:
  1. Fuel tank top off. The Contractor shall supply up to one entire tank of fuel at the end of the project.
  2. Each "operation, maintenance and parts" manual shall be modified or supplemented by the Contractor to reflect all field changes and as-built conditions.
  3. Two sets of keys for all locks.

## GENERATOR DATA SHEET

The following data sheet is a summary of generator required specifications. Not all specification requirements are listed below. The Contractor/Supplier shall return this page with the Submitted Value column completed. If submitted values are less than those listed in the Specification Minimum column, then the supplier shall explain reasons for the exception in cover letter.

Description	Specification Minimum	Units	Submitted Value	Units
Generator Continuous Output Power	<b>1500</b>	KW		KW
	<b>1875</b>	KVA		KVA
Three phase voltage (Nominal)	<b>480</b>	Volts AC		Volts AC
Continuous amperage at 0.8 power factor	<b>2255</b>	Amps AC		Amps AC
Power Frequency	<b>60</b>	Hz		Hz
Max voltage dip with specified motors	<b>12</b>	%		%
Reactance – Subtransient (X''d)	<b>**</b>	%		%
Reactance – Transient (X'd)	<b>**</b>	%		%
Reactance – Synchronous (Xd)	<b>**</b>	%		%
Engine horse power at rated KW	<b>**</b>	HP		HP
Engine RPM at rated power	<b>1800</b>	RPM		RPM
Engine Fuel Type	<b>No. 2 Diesel</b>	-		-
Engine aspiration (Normal/Turbo)	<b>Turbo</b>	-		-
System Voltage	<b>**</b>	Volts DC		Volts DC
Alternator output (at system voltage)	<b>**</b>	Amps DC		Amps DC
Battery charger output	<b>10</b>	Amps DC		Amps DC
Engine block heater power	<b>**</b>	W		W
Alternator condensation strip heater	<b>**</b>	W		W
Heater(s) voltage (1 phase)	<b>208</b>	Voltage		Voltage
Fuel tank capacity (hrs @ 100% load)	<b>24</b>	Hours		Hours
Type (Sub-base/Remote)	<b>Remote</b>	-		-
Main Breaker Maximum Rating	<b>2500</b>	Amps		Amps
Trip Features Per Spec	<b>LSIG</b>	-		-
Interrupt Rating	<b>65</b>	KAIC		KAIC
Load Bank (Pad Mounted)	<b>Yes</b>	of Gen FLA		
Load Bank Rating Percentage	<b>50%</b>			
Enclosure type  (Sound Atten., Weatherproof, None)	<b>75 dB Sound Attenuating</b>			

\*\* Sized per manufacturer recommendations to meet intent of plans and specifications, codes, and environmental conditions at location of installation. Please highlight any deviations from drawings and specifications.

**END OF SECTION**

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## **SECTION 16250**

### **AUTOMATIC TRANSFER SWITCH**

#### **PART 1: GENERAL**

##### **1.01 SCOPE OF WORK**

- A. The Contractor shall supply the automatic transfer switch (ATS) as specified herein.
- B. The ATS scope of work includes:
  - 1. Providing and installing one automatic transfer switch of rating shown on Contract Drawings.
  - 2. Submittal data and drawings.
  - 3. Startup assistance.
  - 4. Factory and field testing.
  - 5. Operation and maintenance manuals.
  - 6. Warranty of all components.
- C. Startup and configuration of ATS with installed voltages and loads.
- D. As required under Electrical Specifications [Factory and Field Testing], furnish all required labor, materials, safety equipment, transportation, test equipment, incidentals and services to perform factory and/or field testing.

##### **1.02 REFERENCES**

- A. Electrical Specifications [Electrical General]
- B. Electrical Specifications [Factory and Field Testing]
- C. Project Drawings

##### **1.03 SUBMITTALS REQUIREMENTS**

- A. Provide Submittals as specified in Electrical Specifications [Electrical General, Submittal Requirements].
- B. Include a record of each parameter available to be changed by the user. The list shall include factory defaults and space for entered values.

##### **1.04 OPERATION AND MAINTENANCE INFORMATION**

- A. Provide operation and maintenance information as specified in Electrical Specifications [Electrical General, Operating and Maintenance Information].
- B. Include a record of each ATS parameter setup during startup and testing and place a copy of setting in each O & M manual.

#### **PART 2: PRODUCTS**

##### **2.01 AUTOMATIC TRANSFER SWITCH**

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A. General:

1. The ATS shall be UL listed in accordance with UL 1008 and be labeled in accordance with that standard's 1½ and 3 cycle, long-time ratings. ATSs which are not tested and labeled with 1½ and 3 cycle (any breaker) ratings and have series, or specific breaker ratings only, are not acceptable.
2. The ATS shall be rated to close on and withstand 42,000 RMS symmetrical short circuit amperes at the ATS terminals or otherwise shown. Provide overcurrent protection as shown on the Contract drawings.
3. The ATS manufacturer shall be certified to ISO 9001 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001.
4. ATS types utilizing components of molded-case circuit breakers, contactors, or parts thereof, are not acceptable.
5. The switch assembly shall be installed in a NEMA enclosure located as shown on Contract drawings.
6. The automatic transfer switch shall be an ASCO Model 7000, with options to meet specified requirements, or equal.

B. Switch Unit:

1. The transfer switch unit shall be electrically operated and mechanically held. The electrical operator shall be solenoid operated and only momentarily energized to minimize power consumption and heat generation.
2. The transfer switch shall feature a delayed transition mode. The switch shall remain in the neutral position (neither emergency nor normal) until the associated time delays have expired and allow the switch to complete the transfer.
3. The switch shall be 3 pole double-throw with inherently interlocked construction. A solid neutral shall be provided for all systems.
4. Wide contact gaps shall be provided to insure positive isolation of the normal and emergency power sources.
5. The switch shall be fully rated for amperage shown on Contract Drawings, for switching all types of loads including induction motors. The ratings shall apply to the voltage and mounting arrangement as shown in the drawings.
6. The main power contacts shall have silver alloy contact construction featuring a wiping action each time the switch is operated. Arc chutes shall be utilized to contain the inherent spark created when switching

under load.

7. The main contact design shall allow repeated making and breaking of rated full load current, with a combination of motor and other loads and without damage or undue wear to the contacts.
8. All main power contacts and auxiliary contacts shall be mechanically driven from a common actuator shaft.
9. The bus shall be constructed of silver plated copper.
10. Inspection of all contacts, linkages and moving parts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors.
11. All switch and relay contacts, coils, mechanical linkages, and control elements shall be serviceable or removable from the front of the mounted switch or accessory assembly without removal of the switch or assembly from the compartment and without disconnection of the power cables or control wiring.
12. The switch shall have a manual operating handle for maintenance purposes.
13. Compression screw type solder-less terminals or lugs shall be provided for connecting all external line & load power cables and control wiring. All connections shall be accessible from the front without removal of internal components.
14. A terminal strip shall be provided for terminating all control wiring. All terminals shall be numbered with machine printed lettering matching the wire number of the terminated wire.
15. All control wiring shall have permanent identification at each point of connection. Wire identification shall be by machine printed numbered wiring sleeves. Electrically common wires shall have the same wire number. Electrically different wiring shall have unique wire numbers.
16. Control wiring shall be neatly bundled and secured in place by plastic cable ties. Wiring shall be protected with plastic spiral wrap where it crosses over a hinge to the door.

C. ATS CONTROL PANEL

1. A control panel shall be provided to direct the operation of the transfer switch. The modules sensing and logic shall be controlled by a built-in microprocessor. Control panels that do not utilize microprocessor electronics to control the operation of the switch are not acceptable.
2. A four line, 20 character LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be



available for viewing and limited control through the serial communications input port.

3. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance.
  - a. Sensing and control logic shall be provided on multi-layer printed circuit boards.
  - b. The panel shall be enclosed with a protective cover and be outer door or deadfront mounted such that it may be operated with the door closed for safety and ease of maintenance.
4. A single controller shall provide twelve selectable nominal voltages for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to  $\pm 1\%$  of nominal voltage. Frequency sensing shall be accurate to  $\pm 0.2\%$ .
  - a. The under-voltage of each phase of the normal source shall be monitored, with pickup adjustable from 85% to 100% of nominal and the dropout adjustable from 75% to 98% of pickup setting, both in increments of 1%. These adjustments shall be factory set at 85% dropout, and 90% pickup.
  - b. The voltage of each phase of the emergency source shall be monitored, with pickup adjustable from 85% to 100% of nominal. This adjustment shall be factory set at 95% pickup.
  - c. Frequency sensing of the emergency source shall be provided, with pickup adjustable from 90% to 100% of nominal. This adjustment shall be factory set at 97% pickup.
  - d. The control panel shall meet or exceed the voltage surge withstand capability in accordance with IEEE Standard 472-1974 (ANSI C37.90a 1974) and the withstand voltage test in accordance with the proposed NEMA Standard ICS1-109.21.
5. The transfer switch control panel shall be capable of operating over a temperature range of -20 to +60 degrees C.
6. The transfer switch shall be provided with advanced in-phase algorithm which measures the frequency difference between the two sources and initiates transfer at appropriate phase angles to minimize disturbances from transferring motor loads.
7. The control panel shall include the following field adjustable time delays:
  - a. Time delay to override momentary normal source outages, adjustable from 0 to 5 minutes. This adjustment shall be field set to place emergency generator on-line in 1 minute.
  - b. Transfer to emergency time delay for controlled timing of load transfer to emergency, adjustable from 0 to 5 minutes. This adjustment shall be field set switch position in 5 seconds after power has stabilized.

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- c. Emergency source failure time delay to ignore momentary transients during initial generator set loading, adjustable from 0 to 6 seconds. Set at 2 seconds.
  - d. Retransfer to normal time delay, adjustable 0 to 60 minutes. This adjustment shall be factory set at 5 minutes. The time delay is automatically bypassed if the emergency source fails and normal source is acceptable.
  - e. Unloaded running time delay for emergency engine generator cooldown, adjustable from 0 to 60 minutes. This adjustment shall be factory set at 5 minutes.
  - f. Delayed transition time delay for setting the dead time when all power is removed from the load side of ATS, adjustable 0 to 5 minutes. Set at 1 minute.
  - g. Generator Exercise Timer: Timer provided for operator adjustment of day of week, time of day and run duration for exercising the generator under operating loads by activating the automatic transfer switch. . Timer shall be mounted on the ATS outer deadfront door.
  - h. The controller shall provide an integral engine exerciser. The timer shall be field set by the Contractor with date and time during training. The engine exerciser shall allow the user to program up to seven different exercise routines. For each routine, the user shall be able to:
    - 1) Enable or disable the routine.
    - 2) Enable or disable transfer of the load during routine.
    - 3) Set the start time of day, day of week, week of month, alternate or every time start, duration of run.
    - 4) At the end of the specified duration the switch shall transfer the load back to normal and run the generator for the specified cool down period. A 10-year life battery that supplies power to the real time clock in the event of a power loss will maintain all time and date information.
8. The controller shall commit-to-start engine which requires the engine to reach proper output and run at least the duration of the cooldown setting, regardless of whether the load is transferred.
9. Provide interface relays or main switch follower contacts to comply with I/O interface requirements as defined in the P&ID diagram. Interfacing relays shall be industrial grade plug-in type with dust covers. Interface connections shall be wired to backpan terminal blocks. At minimum, the switch shall have the following unused I/O contacts available:
- a. Switch in Normal – SPDT rated 10 amps, 120 VAC
  - b. Switch in Emergency – SPDT rated 10 amps, 120 VAC
  - c. Engine starting contact -- DPDT gold-flashed contacts rated 10 amps, 32 VDC
  - d. Emergency Power available – SPDT rated 10 amps, 120 VAC
  - e. Normal Power available – SPDT rated 10 amps, 120 VAC

10. Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal.
11. Communications – The controller shall include a communications module for interface to the PLC and SCADA. All settable parameters and instantaneous operational registers shall be accessible from the communications port.
  - a. Type
    - 1) Modbus TCP (Schneider Automation Standard)
  - b. Command and Metering registers to include:
    - 1) Switch position status normal or emergency
    - 2) Setpoints, timers, delays, voltage levels, etc.
    - 3) 3 phase voltage (normal and emergency)
    - 4) Normal and Emergency voltage available
    - 5) Fault conditions
    - 6) Test, load, no-load.
    - 7) Others as available.
12. Provide separate LED signal lights with nameplates indicating the following:
  - a. Utility power is available (green)
  - b. Generator power is available (red)
  - c. ATS is connected to Utility source (green)
  - d. ATS is connected to the Generator source (red)
  - e. ATS in neutral position (wht)
13. A three position momentary-type test switch shall be provided for the test / automatic / reset modes:
  - a. Test: simulate normal source failure
  - b. Automatic: normal operation
  - c. Reset: bypass the time delays on either transfer to emergency or retransfer to normal.
14. All adjustments shall be field adjustable without the use of tools, meters, power supplies, or special test equipment and can be made safely without personal exposure to live parts
15. Each adjustment resolution shall be settable within minimum increments of 1%.
16. Repetitive accuracy of timer, voltage and frequency settings over a temperature range of  $-20^{\circ}\text{C}$  to  $70^{\circ}\text{C}$  shall be within  $\pm 2\%$ .
17. The control panel programming shall be lockable via password protection.
18. The wire harness for connection of the control panel to the transfer switch shall have sufficient length to reach between the mounting

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locations shown on the Contract drawings.

19. Provide the following displays on the controller:
  - a. Event log to display 99 logged events with the time and date of the event, event type and event reason.
  - b. Total number of ATS transfers.
  - c. Number of ATS transfers caused by power source failures.
  - d. Total number of days ATS has been in operation.
  - e. Total number of hours that the normal and emergency sources have been available.

### **PART 3: EXECUTION**

#### **3.01 WORKMANSHIP**

- A. All work in this Section shall conform to the codes and standards specified in Electrical Specifications [Electrical General, Workmanship].

#### **3.02 FIELD ASSISTANCE**

- A. Testing, checkout and start-up of the ATS equipment shall be performed under the technical direction of a factory trained authorized manufacturer representative.
  1. The setup and programming of the ATS shall be provided by a factory-trained representative who is authorized by the ATS manufacturer to perform the startup. This setup and programming shall be done prior to and during the first application of power.
  2. Provide testing as specified in Electrical Specifications [Factory and Field Testing].
- B. Provide 1 hour of "ATS Setup" Training on operating and maintenance procedures.

#### **3.03 WARRANTY**

- A. Provide warranty as specified in Electrical Specifications [Electrical General, Warranty].

### **END OF SECTION**

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## SECTION 16430

### LOW VOLTAGE SWITCHBOARD

#### PART 1: GENERAL

##### 1.01 SCOPE OF WORK

- A. This section applies to specific switchboards rated 600 volts and below.
- B. Provide Switchboard(s) (SWBD) as specified herein and shown on the drawings.
  - 1. The System Integrator shall perform and be responsible for procurement, submittals, shop drawings, interconnection drawings, factory testing, and all control wiring for the SWBD. System Integrator is defined in Electrical Specifications [Electrical General].
- C. All wiring, wire color codes, wire labeling and terminal blocks within SWBD shall be as specified in Electrical Specifications [Low Voltage Wire & Data Cable].
- D. The SWBD scope of work includes:
  - 1. Providing SWBD structure and all internal components.
  - 2. Installation of the SWBD on concrete pad per details.
  - 3. Submittal data and drawings.
  - 4. Startup and configuration of SWBD internal components.
  - 5. Factory and field testing.
  - 6. Operation and maintenance manuals.
  - 7. Warranty of all components.
  - 8. Seismic Anchorage Design Calculations and conforming installation.
  - 9. Conduit – support systems, wire, and grounding system, for equipment interconnection, and operation.
  - 10. System calibration, testing and documentation.
- E. Electrical Specifications [Factory and Field Testing]. Furnish all required labor, materials, safety equipment, transportation, test equipment, incidentals and services to perform factory and/or field testing.
- F. All electrical equipment and materials, and methods - including installation, calibration, and testing - shall conform to the applicable codes and standards listed in this and other Sections. All electrical materials and work shall conform to published standards of the National Electric Code (NEC), Institute of Electrical and Electronic Engineers (IEEE), and Underwriters Laboratories Inc (UL).

##### 1.02 REFERENCES

- A. Electrical Specifications [Electrical General]
- B. Electrical Specifications [Low Voltage Wire & Data Cable]
- C. Electrical Specifications [Automatic Transfer Switch]
- D. Electrical Specifications [Panelboard and Power Transformer]
- E. Electrical Specifications [Factory and Field Testing]

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### 1.03 SUBMITTALS REQUIREMENTS

- A. Provide Submittals as specified in Electrical Specifications [Electrical General, Submittal Requirements].
- B. Include a record of each configurable parameter available to be changed by the user for internal components. The list shall include factory defaults and space for entered values for each configurable component.

### 1.04 OPERATION AND MAINTENANCE INFORMATION

- A. Provide operation and maintenance instructions as specified in Electrical Specifications [Electrical General].

## **PART 2: PRODUCTS**

### 2.01 SWITCHBOARD

- A. General:
  - 1. The Switchboard shall be Cutler Hammer, Square D or approved equal.
  - 2. The Switchboard (SWBD) shall be built and tested in accordance with:
    - a. NEMA Standards
    - b. ANSI
    - c. Underwriters Laboratories, Inc.
  - 3. Switchboard enclosure shall be NEMA rated as shown in the drawings.
- B. Metering Panel:
  - 1. Metering panel shall comply with Roseville Electric Standards.
  - 2. Provide metal enclosed, front accessible, self contained utility metering panel. Voltage, phase, AIC and continuous amperage rating shall be as shown on Contract Drawings. Panel will include meter socket, factory installed main breaker(s) and test by-pass facility.
  - 3. Design utility entrance and termination and other features per NEC, local codes, and serving Utility requirements.
  - 4. Enclosure shall be NEMA 3R construction for underground utility service. Enclosure shall be manufactured from galvanized 16 ga. (min) sheet steel. The enclosure shall be finished with ANSI 61 gray enamel paint. Provide pad mount, cabinet per installation detail.
  - 5. Utility metering switchboard shall be Cutler Hammer Pow-R-Line, Tesco Metering Switchboard or equal.
- C. Switchboard:
  - 1. Switchboard shall be front accessible with group mounted, buss

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connected circuit protective devices. Where provisions for future circuit protective devices are required, space for the device, corresponding vertical buss, device connectors and the necessary mounting hardware shall be supplied.

2. Distribution section shall meet all requirements per NEC, local codes, and as defined in the drawings.
3. Buss shall be copper. Aluminum buss is not equal to copper buss. Furnish buss mounted cable lugs sized for cabling that is required to be directly buss connected.
4. Buss shall, 3 phase, 4 wire, 480 volt, 65,000 AIC minimum symmetrical (or as shown otherwise in the drawings).
5. Power buss:
  - a. Continuous amperage rating at least equal to the main circuit breaker or the power source and shall be braced to withstand stresses resulting from the maximum short-circuit current available.
  - b. Horizontal bus shall extend through all sections of the switchgear unless shown otherwise in the drawings with vertical connections to circuit breakers in each section.
  - c. Buss shall be mounted on heavy-duty insulated glass polyester supports, and main bus joints shall be bolted using a minimum of two bolts.
  - d. Shipping splits and provisions for future bus extensions shall have tin-plated bolted connections.
6. Neutral bus, when specified or required, shall have the same capacity as the main bus.
7. Ground buss shall be rated per NEC relative to the power buss amperage rating and shall extend the entire length of the switchboard.

D. Molded Case Circuit Breakers:

1. General:
  - a. Circuit breakers and motor circuit protectors shall be manufactured by Eaton Cutler-Hammer, Square D, G.E., Siemens, or equal.
  - b. All circuit breakers greater than 400A and 480V shall be provided with arc flash reduction feature.
  - c. Circuit breakers shall be the bolt-on type.
  - d. Multiple-pole circuit breakers shall be designed so that an overload on one pole automatically causes all poles to open.

The use of tandem or dual circuit breakers in a normal single-pole space to provide the number of poles or spaces specified are not acceptable.

- e. Molded case circuit breakers shall be operated by a single toggle-type handle and shall have a quick-make, quick-break switching mechanism. An automatic trip of the breaker shall be clearly indicated by the handle position. Contacts shall be non-welding silver alloy and have flash reduction arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.
- f. Minimum interrupting capacity:
  - 1) 480 volt circuit breaker shall have a minimum interrupting capacity of 42,000 amperes.
  - 2) 120 or 208 or 240 volt breaker shall have a minimum interrupting capacity of 22,000 amperes
- g. Circuit Breakers less than 400 volt shall have thermal-magnetic (TM) trip units and inverse time-current characteristics unless protecting full voltage or solid state reduced voltage motor starters, 15kva or larger transformer secondary, or as specifically shown on drawings.
- h. Circuit breakers shall be UL listed for series application.
- i. Where indicated circuit breakers shall be current limiting.
- j. Where indicated on drawings, provide UL listed circuit breakers for continuous duty at 100% of their ampere rating in the intended enclosure.

## 2. TRIP UNIT

- a. Each molded case circuit breaker microprocessor-based tripping system shall consist of three (3) current sensors, a trip unit and a flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors, and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time-delay settings are reached.
- b. Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be fixed-type. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.
- c. System coordination shall be provided by the following microprocessor-based time-current curve shaping adjustments:

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- 1) Adjustable long-time setting (set by adjusting the trip setting dial to an amount not to exceed rating plug)
  - 2) Adjustable short-time setting and delay with selective flat or I<sup>2</sup>t curve shaping,
  - 3) Adjustable instantaneous setting
  - 4) Adjustable ground fault setting and delay with selective flat or I<sup>2</sup>t curve shaping.
- d. The microprocessor-based trip unit shall have both powered and unpowered thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession.
  - e. Furnish internal ground fault protection with adjustable settings. Provide neutral ground fault sensor for four-wire loads.
  - f. Breakers shall have built-in test points for testing the long-time delay, instantaneous, and ground fault functions of the breaker by means of a test set.

E. Space Heaters:

1. Outdoor rated switchgear shall be provided with 120 volts AC thermostatically controlled space heaters. Heater wiring shall be to terminal blocks for connection to external power source. One heater shall be provided in each vertical breaker section. Heaters shall have guards to prevent accidental contact with power or control wiring.

F. Key Interlocks:

1. Key interlocks shall be provided as shown on the drawings. The switchgear manufacturer shall be responsible for coordinating interlocks for switchgear main circuit breakers interlocked with generator circuit breakers. Key interlocks shall be as manufactured by Kirk Key Interlock Company, or equal.

G. Surge Protective Device (SPD)

1. SPD shall be suitable Service entrance location per ANSI/IEEE C62.41, IEEE C62.45, and UL1449 3<sup>rd</sup> edition and tested according to IEEE C62.44 as Secondary Surge Arrestor.
2. Unit shall be sealed and not allow vapors from entering the switchboard enclosure after a voltage surge event.
3. Modes of protection – Line to Line, Line to Ground, Line to Neutral (as applicable). Voltage, phase and neutral connections per one-line diagram. Current surge capacity shall be 60,000 amps per mode minimum
4. The SPD shall be factory installed inside the switchboard during

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assembly by the original equipment manufacturer. The OEM design shall be integral to the design of the switchgear with special paneling and cutouts specifically designed for unit mounting.

5. The SPD connections shall be located as close as possible to the load side of main disconnect device and ground/neutral bar.
6. The SPD shall have integral 30-amp disconnect and fuses. Service of the SPD assembly, fuses or other serviceable components shall be from front access of the switchboard and shall not require disassembly of switchboard panels to repair or replace parts.
7. SPD shall be Cutler-Hammer Clipper, Current Technology TransGuard or equal.

H. Power Monitor:

1. Provide a microprocessor based line of multifunction, power and energy meters. The meter device shall be UL listed. All meters shall have the following ratings, features, and functions; unless a specific meter type is designated.
  - a. Meter shall be designed for Multifunction Electrical Measurement on 3 phase power systems. The Meter shall support 3-Element Wye, 2.5 Element Wye, 2 Element Delta, 4 wire Delta systems.
  - b. Meter surge withstand shall conform to ANSI C62.41 (6KV)
  - c. The meter shall be user programmable for voltage range to any PT ratio.
  - d. The meter shall have a burden of 1 Mega Ohm, 0.014W at 120 Volts.
  - e. The meter shall accept a direct voltage input range of up to 576 Volts Line to Neutral, and a range of up to 721 Volts Line to Line.
  - f. Meter shall accept a current input of up to 11 amps continuous. Start up current for a 5 Amp input shall be no greater than .005 Amps.
2. Power meter shall be capable of a dual input method for current inputs. As standard the meter shall be designed to allow the CT circuit to pass directly through the meter without any physical termination on the meter, ensuring the meter cannot be a point of failure on the CT circuit. As an option where indicated on the drawing or required for the application, provide additional termination pass-through bars, allowing the CT leads to be terminated on the meter. The meter must be capable of supporting both termination methods.
3. The meter shall have the following additional ratings and features:

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- a. Fault Current Withstand shall be 100 Amps for 10 seconds, 300 Amps for 3 seconds, and 500 Amps for 1 second.
  - b. Meter shall be programmable for current to any CT ratio. The use of DIP switches for selecting fixed ratios shall not be acceptable
  - c. Meter shall have a maximum burden of 0.005VA per phase, at the maximum at 11 Amperes continuous input.
  - d. Meter to accept a pass through wire gauge dimension of 0.177" / 4.5 mm.
4. The meter shall have an accuracy of +/- 0.1% or better for volts and amps, and 0.2% for power and energy functions. The meter shall meet the accuracy requirements of IEC687 (class 0.2%) and ANSI C12.20 (Class 0.2%).
- a. The meter shall provide true RMS measurements of voltage, phase to neutral and phase to phase; current, per phase and neutral.
  - b. The meter shall provide sampling at 400+ samples per cycle on all channels measured readings simultaneously.
  - c. Type meter shall provide total % THD (Total Harmonic Distortion) Monitoring to the 40th order for Voltage and current per phase, and shall provide Volts, Amps, kW, kVAR, PF, kVA, Frequency., kWh, kVAh, kVARh and 1 KYZ pulse output and limit exceeded alarms.
5. The meter shall include a three-line, bright red, .56" LED display.
- a. The meter shall fit in both DIN 92mm and ANSI C39.1 Round cut-outs.
  - b. The meter must display a % of FULL SCALE on the front panel to provide an analog feel. The % FULL SCALE shall have not less than 10 segments.
6. The meter shall be available in transducer only version, which shall not include a display. The transducer version shall mount directly to a DIN rail.
7. The Transducer portion of the meter shall be capable of RS485 Modbus communications.
8. Meter shall be a traceable revenue meter, which shall contain a utility grade test pulse allowing power providers to verify and confirm that the meter is performing to its rated accuracy.
9. The meter shall include 1 independent communications port on the back, with advanced features.

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- a. The port shall provide Modbus TCP/IP protocol.
- 10. The meter shall be capable of operating on a power supply of 90 to 265 Volts AC and 100 to 370 Volts DC. Universal Power AC/DC Supply shall be available. An option shall also be available to operate on a power supply from 18-60 VDC.
  - a. Meter AC/DC power supply shall accept burden of 10VA max.
- 11. Meter shall provide update rate of 100msec for Watts, Var and VA. All other parameters shall be 1 second.
- 12. The meter shall have I/O and communication expandability through two Option card slots on the back.
  - a. The cards shall be capable of being installed in the field, without removing the meter from installation.
  - b. The meter shall auto-detect the presence of any I/O Option cards.
  - c. The Option card slots shall accept I/O cards in all of the following formats: Four channel bi-directional 0-1mA Output Card; Four Channel 4-20mA Output Card; Two Relay Outputs/2 Status Inputs Card; Four Pulses/4 Status Inputs Card.
  - d. The Option card slots shall accept communication cards in the following format: 100BaseT or Fiber Optic Card Ethernet Modbus TCP.
  - e. The meter shall be capable of accepting any combination of up to two cards.
- 13. Operating temperature shall be (-20 to +70) degrees C.
- 14. The meter faceplate shall be rated NEMA 12.
- 15. Power Monitor shall be Electro Industries/GaugeTech Shark200 with INP100S 100BaseT Ethernet (Modbus TCP) and RO1S Relay Output expansion cards, or equal.

I. Current Transformers

- 1. Furnish mounted (preferable) or unmounted current transformers based on space allocated and installation requirements. The current transformer shall have wire leads or binding posts and ratio as shown on the drawings. The accuracy shall be metering accuracy class 0.6 at a minimum burden at 60 hz shall be 2.5 VA and as required to meet specified accuracy of device(s) fed.

### **PART 3: EXECUTION**

#### **3.01 WORKMANSHIP**

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- A. All work in this Section shall conform to the codes and standards specified in Electrical Specifications [Electrical General, Workmanship] and as specified herein.

### 3.02 INSTALLATION

- A. Vertical sections shall be mounted on steel channel sills continuous on two sides. The steel channel sills shall be heavy duty to meet the specific seismic requirements of this project location. These sills shall be mounted on the concrete pad to be installed per the Contract Drawings.
- B. Conduit entering Switchboard shall be stubbed up 1" into the bottom horizontal wireway (typically) directly below the vertical section in which the conductors are to be terminated.
- C. Base of Switchboard shall be adequately grouted, caulked or sealed to prevent the entry of insects and rodents.

### 3.03 FIELD ASSISTANCE

- A. Provide field testing as specified in Electrical Specifications [Electrical General, Testing].

### 3.04 WARRANTY

- A. Provide warranty as specified in Electrical Specifications [Electrical General, Warranty].

## **END OF SECTION**

## **SECTION 16450**

### **GROUNDING**

#### **PART 1: GENERAL**

##### **1.01 SCOPE OF WORK**

- A. Labor, materials, equipment, tools, safety gear, test equipment, incidentals, services, and transportation for a complete electro-mechanical installation as shown on the Drawings, included in these Specifications, or as can be reasonably implied from project descriptions.
- B. The scope of work includes:
  - 1. Furnish and install grounding system required by drawings, or if not shown or defined, as required by Article 250 of the NEC. Ground conductors shall be sized for the protective device, minimum.
  - 2. Furnish and install conduits, junction boxes, underground boxes, and associated hardware. Provide hardware, conduit, fittings, and other parts for a complete grounding installation.
  - 3. Installations shall be designed and installed with components meeting the NEMA area designation.
- C. Work includes that specified in Electrical Specifications [Electrical General].

##### **1.02 REFERENCES**

- A. Electrical Specifications [Electrical General]
- B. Electrical Specifications [Low Voltage Wire & Data Cable]
- C. Project Drawings

##### **1.03 QUALIFICATIONS**

- A. Material furnished under this specification shall be installed by qualified installers meeting requirements specified in Electrical Specifications [Electrical General, Qualifications].

##### **1.04 SUBMITTAL REQUIREMENTS**

- A. Provide submittals and drawings as specified in Electrical Specifications [Electrical General, Submittal Requirements].
- B. Submit manufacturer's product information for connections, clamps, rods, terminals, and grounding system components.

#### **PART 2: PRODUCTS**

##### **2.01 GROUNDING SYSTEM**

- A. General

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1. Grounding conductors shall be sized as shown on the drawings or in accordance with NEC table 250, whichever is larger.
2. Components of the grounding electrode system shall be manufactured in accordance with UL 467 - Standard for Safety Grounding and Bonding Equipment.

B. Grounding System

1. The utility service ground shall be tied to a building ground grid consisting of a "UFER" and/or ground rod type grounding system.
2. The UFER shall consist of minimum 25 feet minimum of code sized bare copper wire conductor laid at 3 foot nominal depth encased with concrete or ground or as detailed on the Contract Drawings. UFER ground shall be located where soil moisture content will be maximized.
3. Ground enhancement material shall be permanent and be designed to lower earth resistance in all soil conditions. Once set, material shall have resistivity of not more than 20 ohm-cm resistance. Material shall be set by mixing it with water to form a slurry and shall not dissolve or decompose once cured. Ground enhancement material shall be Erico Ground Enhancement Material (GEM), Lyncole XIT, or equal.
4. The main ground bonding wire from the ground rod shall extend up into the utility service panel with readily visible UL approved "ground clamp" attached to the ground bus.
5. Install bare copper ground bond wires from the UFER ground to the various locations shown on the drawings.

C. Raceway Grounds

1. Metallic conduits shall be assembled to provide a continuous ground path. Metallic conduits shall be bonded using insulated grounding bushings.

D. Equipment and Enclosure Grounds

1. Electrical and distribution equipment shall be connected to the grounding system. Cables shall be sized as specified.

E. Components

1. Ground rod shall be  $\frac{3}{4}$ " x 10 ft solid steel with 10-mil copper-cladding.
2. Provide ground well enclosures for all outdoor ground rods. Furnish Christy type F8 or equal unless otherwise shown on the drawings.
3. Ground rod clamps shall be bolt-on type as manufactured by O-Z Gedney type GRC, or equal.
4. Grounding and bonding wires shall be installed in all PVC conduits and

nonmetallic raceways and connected to the ground bus and all equipment.

5. Each electrical enclosure shall have a copper ground bus. Screw type fasteners shall be provided on all ground busses for connection of grounding conductors. Ground bus shall be a Challenger GB series, ILSCO CAN series or equal.

### **PART 3: EXECUTION**

#### **3.01 WORKMANSHIP**

- A. All work in this Section shall conform to the codes and standards specified in specified in Electrical Specifications [Electrical General, Workmanship].

#### **3.02 INSTALLATION**

- A. Grounding System:
  1. Install all products per Electrical Specifications [Electrical General, Installation].
  2. Each nonmetallic conduit shall contain a code sized grounding conductor.
  3. The system neutral conductor and all equipment and devices required to be grounded by the National Electrical Code shall be grounded in a manner that satisfies the requirements of the National Code.
  4. The system neutral (grounded conductor) shall be connected to the system's grounding conductor at only a single point in the system. This connection shall be made by a removable bonding jumper sized in accordance with the applicable provisions of the National Electrical Code if the size is not shown on the Drawings. The grounding of the system neutral shall be in the enclosure that houses the service entrance main overcurrent protection.
  5. Utilize mechanical connections in accessible locations and exothermic connections in non-accessible or buried locations.
  6. The secondary on all transformers shall be grounded.
  7. All raceway systems, supports, enclosures, panels, motor frames, and equipment housings shall be permanently and effectively grounded.
  8. Install insulated grounding conductor with feeders and branch circuit conductors in conduits. Size grounding conductors in accordance with NEC. Install from grounding bus of serving panel to ground bus of served panel, grounding screw of receptacles, lighting fixture housing, light switch outlet boxes or metal enclosures of service equipment. Ground conduits by means of grounding bushings on terminations at panelboards and distribution panels with 12ga. conductor to grounding bus



9. All receptacles shall have their grounding contact connected to a grounding conductor.
10. Branch circuit grounding conductors for receptacles or other electrical loads shall be arranged such that the removal of a lighting fixture, receptacle, or other load does not interrupt the ground continuity to any other part of the circuit.
11. Attachment of the grounding conductor to equipment or enclosures shall be by connectors specifically provided for grounding. Mounting, support, or bracing bolts shall not be used as an attachment point for ground conductors.
12. Install grounding electrode conductor and connect to reinforcing steel in foundation footing. Electrically bond building steel to ground system. Bond metal siding not attached to grounded structure.

B. Ductbanks

1. Provide #4/0 AWG bare, stranded ground conductor in approximately the center of the ductbank where shown on plans and for all ductbanks containing cables rated 2kV or greater
2. Ground wire, where required, shall be strapped to a conduit every 5 feet.

3.03 FIELD QUALITY CONTROL

A. Inspections:

1. Engineer shall inspect ground system prior to cover.

B. Testing:

1. Complete applicable test forms if provided in testing specifications [Factory and Field Testing]. If form is not provided, furnish results on a vendor standard form.
2. Test each grounding connection to determine the ground resistance. The grounding test shall be IEEE 81.2 and NETA 7.13. 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 20 feet from the test electrode and ending 80 feet from it, in direct line between the ground rod or center of grid and the current reference electrode.

**END OF SECTION**

## **SECTION 16470**

### **PANELBOARD AND POWER TRANSFORMER**

#### **PART 1: GENERAL**

##### **1.01 SCOPE OF WORK**

- A. The Contractor shall supply panelboards and power transformers as specified herein and as shown in the Contract Drawings.
- B. The Contractor shall perform complete startup and testing services for the panelboard and power transformer per Electrical Specifications [Factory and Field Testing].
- C. Work includes that specified in Electrical Specifications [Electrical General].
- D. Reference drawings for panelboard and transformer location – electrical structures or stand-alone. If within electrical structures, the Contractor shall supply the electrical section with factory installed panelboard and transformer. If stand-alone, the Contractor shall install individual components with enclosures as specified herein.
  - 1. The quantity of breakers with size and number of poles as shown on panelboard schedules.
  - 2. Submittal data and drawings.
  - 3. Startup assistance.
  - 4. Panelboard testing.
  - 5. Operation and maintenance manuals.
  - 6. Warranty of all components of the panelboard and power transformer.

##### **1.02 SUBMITTAL REQUIREMENTS**

- A. Provide submittals and drawings as specified in Electrical Specifications [Electrical General, Submittal Requirements].
- B. Provide ratings and characteristics including voltage, temperature rise, KVA, efficiency, materials of construction, NEMA enclosure rating, voltage taps, and impedance.
- C. Provide catalog cuts for circuit breakers and devices.
- D. Submit panelboard schedule for approval.

##### **1.03 OPERATION AND MAINTENANCE INFORMATION**

- A. Provide operating instructions as specified in Electrical Specifications [Electrical General, Operating and Maintenance Instructions].

#### **PART 2 – PRODUCTS**

##### **2.01 PANELBOARDS**

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A. General

1. The Contractor shall furnish panelboards of a type indicated on the one-line Contract drawings and specified herein.
2. Furnish and install padlock lock-off attachment for each circuit breaker.
3. Panelboards shall comply with the applicable sections of UL, NEC, and NEMA and shall be Cutler Hammer Pow-R-Line, Square D, ITT or equal.
4. A machine-typed circuit directory with clear plastic cover shall be supplied mounted on the inside of door in a frame when equipment is shipped. Circuit directory shall be as approved in the Submittal.

B. Interiors

1. Interiors shall be completely factory assembled with bolt-on devices.
2. Main and feeder breakers shall include lockout padlock hasp suitable for frame size. Provide Cutler Hammer QLPB123PL, PLK1, or similar.
3. Full size insulated neutral bars shall be included. Neutral busing shall have a suitable lug for each outgoing feeder requiring a neutral connection.
4. Main bus bars shall be plated copper sized in accordance with UL standards to limit temperature rise on any current carrying part to a maximum of 50 degrees C above an ambient 40 degrees C maximum.
5. A copper ground and neutral bus shall be included in all panelboards with terminal screws.

C. Boxes

1. Provide minimum gutter space in accordance with the National Electric Code. Where feeder cables supplying the mains of a panel are carried through its box to supply other electrical equipment, the box shall be sized to include the additional required wiring space. At least four interior mounting studs with adjustable nuts shall be provided.

D. Trims

1. Provide a hinged door over all circuit breaker handles. Doors in panelboard trims shall not uncover any live parts. Doors shall have a catch, lock and trim.
2. Surfaces of the trim assembly shall be properly cleaned, primed and a finish coat of gray ANSI 61 or 49 or to Switchboards and MCCs.
3. Surface trims shall be same height and width as box for surface mount, and  $\frac{3}{4}$ " (min) beyond box on all sides for flush mount.

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E. Panelboard Ratings

1. Panelboards shall have voltage, phase and short circuit (AIC) ratings as shown on the drawings.
2. Breakers shall be a minimum of 100 ampere frame. Breakers 15 through 100 amperes trip size shall take up the same pole spacing.
3. Panelboards shall be labeled with a UL short circuit rating. When series ratings are applied with integral or remote upstream devices, a label shall be provided. Series ratings shall cover all trip ratings of installed frames. It shall state the conditions of the UL series ratings including:
  - a. Size and type of upstream device
  - b. Branch devices that can be used
  - c. UL series short circuit rating

2.02 POWER TRANSFORMER

- A. The power transformer shall be ventilated dry type. Voltage and KVA ratings shall be as shown on the Contract Drawings. The transformer shall be as manufactured by Cutler Hammer, Jefferson, ACME, Square D, G.E., or equal.
- B. Transformer shall meet latest NEMA TP-1 and Energy Star efficiency standards.
- C. Coils shall be manufactured of electrical grade aluminum (if stand-alone) or copper (if within a MCC or Switchboard) and shall be adequately braced for short circuit ratings and defined in ANSI and NEMA standards.
- D. Transformers rated 31KVA and above shall have two 2½ percent taps above and below normal full capacity (ANFC and BNFC).
- E. The transformer shall carry full load continuously at rated voltage and frequency without exceeding the average temperature rise of 115°C above an ambient temperature of 40°C. Insulation shall be rated for 220°C (UL class 220°C).
- F. For transformers installed within electrical equipment, vibration isolators shall be installed between the transformer and its mounting surface to reduce case vibration and associated noise.
- G. For stand alone transformers, the transformer housing shall be securely fastened to the mounting surface with bolted connections sized appropriately to withstand seismic zone 4 forces.
- H. The transformer shall be finished with two coats of enamel to resist rust and corrosion.
- I. Transformers located inside electrical structures or enclosures shall be provided with adequate ventilation for heat removal as required.

- J. Transformer neutral shall be grounded in accordance with Article 250-26 and 450-10 of NEC and any applicable local ordinances. Installation and protection of the transformer grounding conductors and attachments shall be per NEC 250-24.

### **PART 3 – EXECUTION**

#### **3.01 WORKMANSHIP**

- A. All work in this Section shall conform to the codes and standards specified in Electrical Specifications [Electrical General, Workmanship].
- B. Perform work to remedy non-compliant installations after inspection.

#### **3.02 INSTALLATION**

- A. Provide installation as recommended by the manufacturer and as specified in Electrical Specifications [Electrical General, Installation].

#### **3.03 FIELD ASSISTANCE**

- A. Provide testing as specified in Electrical Specifications [Factory and Field Testing].

#### **3.04 WARRANTY**

- A. Provide warranty as specified in Electrical Specifications [Electrical General, Warranty].

### **END OF SECTION**

## SECTION 16481

### VARIABLE FREQUENCY DRIVE

#### PART 1: GENERAL

##### 1.01 SCOPE OF WORK

- A. Provide each variable frequency drive as shown on elementary and one-line drawings. Variable frequency drive shall be provided with full speed bypass, harmonic conditioner, line and/or load reactor, RFI filter and/or other accessories where shown on The Drawings. All VFDs shall be of the same manufacturer.
  - 1. The System Integrator shall perform and be responsible for procurement, submittals, shop drawings, testing, and all control wiring for the VFD. System Integrator is defined in Electrical Specifications [Electrical General].
- B. Provide enclosure (and side mounted wire chase as required) for top or bottom feed conduit connection as shown in the drawings. Enclosure size shall not exceed the space allocated in the drawings for such use.
- C. Provide cooling/ventilation system, mounting hardware, associated components, devices, and field control stations. Some components may be specified in other Electrical Specifications such as terminal blocks, wire, buttons, etc.
- D. Installation of the VFD with components as specified in Electrical Specifications [Electrical General]. The VFD scope of work includes:
  - 1. Providing and installing VFD(s) of rating shown on The Drawings.
  - 2. Submittal data and drawings.
  - 3. Startup assistance.
  - 4. Factory and field testing.
  - 5. Operation and maintenance manuals.
  - 6. Warranty of all components.
- E. Startup and configuration of VFD with actual motor load.
- F. Electrical Specifications [Factory and Field Testing]. Furnish all required labor, materials, safety equipment, transportation, test equipment, incidentals and services to perform factory and/or field testing.

##### 1.02 REFERENCES

- A. Electrical Specifications [Electrical General]
- B. Electrical Specifications [Low Voltage Wire & Data Cable]
- C. Electrical Specifications [Factory and Field Testing]

##### 1.03 SUBMITTALS REQUIREMENTS

- A. Provide Submittals as specified in Electrical Specifications [Electrical General,

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Submittal Requirements].

- B. Include a record of each VFD parameter available to be changed by the user. The list shall include factory defaults and space for entered values.

#### 1.04 OPERATING AND MAINTENANCE INFORMATION

- A. Provide operation and maintenance instructions as specified in Electrical Specifications [Electrical General].
- B. Include a record of each VFD parameter setup during startup and testing and place a copy of setting in each O & M manual.

### **PART 2: PRODUCTS**

#### 2.01 GENERAL

- A. All equipment shall be designed for the service intended and shall be of rugged construction, of ample strength for all stresses which may occur during fabrication, transportation, erection, and continuous or intermittent operation. All equipment shall be adequately stayed and braced and anchored and shall be installed in a neat and workmanlike manner. Appearance and safety, as well as utility, shall be given consideration in the design of details. All components and devices installed shall be industrial grade and shall be of sturdy and durable construction suitable for long, trouble-free service. Light duty, fragile, and competitive grade devices of questionable durability shall not be used.
- B. The VFD is inclusive of the input stage, buss, output stage, input filters, output filters, and all other assemblies, boards, or conditioning equipment, that make up the entire VFD system. The VFD system is herein referred to simply as "VFD" and is not to be parsed in any way to meet a specification as a specific part or assembly where it cannot be met as a system.
- C. Products that are specified by manufacturer, trade name, or catalog number establish a standard of quality and do not prohibit the use of equal products of other manufacturers provided they are favorably reviewed by the Owner and/or Engineer prior to installation.
- D. Underwriter's Laboratories (UL) listing is required for all substituted equipment when such a listing is available for the first named equipment.

#### 2.02 QUALITY

- A. All equipment and materials shall be new and the products of reputable suppliers having adequate experience in the manufacture of these particular items. For uniformity, only one manufacturer will be accepted for each type of product.
- B. All equipment shall be designed for the service intended and shall be of rugged construction, of ample strength for all stresses which may occur during fabrication, transportation, erection, and continuous or intermittent operation. All equipment shall be adequately stayed and braced and

anchored and shall be installed in a neat and workmanlike manner. Appearance and safety, as well as utility, shall be given consideration in the design of details. All components and devices installed shall be standard items of industrial grade, unless otherwise noted, and shall be of sturdy and durable construction suitable for long, trouble-free service. Light duty, fragile, and competitive grade devices of questionable durability shall not be used.

- C. Products that are specified by manufacturer, trade name, or catalog number establish a standard of quality and do not prohibit the use of equal products of other manufacturers provided they are favorably reviewed by the Owner and/or Engineer prior to installation.
- D. Underwriter's Laboratories (UL) listing is required for all substituted equipment when such a listing is available for the first named equipment.

## 2.03 VARIABLE FREQUENCY DRIVE

- A. **This specification is based on Allen Bradey 755T, Schneider Altivar 680 with AFE (Active Front End Attenuation), Siemens Robicon W150CP or Eaton Cutler Hammer SVX9000 series with HCU2 (active harmonic filter), or equal.**
- B. The VFD shall be of the latest technology used to control and maintain a process variable (level, flow, pressure, speed, etc.) by varying the motor speed. The VFD shall be available from a single manufacturer in the horsepower range of 1 to 500 HP.
- C. Performance Requirements
  - 1. Harmonic Attenuation (applies to Ultra Low Harmonic (ULH) as shown in drawings)
    - a. The VFD shall have an active filter line supply unit which controls the low order harmonic current or 18 pulse rectifiers to reduce the harmonic current impressed on the incoming power feeder.
    - b. The input current to the VFD shall limit the total harmonic content to less than 5% of the VFD's rated input on any power system and under all operating conditions.
    - c. The VFD shall comply with IEEE 519 requirements.
  - 2. Open loop static speed regulation shall be 0.5 % to 1% of rated motor speed. When motor speed feedback is provided from a suitable encoder, closed loop speed regulation shall be 0.1% of motor nominal speed. Dynamic speed accuracy shall be less than 1%-sec with 100% torque step open loop and 0.5%-sec closed loop with 100% torque step. 2. Torque control response time shall be less than 10 ms with nominal torque. In the torque regulating mode, torque regulating accuracy open loop shall be +/- 5%; torque regulating accuracy closed loop shall be +/- 2%;



#### D. Ratings

1. The VFD shall employ a full wave rectifier to prevent input line notching and operate at a fundamental (displacement) input power factor of 0.98 at all speeds and nominal load.
2. The VFD efficiency shall be 97.5% or better at full speed and load. Efficiency is defined as the output power divided by the input power in terms of percentage. All internal system losses recognized.
3. Load - The VFD shall be designed to continuously operate the following motor/pump load:
  - a. Motor NEMA design B, squirrel-cage induction or specialty specific use motor per Mechanical Division Specification as shown in drawings.
  - b. Horsepower at full speed R.P.M. of submitted/approved motor.
  - c. Voltage, 230/460 VAC, three phase, 60 Hz.
  - d. Service factor, 1.15 S.F.
4. Input Power - The VFD shall be rated to continuously operate under the following input power conditions:
  - a. The Drive shall be rated to operate from 3-phase power at nominal voltage (208VAC to 600VAC, +10% /-15% as shown in drawings), 48Hz to 63Hz.
  - b. The overvoltage trip level shall be a minimum of 30% over nominal, and the undervoltage trip level shall be a minimum 35% under the nominal voltage.
  - c. Three phase, phase rotation insensitive.
  - d. Displacement power factor, 0.95 lagging at all loads and speeds above 10% rated load.
5. Output Power - The VFD shall be rated to continuously operate while providing the following output power conditions:
  - a. Voltage, 0 to 500 VAC.
  - b. Frequency, 3 to 60 Hz.
  - c. Continuous motor horsepower.
  - d. VFD amp output (minimum).
  - e. Continuous current - as shown in drawings or 115% of rated motor nameplate amps, whichever is higher.
  - f. Short term normal current, 110% of continuous rated current for a minimum duration of 1 minute per every 10 minutes running.
  - g. Short term heavy duty overload current, 150% of continuous rated current for a minimum duration of 1 minute per every 10 minutes running.
  - h. Waveform - sine coded PWM.
  - i. The drive's switching pattern shall be continually adjusted to provide optimum motor flux and avoid the high-pitched audible noise.
  - j. Diodes and transistors shall have a minimum withstand of

1,200 peak inverse voltage (PIV).

6. Environmental - The VFD shall be rated to continuously operate under the following environmental conditions:
  - a. Ambient temperature, 5°F to 122°F (-15°C to 50°C).
  - b. Altitude, no derating below 3,300 ft.
  - c. Relative humidity, 95% non-condensing.
  - d. The drive shall be protected from atmospheric contamination by chemical gasses and solid particles per IEC 60721-3-3, chemical gasses Class 3C2 and solid particles Class 3S2.
  - e. The drive shall be protected from vibration per IEC 60721-3-3 Class 3M4 (sinusoidal displacement 3.0 mm, 2Hz to 9Hz; acceleration 10m/s<sup>2</sup>, 9Hz to 200Hz).

E. Protection - The VFD shall be provided with the following protection:

1. For each programmed warning and fault protection function, the Drive shall display a message in complete English words or Standard English abbreviations. The three (3) most recent fault messages along with time, current, speed, voltage, frequency and DI Status shall be stored in the Drive's fault history. The last ten (10) fault names shall be stored in Drive memory.
2. The Drive shall include internal MOV's for phase to phase and phase to ground line voltage transient protection.
3. Output short circuit withstand rating and ground fault protection rated for 100,000 AIC shall be provided per UL508C without relying on line fuses. Motor phase loss protection shall be provided.
4. The Drive shall provide electronic motor overload protection qualified per UL508C.
5. Protection shall be provided for AC line or DC bus overvoltage at 130% of max. rated or undervoltage at 65% of min. rated and input phase loss.
6. A power loss ride through feature will allow the Drive to remain fully operational after losing power as long as kinetic energy can be recovered from the rotating mass of the motor and load.
7. Stall protection shall be programmable to provide a warning or stop the Drive after the motor has operated above a programmed torque level for a programmed time limit.
8. Underload protection shall be programmable to provide a warning or stop the Drive after the motor has operated below a selected underload curve for a programmed time limit.
9. Over-temperature protection shall provide a warning if the power module temperature is less than 5°C below the over-temperature trip level.

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10. The VFD shall constantly monitor the load current with an electronic thermal overload relay and trip the drive on motor overload. The electronic overload relay shall be adjustable and compensate for the reduced cooling of the motor at reduced speeds. This protection provides an orderly shutdown should the motor's thermal capabilities be exceeded and eliminates the requirement for conventional motor overload relays.
- F. Digital programmer/controller –The VFD shall be equipped with a front mounted operator control panel (keypad) consisting of a backlit, alphanumeric, graphic display and a keypad with keys for Start/Stop, Local/Remote, Up/Down and Help. Two (2) Softkeys will be provided which change functionality depending upon the position within the parameter hierarchy or state of panel.
1. All parameter names, fault messages, warnings and other information shall be displayed in complete English words or standard English abbreviations to allow the user to understand what is being displayed without the use of a manual or cross-reference table.
  2. The Display shall have contrast adjustment provisions to optimize viewing at any angle.
  3. The control panel shall provide a real time clock for time stamping events and fault conditions.
  4. The control panel shall include a feature for uploading parameter settings to control panel memory and downloading from the control panel to the same Drive or to another Drive.
  5. All Drives throughout the entire power range shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating.
  6. The keypad is to be used for local control, for setting all parameters, and for stepping through the displays and menus.
  7. The keypad shall be removable and insertable under Drive power, capable of remote mounting, and shall have its own non-volatile memory.
  8. Digital Programmer/Controller (HIM) shall be capable of remote door mounting. Cable for remote digital programmer/controller shall be supplied as shown in the drawings. The HIM shall be mounted and housed to maintain the NEMA 12 door rating.
  9. The standard operator panel shall provide a start-up, maintenance and diagnostic assistants that guides a new user through initial start-up and commissioning of the Drive as well as provide indications for maintenance and help to diagnose a fault. In addition, a PID assistant, Real-time Clock assistant, Serial Communications assistant, and Drive Optimizer assistant shall be included. A Drive Optimizer assistant permits the user to choose Drive set-up for low noise, drive & motor

efficiency or motor control accuracy.

10. The door mounted human interface module (HIM) display shall be capable to view and adjust the following diagnostic and status indicators:
    - a. VFD Speed % or Frequency
    - b. Instantaneous overcurrent.
    - c. Ground fault.
    - d. Overtemperature.
    - e. Overvoltage.
    - f. Undervoltage.
    - g. Overload.
    - h. Overfrequency.
    - i. Amps.
    - j. Voltage.
    - k. Temperature.
    - l. Auxiliary Fault.
    - m. Phase loss.
    - n. Current limit.
    - o. Power and kilowatt hours
    - p. Power up delay.
    - q. Status of discrete inputs and outputs.
    - r. Values of analog input and output signals
    - s. Values of PID controller reference, feedback and error signals.
  11. Adjustments - The following setting ranges shall be provided and made independently accessible for operator adjustment:
  12. Speed/Torque control functions shall include:
    - a. Minimum speed/torque limits.
    - b. Maximum speed/torque limits.
    - c. Selection of up to seven (7) preset speed settings or external speed control
    - d. Two (2) independent built-in PID controllers to control a process variable such as pressure, flow or fluid level.
    - e. Two (2) analog inputs shall be programmable to form a reference by addition, subtraction, multiplication, minimum selection or maximum selection.
  13. Output control functions shall include:
    - a. Current and torque limit adjustments to limit the maximum Drive output current and the maximum torque produced by the motor. These limits shall govern the inner loop torque regulator to provide tight conformance with the limits with minimum overshoot.
    - b. A torque regulated operating mode with adjustable torque ramp up/down and speed/torque limits.
- G. Input and Output Terminations - The VFD shall have terminals for input and output cabling as defined in the Conduit and Wire Schedule as shown on the Contract Electrical Drawings.

1. Provide power terminal blocks for motor lead connections where drive terminals are hard to reach or require drive cabinet disassembly to connect.
  2. Five (5) digital inputs, all independently programmable with at least twenty-five (25) input function selections. Inputs shall be designed for 120 volts AC input or as otherwise shown in the drawings. Input functions must include time delay start and hand and auto (Ethernet) control.
  3. Two (2) form C relay contact digital outputs, all independently programmable with at least thirty (30) output function selections. Relay contacts shall be rated to switch a maximum two (2) Amps rms continuous current at a maximum switching voltage of 30VDC or 250VAC. Function selections shall include indications that the drive is ready (no faults and in remote), running, and are addressable from Ethernet as users choice.
  4. Two (2) analog inputs, each selectable for 0VAC - 10VAC or 4mA - 20mA, and independently programmable with at least ten (10) input function selections. Analog input signal processing functions shall include scaling adjustments, adjustable filtering and signal inversion. If the input reference (4-20mA or 0-10V) is lost, the VFD shall give the user the option of the following: (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The Drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus.
  5. Two (2) analog outputs providing 0 (4) to 20mA signals. Outputs shall be independently programmable to provide signals proportional to at least twelve (12) output function selections including output speed, frequency, voltage, current and power.
  6. Provide I/O input and relay output expansion card(s) as needed to accommodate the I/O wiring as shown in the drawings. The option card shall be integrally mounted to the drive.
- H. Communications – The VFD shall include communications module for interface to the PLC. All settable parameters and instantaneous operational registers shall be accessible from the communications port.
1. Type
    - a. Modbus TCP (Schneider Automation Standard)
  2. Add-On Instructions
    - a. The VFD manufacturer must have an add-on instruction that is compatible with the PLC on this project. The add-on instruction provides a preconfigured message command to send and receive information from the drive. The add-on instruction must be a free download available from the manufacturer

website at the time of bid and thereafter.

3. Command and Metering registers to include:
  - a. Digital input reads (giving status of inputs)
  - b. Digital output commands (to relay DOs)
  - c. 3 phase voltage and current
  - d. Power in KW, KWH and Power factor
  - e. Elapsed motor run time
  - f. Start/Stop
  - g. Running
  - h. Fault conditions
  - i. Heat Sink Temperature
  - j. Others as available.

I. Features - The VFD shall have the following features:

1. Connection of the three incoming line leads and three-motor leads shall be the only connections necessary for manual operation of the VFD unit. All other wiring shall be prewired at the factory and self-contained within the VFD unit. A 120 VAC control power transformer and other auxiliary power supplies shall be provided with the VFD for power to pilot lights, meters, relays, and miscellaneous devices specified to be supplied with the VFD. Lugs shall be provided for connection of all power leads; terminal blocks shall be provided for all other wiring. Relay logic, wiring and enclosure layout shall be equivalent to that shown on the Drawings.
2. The VFD shall be protected by a circuit breaker disconnect unless otherwise shown in the drawings. The disconnect shall be externally operated and shall have an operator mechanism that is an integral part of the enclosure. An operator mechanism shall be provided to allow padlocking the disconnect in the "off" position with up to two padlocks.
3. AC input fuses shall be provided on the line and/or load side of the VFD (if required by the manufacturer) to isolate the VFD power circuitry upon a fault condition.
4. The VFD shall be capable of sensing load outside of normal range. A User Load Curve with range settings shall be available to be configured. If the motor horsepower as a function of speed is not within a predefined range, then an alarm shall be set within a setpoint delay. The alarm may be configured to shut down the drive and/or set a digital output for connection to a indicating light or PLC. The intent of this alarm is to protect the machine or pump from operating with a broken shaft, or clog, or flow restriction, or similar condition.
5. Three (3) programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed.
6. Transient and surge voltage power line input protection shall be provided for the VFD through use of metal oxide varistors (MOVs), surge protective module, or other approved equal methods. Transient

protection integral to the VFD shall be provided to a minimum of 10,000 volts, 50 joules without failure. The transient protection shall meet or exceed ANSI C7, 90-1971 and IEEE 472-1974 Standards without failure. Failure is defined as loss of components in the VFD including power semiconductors and fuses. The VFD shall be protected from the following, as a minimum, power line transients and recover to automatically restart and resume normal operation without posting a fault:

- a. Switching the primary of a power transformer.
  - b. Switching power factor correction capacitors "ON" and "OFF" line.
  - c. De-energization or energization of contactors, relays, and other power equipment from the power line.
  - d. Starting and stopping of other motors when powered from Utility.
7. The VFD shall not be affected by or generate excessive electro-magnetic interference (EMI). The VFD shall be provided with a radio interference filter (RIF) to meet the following requirements:
- a. The use of a 4 Watt hand-held VHF/UHF transceiver within three feet of the VFD with its doors closed shall not cause erratic operation, loss of configuration, or any other deviation from normal operation.
  - b. The worst case conducted and radiated EMI generated by the VFD shall not be enough to prevent the use of hand held VHF-UHF transceivers within three feet of the VFD with its doors closed.
8. Opening of the VFDs input switches, circuit breakers, or output contactors while the VFD is operating under load shall not result in damage to the VFD power or control circuit components.
9. The VFD shall be capable of starting and operating without a motor load connected.
10. Phase loss protection shall be provided to prevent single phasing of the motor load.
11. The VFD shall have an instantaneous electronic trip circuit to protect the VFD from output line-to-line and line-to-ground short circuits. Output line-to-line and line-to-ground short circuits shall not damage the VFD.
12. Automatic fault reset to automatically restart the drive after any type of fault condition. This automatic restart shall repeat up to three attempts. This automatic reset shall be provided to prevent a drive fault from completely locking out on isolated nuisance fluctuations. When the drive is locked out after its automatic reset attempts the operator shall be able to reset the VFD by a local or remote manual reset pushbutton. Fault lockout shall be indicated on the door

mounted drive fail pilot light.

13. The VFD shall be capable of continued operation during an intermittent loss of incoming line power up to five cycles.
  14. The VFD shall automatically restart upon reapplication of power after a loss of line power. Momentary or sustained power failures shall not fault trip out the VFD or blow any fuses.
  15. Any configuration of adjustments or controls not set by a switch or potentiometer shall be stored in nonvolatile memory. No configuration information shall be lost due to power failures of any duration.
  16. The VFD shall be capable of starting into a rotating motor without tripping out on a fault.
  17. The drive shall have an adjustable voltage boost control capable of providing additional starting torque to the motor at start. This control shall provide the additional voltage only at the frequency range required to start the motor thus reducing the additional motor heating excess voltage would cause at normal operating speeds.
  18. The drive shall be equipped with critical frequency jump circuitry which allows the VFD to be setup to skip two bands of frequencies which cause excessive vibration or noise.
- J. Enclosure - The enclosure type shall be as shown in the drawings - freestanding, wall mount, motor control center full section, or MCC cubicle mount construction. All components shall be accessible from the front of the enclosure. Rear or side access shall not be required in order to remove or service any component. The enclosure shall include the following in its construction:
1. The VFD shall incorporate thermostat/run controlled fans for cooling. The air flow through the VFD compartment shall provide proper cooling of the operating VFD at an (external cabinet) ambient temperature of 104°F. Fan mounting shall include reusable air filters on suction. Provide fans for suction and discharge vents as required maintaining air flow and forcing circulation.
  2. Provide specific use fans located within the enclosure to cool, directly, specific components such as line filters or DV/DT filters.
  3. Thermostat shall have bi-metallic adjustable set point range of 30° to 140°F. Thermostat shall have a switching capacity of 10A at 120 VAC. Provide Hoffman A-TEMNO temperature switch or approved equal to operate fans. Thermostat shall operate fans in parallel with motor running output of VFD.
  4. The VFD, including the enclosure and input protection, shall be UL listed for a minimum of 42,000 RMS symmetrical ampere fault withstand capability. VFDs consisting of the VFD, enclosure, and all accessories, that are not UL listed will not be approved.

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## **PART 3: EXECUTION**

### **3.01 WORKMANSHIP**

- A. All work in this Section shall conform to the codes and standards specified in Electrical Specifications [Electrical General, Workmanship].
- B. Requirements of Related Electrical Sections apply to design, documentation construction and assembly of Variable Frequency Drives.
- C. Perform work to remedy non-compliant installations after inspection.

### **3.02 FIELD ASSISTANCE**

- A. Testing, checkout and start-up of the variable frequency drive equipment shall be performed under the technical direction of a factory trained authorized manufacturer representative.
  - 1. The setup and programming of the VFD shall be provided by a factory-trained representative who is authorized by the VFD manufacturer to perform the startup. This setup and programming shall be done prior to and during the first application of power to the motor. The VFD electronic motor overload protection shall be set to meet the motor nameplate and NEC Code requirements.
  - 2. Provide testing as specified in Electrical Specifications [Factory and Field Testing].
- B. Provide 1 hour of "VFD Setup" Training on operating and maintenance procedures.

### **3.03 WARRANTY**

- A. Provide warranty as specified in Electrical Specifications [Electrical General; Warranty].

**END OF SECTION**

## **SECTION 16482**

### **SOLID STATE SOFT STARTER**

#### **PART 1: GENERAL**

##### **1.01 SCOPE OF WORK**

- A. Provide each Solid State Starter (SSS) drive as shown on elementary and one-line drawings. All SSSs shall be of the same manufacturer.
- B. Provide enclosure (and wire chase as required) for top or bottom feed conduit connection as shown in the drawings. Enclosure size shall not exceed the space allocated in the drawings for such use.
- C. Provide cooling/ventilation system, mounting hardware, associated components, devices, and field control stations. Some components may be specified in other Electrical Specifications such as terminal blocks, wire, buttons, etc.
- D. The SSS scope of work includes:
  - 1. Providing and installing SSS(s) of rating shown on Contract Drawings.
  - 2. Submittal data and drawings.
  - 3. Startup assistance.
  - 4. Factory and field testing.
  - 5. Operation and maintenance manuals.
  - 6. Warranty of all components.
- E. Startup and configuration of SSS with actual motor load.
- F. Electrical Specifications [Factory and Field Testing]. Furnish all required labor, materials, safety equipment, transportation, test equipment, incidentals and services to perform factory and/or field testing.

##### **1.02 REFERENCES**

- A. Electrical Specifications [Electrical General]
- B. Electrical Specifications [Low Voltage Wire & Data Cable]
- C. Electrical Specifications [Factory and Field Testing]

##### **1.03 SUBMITTALS REQUIREMENTS**

- A. Provide Submittals as specified in Electrical Specifications [Electrical General, Submittal Requirements].
- B. Include a record of each SSS parameter available to be changed by the user. The list shall include factory defaults and space for entered values.

##### **1.04 OPERATION AND MAINTENANCE INFORMATION**

- A. Provide operation and maintenance instructions as specified in Electrical

Specifications [Electrical General].

- B. Include a record of each SSS parameter setup during startup and testing and place a copy of setting in each O & M manual.

## **PART 2: PRODUCTS**

### **2.01 QUALITY**

- A. It is the intent of the Contract Specifications and Drawings to secure the highest quality in all materials and equipment in order to facilitate operation and maintenance of the facility. All equipment and materials shall be new and the products of reputable suppliers having adequate experience in the manufacture of these particular items. For uniformity, only one manufacturer will be accepted for each type of product.
- B. All equipment shall be designed for the service intended and shall be of rugged construction, of ample strength for all stresses which may occur during fabrication, transportation, erection, and continuous or intermittent operation. All equipment shall be adequately stayed and braced and anchored and shall be installed in a neat and workmanlike manner. Appearance and safety, as well as utility, shall be given consideration in the design of details. All components and devices installed shall be standard items of industrial grade, unless otherwise noted, and shall be of sturdy and durable construction suitable for long, trouble-free service. Light duty, fragile, and competitive grade devices of questionable durability shall not be used.
- C. Products that are specified by manufacturer, trade name, or catalog number establish a standard of quality and do not prohibit the use of equal products of other manufacturers provided they are favorably reviewed prior to installation.
- D. Underwriter's Laboratories (UL) listing is required for all substituted equipment when such a listing is available for the first named equipment.

### **2.02 SOLID STATE SOFT STARTER**

- A. General:
  - 1. Each solid state soft starter (SSS) shall be provided as a standalone system as an integral unit. The SSS shall be of the latest technology used exclusively for starting motors of the voltage and horsepower shown in the drawings by limiting the voltage and/or current provided to the motor. The SSS shall be available from a single manufacturer in the horsepower range of 1 to 500. The SSS shall be microprocessor controlled and use high efficiency gated power Silicon Controlled Rectifiers (SCRs). The SSS shall be an Allen-Bradley or Square D with soft stop pump control and Ethernet communication module, or approved equal.
  - 2. The SSS shall feature the following selectable motor starting/stopping modes:

- a. Internal bypass contactor - The SSS shall have an internal running load rated full voltage contactor. The contactor shall automatically engage when the SSS has completed the ramp start of the motor. The bypass contactor shall automatically disengage at the beginning of the ramp stop of the motor. The voltage across the bypass contactor while engaged shall be less than 0.1 volts.
  - b. Soft Start – The motor shall be raised to an initial torque value that is programmable from 0-90% of locked rotor torque. The motor voltage is gradually increased during the acceleration ramp time, which is adjustable from 0-30 seconds.
  - c. Soft Start with Selectable Kickstart – The kickstart, or voltage boost, is in addition to the normal soft start as described above. The soft starter shall provide a 0-2 second (selectable) current pulse equal to 550% of the motors full load current.
  - d. Current Limit Start – This starting mode will limit the maximum starting current supplied to the motor during starting. The user shall be able to adjust the current limit from 50% to 600% of full load current.
  - e. Full voltage Start- This mode will provide full voltage and current to the motor with a 1/4 second ramp.
  - f. Soft Stop – This feature will linearly ramp down the voltage over a time interval of 0-60 seconds (selectable)
  - g. Pump Control – This optional mode (required as specified herein) provides non-linear voltage ramp starting and stopping to smoothly accelerate and decelerate the motor. The starting time shall be programmable from 0-30 seconds and the stopping time programmable from 0-120 seconds.
- B. Load - The SSS shall be designed to continuously operate the following motor/pump load:
- 1. Motor, squirrel-cage induction.
  - 2. Pump, per Mechanical Division Specification.
  - 3. Horsepower, at Full speed R.P.M. of supplied motor.
  - 4. Voltage, 460 VAC, three phase, 60 cycle.
  - 5. Service factor, 1.15 S.F.
- C. Input Power - The SSS shall be rated to continuously operate under the following input power conditions:
- 1. Voltage, VAC as shown in Contract one-line diagram, +10%, -10%.
  - 2. Frequency, 60 Hz.
  - 3. Three phase.
- D. Output Power - The SSS shall be rated to continuously operate while providing the following output power conditions:

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1. Voltage, 0 to 460 VAC.
  2. Frequency, 60 Hz.
  3. SSS amp size (minimum) as shown on Contract one-line drawing.
  4. Continuous motor horsepower.
  5. Continuous current, 125% of rated motor nameplate Amps.
- E. Environmental - The SSS shall be rated to continuously operate under the following environmental conditions:
1. Ambient temperature, 32°F to 122°F (0°C to 50°C).
  2. Altitude, no derating below 3,300 ft.
  3. Relative humidity, 95% non-condensing.
- F. Digital programmer/controller –The SSS shall be provided with a door mounted alpha-numeric human interface module (HIM) digital display with keypad to view and adjust the following diagnostic and status registers:
1. Volts AC per phase.
  2. Current per phase.
  3. Watts.
  4. KWH.
  5. Power Factor.
- G. Adjustments - The following setting ranges shall be provided and made independently accessible for operator adjustment:
1. Overvoltage level/delay.
  2. Undervoltage level/delay.
  3. Current unbalance level/delay.
  4. Underload level/delay
  5. Phase reversal
  6. Jam level/delay.
  7. Starts per hour.
  8. Backspin delay.
  9. Ramp times (start and stop).
  10. Motor code letter
  11. Overload class
  12. Motor FLA
  13. Motor Service Factor.
- H. Input and Output Terminations - The SSS assembly shall have terminals for input and output cabling as defined in the Conduit and Wire Schedule as shown on the Contract Electrical Drawings.
- I. Communications – The SSS shall include an Ethernet TCP/IP communications module for interface to the PLC. All settable parameters and instantaneous operational registers shall be accessible from the communications port. The VFD supplier shall assist the Operator Station Programmer in configuration and commissioning of communications.
1. Metering registers to include:
    - a. 3 phase voltage and current

- b. Power in KW, KWH and Power factor
- c. Elapsed motor run time

J. Features - The SSS assembly shall have the following features:

1. Bypass Contactor Control - The SSS shall be capable of controlling a bypass motor contactor to allow motor current to flow around the soft starter, through the contactor, and to the motor. Once the motor is up to speed, the contactor shall be closed and held until a fault or stop command. In this mode, no current will flow through the soft starter power terminals but shall remain in the "on" state. An external current sensing module shall monitor the motor current to maintain the diagnostic, fault and control functions. Upon shutdown, the bypass contactor shall open and allow the soft starter to ramp down the motor. Provide sensing module as required per one-line or elementary diagram.
2. Phase rebalance – If enabled, the soft starter shall monitor the incoming three-phase line voltage and automatically adjust the output voltage to balance the three phase currents drawn by the motor.
3. Connection of the three incoming line leads and three-motor leads shall be the only connections necessary for manual operation of the SSS unit. All other wiring shall be prewired at the factory and self-contained within the SSS unit. A 120 VAC control power transformer and other auxiliary power supplies shall be provided with the SSS assembly for power to pilot lights, meters, relays, and miscellaneous devices specified to be supplied with the SSS. Lugs shall be provided for connection of all power leads; terminal blocks shall be provided for all other wiring.
4. The SSS shall be protected by a circuit breaker disconnect. The disconnect shall be externally operated and shall have an operator mechanism that is an integral part of the enclosure. An operator mechanism shall be provided to allow padlocking the disconnect in the "off" position with up to two padlocks.
5. AC input fuses shall be provided on the line and/or load side of the SSS (if required by the manufacturer) to isolate the SSS power circuitry upon a fault condition.
6. Transient and surge voltage power line input protection shall be provided for the SSS through use of metal oxide varistors (MOVs), surge protective module, or other approved equal methods. Transient protection integral to the SSS shall be provided to a minimum of 1,600 volts, 220 joules without failure. The transient protection shall meet or exceed ANSI C7, 90-1971 and IEEE 472-1974 Standards without failure. Failure is defined as loss of components in the SSS including power SCRs and fuses. The SSS shall be protected from the following, as a minimum, power line transients and recover to automatically restart and resume normal operation without posting a fault:
  - a. Switching the primary of a power transformer.

- b. Switching power factor correction capacitors "ON" and "OFF" line.
  - c. De-energization or energization of contactors, relays, and other power equipment from the power line.
  - d. Starting and stopping of other motors when powered from Utility.
- 7. Opening of the SSS's input switches, or breakers while the SSS is operating under load shall not result in damage to the SSS power or control circuit components.
- 8. The SSS shall be capable of starting and operating without a motor load connected.
- 9. Phase loss, reversal, undervoltage, overvoltage, and unbalance motor protection shall be provided built in to the SSS.
- 10. External motor overload protection shall be required per drawings. External overload shall be solid state and adjustable. Provide Allen Bradley SMP-3 or equal.
- 11. Any configuration of adjustments or controls not set by a switch or potentiometer shall be stored in nonvolatile memory. No configuration information shall be lost due to power failures of any duration.
- 12. The SSS shall be capable of starting into a rotating motor without tripping out on a fault.
- 13. Digital Programmer/Controller (HIM) shall be provided and remote door mounted. Remote serial interface shall be suitable for communication via Allen-Bradley standard protocol. Cable for remote digital programmer/controller shall be supplied. The remote controller shall be mounted and housed to maintain the NEMA 12 door rating.
- 14. Laptop programming connectivity shall be provided to access the drives internal parameters. Provide a USB or RS232 serial converter device and cable for connection to the laptop. Provide programming software as necessary to allow upload/download of data parameters and view current drive status. Provide Allen Bradley Drive Tools software and 1203 USB converter, or approved equal to match drive being submitted.
- K. Enclosure - The enclosure shall be free standing, and stand-alone as shown on the drawings. All components shall be accessible from the front of the enclosure. Rear or side access shall not be required in order to remove or service any component. The enclosure shall include the following in its construction:
  - 1. The SSS shall incorporate fans for cooling. The air flow through the SSS compartment shall provide proper cooling of the operating SSS at an ambient temperature of 104° F. The thermostat shall be monitor and regulate air temperature in the SSS enclosure. Thermostat shall have bi-metallic adjustable set point range of 30 to 140° F.

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Thermostat shall have a switching capacity of 10A at 120 VAC. Provide Hoffman A-TEMNO temperature switch or approved equal to operate fans.

2. The complete SSS unit, including the enclosure assembly, shall be UL listed for a minimum of 42,000 RMS symmetrical ampere fault withstand capability or as otherwise shown on the drawings. SSS assemblies consisting of the SSS, enclosure and all accessories that are not UL listed will not be approved.

### **PART 3: EXECUTION**

#### **3.01 WORKMANSHIP**

- A. All work in this Section shall conform to the codes and standards specified in Electrical Specifications [Electrical General, Workmanship].
- B. Requirements of Related Electrical Sections apply to design, documentation construction and assembly of Solid State Soft Starters.
- C. Perform work to remedy non-compliant installations after inspection.

#### **3.02 FIELD ASSISTANCE**

- A. Testing, checkout and start-up of the solid state starter equipment shall be performed under the technical direction of a factory trained authorized representative.
  1. The setup and programming of the SSS shall be provided by a factory-trained representative who is authorized by the SSS manufacturer to perform the startup. This setup and programming shall be done prior to and during the first application of power to the motor. The SSS electronic motor overload protection shall be set to meet the motor nameplate and NEC Code requirements.
  2. Provide testing as specified in Electrical Specifications [Factory and Field Testing].
- B. Provide 1 hour of "SSS Setup" Training on operating and maintenance procedures.

#### **3.03 WARRANTY**

- A. Provide warranty as specified in Electrical Specifications [Electrical General, Warranty].

END OF SECTION

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## **SECTION 16600**

### **FACTORY AND FIELD TESTING**

#### **PART 1: GENERAL**

##### **1.01 SCOPE OF WORK**

- A. This division defines factory and field testing requirements of electrical and instrumentation equipment and as specified in this section and in Electrical Specifications. All equipment provided under Electrical Specifications and electrical equipment provided under other sections shall be tested as specified herein.
- B. The Electrical Contractor shall coordinate at no additional cost to the Owner, the services of an approved qualified third party independent testing company for the purpose of performing specific tests as outlined in EXECUTION, Field Test of this section.
- C. The System Integrator, Testing Company and/or Electrical Contractor shall provide all labor, tools, material, power, and technical supervision to perform the specified tests and inspections.
- D. The Electrical Contractor shall be present during field testing and assist the System Integrator and/or Testing Company in testing all equipment. The Electrical Contractor shall be ready to correct any wiring problems found during testing.
- E. The Application Programmer (defined in Electrical Specifications [Electrical General].) and/or Construction Manager will be actively engaged in Operational Testing and Commissioning. These efforts shall be combined efforts of the Application-Programmer/Construction-Manager/Engineer and Contractor. The Contractor shall facilitate test as outlined herein such that hardware, software and application programming are tested completely and all applicable test documentation is completed.
  - 1. Expect that field testing of plant operational testing, SCADA and PLC checkout, is going to require 2 weeks after pre-operational tests are done. Contractor and System Integrator shall assist in this start-up. Coordinate with Owner Representative to schedule this start-up period.
- F. It is the intent of these tests to ensure that all equipment is operational within industry and manufacturer's tolerances and is assembled in accordance with design plans and Specifications.
- G. All tests shall be documented in writing by the person performing the test on the test forms submitted (and similar to those shown at the end of this section) and signed by the Engineer as satisfactorily completed. The Testing Company, Electrical Contractor or System Integrator performing tests shall keep a detailed log of all tests that failed or did not meet Specifications, including date of occurrence and correction.
- H. The Contractor shall perform all applicable testing of Owner supplied or

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existing equipment as a unit and as part of a system. Testing shall include documentation and witness sign-off.

## 1.02 REFERENCES

- A. Electrical Specifications [Electrical General]
- B. Project Drawings
- C. Additional testing may be specified in other Electrical Specifications.

## 1.03 FACTORY AND FIELD GENERAL REQUIREMENTS

### A. Testing General

- 1. Prior to any field testing Operation & Maintenance Manuals shall have been submitted and approved.
- 2. The test forms shall be completed by the contractor during testing and calibration of all equipment. All tests shall be witnessed by the Owner's Representative. Completed test forms shall be given to the Owner's Representative the day of the test. Complete two sets of test forms if Contractor wants to keep a copy.
- 3. The Contractor shall give the Engineer 10 working days notice of the dates and time for inspections and testing.
- 4. Include test results in the Maintenance and Operational Manual.
- 5. As a minimum, all the tests indicated/specified on the test forms shall be performed and test forms filled out by the Contractor.
- 6. Prepare and submit formal test procedures and forms at least two weeks prior to the start of testing. Testing shall not commence until the test procedures have been reviewed and approved. Submit a combined test procedure submittal with separate sections for factory and field tests.
- 7. If the results of any of tests are unacceptable, the Contractor shall make corrections and perform the tests again until they are acceptable; these tests shall be done at no additional cost.

### B. Failure to Meet Test

- 1. Any system, material or workmanship which is found defective on the basis of these tests shall be reported immediately following the test. The Contractor shall replace the defective material or equipment and have tests repeated.

### C. Safety

- 1. Testing shall conform to the respective manufacturer's recommendations. All manufacturers' safety precautions shall be followed.
- 2. Safety, as shown herein and in other divisions, shall be a combination

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of all methods and practices described. Safety practices may not be determined based on the least restrictive requirement, but instead, on the most restrictive requirement. Obtain clarification if there is any question prior to performing tests.

3. The procedures stated herein are guidelines for the intended tests, the Contractor shall be responsible to modify these tests to fit the particular application and ensure personnel safety. Absolutely no tests shall be performed in such a fashion that personnel safety is jeopardized.
4. The Contractor shall have two or more personnel present at all tests.
5. Two non-licensed portable radios shall be provided by the Contractor for use during testing.
6. Contractor shall comply with California Electrical Safety Orders (ESO) and Occupational Safety and Health Act (OSHA): All test and procedures shall comply with ESO and OSHA as to safety, protective clothing, clearances, padlocks and barriers around electrical equipment energized during testing.
7. The first set of tests to be performed (**pre-energization**) shall determine the suitability for energization and shall be completed with all power turned off.

#### 1.04 QUALIFICATIONS

##### A. Testing Company

1. Testing company shall have been actively engaged in the type of electrical testing specified in this Division for the past three years (minimum). The Testing Company representative shall have two years experience in field testing of equipment working for the Testing Company or equivalent. The following Electrical Testing Companies are pre-approved.
  - a. EETS (916) 339-9691
  - b. Industrial Test (888)-809-8550
  - c. Emerson Electrical Reliability Services
  - d. Apparatus Testing and Engineering (916) 853-6280
  - e. Apparatus Testing and Engineering (925) 454-1363
  - f. Power Systems Testing (925) 583-2361
2. Testing Companies not listed are required to submit company and individual representative resumes for review and approval.

##### B. System Integrator Representative

1. The system integrator representative shall have 1 year experience in field testing of equipment working for the System Integrator or equivalent. If the representative does not demonstrate necessary experience or competence during testing or start-up, the System

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Integrator shall provide a representative meeting the required competence and experience.

C. Electrical Contractor Representative

1. The Electrician shall have 5 years minimum experience working with industrial control systems and have a Journeyman level experience rating.

1.05 SUBMITTAL REQUIREMENTS

- A. The Contractor shall ensure that the Testing Company, System Integrator, and all equipment suppliers provide the submittal documentation required in this section. Submittals shall be complete, neat, orderly, and indexed. The Contractor shall check all submittals required under this Division for the correct number of copies, adequate identification, correctness, and compliance with the Contract Specifications and Drawings, and initial all copies certifying compliance.
- B. The System Integrator shall assemble and submit for approval complete testing procedures and forms at least two weeks prior to the start of testing. Contractor is responsible for compiling testing procedures and forms from multiple sub-contractors as required.
- C. Test submittal shall include: (as applicable)
  1. Proposed procedure for operational testing whether it is performed in the factory or field. Procedure shall include method, simulated I/O requirements, bypass piping, telemetry, and necessary materials and equipment to conduct test.
  2. Test forms (for all tests, factory and field, and regardless of who performs tests). Test forms shall be electronically completed prior to submittal with entry spaces filled to the extent possible. The only remaining data that shall require completion during the test is the test data itself. Test forms shall be provided as illustrated at the end of this section or equal.
  3. Approved shop one-line, elementary diagrams and PLC I/O drawings.
  4. Control strategies photocopied at 75% reduction with room at the side of page for comments on each paragraph or control strategy.

**PART 2: PRODUCTS**

2.01 TEST EQUIPMENT

- A. Test equipment required to perform testing and document results shall be provided by Contractor, Testing Company or System Integrator.
- B. Test instruments shall be calibrated to references traceable to the National Institute of Standards and Technology. Instrument calibration shall be current to one year from date of start-up. Test equipment accuracy shall be at

least twice the accuracy of instrument being calibrated. Test instrument certificates of calibration shall be on-hand and provided prior to testing.

- C. All test equipment to be used as part of the testing shall be listed in the submitted testing sheets. Contractor supplying the component or system to be tested shall provide all necessary test equipment.
- D. The overall accuracy of each input and output loop shall be checked to ensure that it is within manufacturer's Specification tolerances. In no case shall the error exceed 0.25% or 0.04 mA.

### **PART 3: EXECUTION**

#### **3.01 FACTORY TESTING**

##### **A. General Requirements**

1. The System Integrator shall conduct a thorough and complete factory test witnessed by Engineer per the criteria specified herein. Factory test shall be held within 150 miles of project location.
2. Temporary wiring and equipment shall be provided and connected during these tests to simulate the complete assembled system.
3. The testing shall not be started until the manufacturer has completed fabrication, wiring, setup, programming; quality control testing; and can demonstrate the system is complete and operational.
4. The equipment required for factory testing shall consist of, but is not limited to, control panels, MCCs, and/or miscellaneous electrical panels as provided under this contract.
5. Two digital multimeters/signal generators (minimum +/- 0.1% accuracy) with clip-on leads shall be supplied and utilized during testing for measurement of digital and analog outputs.
6. All factory tests shall be conducted at the System Integrator's facility. All factory tests shall be completed prior to shipment to the jobsite. The equipment shall be fully assembled, and connected (and programmed) similar to as it will be installed.
7. The length of the factory testing shall be a minimum of one (1) working day(s) (8 hours per day).
8. If the equipment is not ready for factory testing, the test will be cancelled and rescheduled for a later date. The Contractor shall be responsible for paying liquidated damages for expenses incurred by the Owner Representative to come to a cancelled test. One thousand dollars (\$1000.00) in liquidated damages shall be deducted from his contract each occurrence.
9. Faulty and/or incorrect hardware or software operation of major portions of the system may, at the discretion of the Engineer, be cause

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for suspension, cancellation, or restarting of the factory test, at no additional cost to the Owner or extension in Contract time.

10. The factory test will be considered complete only when the integrated system has successfully passed all tests. No electrical equipment shall be shipped to jobsite without completed test documentation.
11. During the testing period, under the supervision of the System Integrator, the Owner's Representative shall have unlimited and unrestricted access to the usage and testing of system hardware, configuration, software, meters and tools.
12. The System Integrator shall pay all expenses incurred by his personnel including labor, material, transportation, lodging, daily subsistence, and other associated incidental costs during the factory testing.
13. Acceptance and witnessing of the factory tests does not relieve or exclude the Contractor from conforming to the requirements of the Contract Documents.
14. All modifications to documentation as a result of the factory tests shall be corrected and completed before the submittal and delivery of "Operation and Maintenance" Manuals.
15. Copies of the completed and witnessed factory testing forms shall be included in the Operation and Maintenance Manual.

B. Factory Tests

1. External network connection required to permit polling of the PLC during the Factory Test.
2. Structured Factory Tests: The associated factory tests are to be performed by the System Integrator and witnessed by the Owner's Representative. The associated test forms shall be completed during each stage of the test.
  - a. Visual and Mechanical Inspection Tests
  - b. Wiring Tests
    - 1) Contractor shall confirm correct panel wiring per System Integrator panel shop drawings. Panel shop drawings shall be compared with Contract P&IDs and other drawings to verify all hardwire logic are accounted for. Panel drawings used in factory tests shall be redlined and inserted into Factory Testing Results submittal.
  - c. MCC and Control Panel Pre-Operational Tests
  - d. Logic Controller I/O Point to Point Tests
  - e. Simulated Alarm Tests

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- 1) Simulate the digital and/or analog signals at the terminals to verify that each PLC I/O point is functional and properly programmed. Verify that all parameters (i.e., setpoints, enable/disable toggle bits, timers, etc.) for the alarms operate according to the Specifications. Multiple alarm states (i.e., LO, LO-LO, HI, HI-HI, etc.) shall be checked.
- f. Simulated Operational Control Tests
  - 1) Simulate the digital and/or analog signals at the field terminals to verify that each control system is functional and properly configured and programmed.
  - 2) Each line of control logic in the Control Strategies section shall be checked. When the complete control strategy has been checked, it shall be signed and dated by testing person and person witnessing test.
  - 3) Verify that all parameters (i.e., setpoints, runtimers, totalization, etc.) operate according to the Specifications.
3. Unstructured Factory Tests: The various unstructured tests shall include, but are not limited to, the following.
  - a. Simulate the equipment failure and power fail/restart of PLC. Check the effects of each failure on maintaining operations with the remaining equipment.
  - b. The factory tests, as a minimum, shall simulate all normal and abnormal operating conditions including steady state, change of state, variable changes, fluctuations, transients, upsets, start-up, shutdown, power failure, and equipment failure conditions.
  - c. Communications test to devices located within control panel and/or in MCCs.
  - d. Simulation of PLC communication error. Demonstrate error detection, alarming, and recovery.
  - e. Measure and test all power supplies for correct voltage. Operate rechargeable devices under battery power to test run duration, alarms and automatic recovery.

### 3.02 FIELD TESTING

#### A. General Requirements

1. Field testing is broken down into 4 components
  - a. Pre-Energization testing

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- b. Pre-Operational Testing
  - c. Operational Testing
  - d. Commissioning
2. Project wide, all Pre-Energization testing must be completed prior to Pre-Operational testing, all Pre-Operational testing must be completed prior to Operational Testing, and all Operational Testing must be completed prior to Commissioning.
- a. Any deviation of this order, whether on a component level or larger scale, must be approved.
  - b. Out of order testing, if allowed, will be evaluated on a case-by-case basis when brought to the attention of the Owner's Representative. The Owner's Representative may require that the entire system, or portions thereof, be retested once the missing component(s) are installed and functional.
3. All equipment supplied by the Contractor or others shall be tested by Contractor per these specifications.
4. Two digital multimeters/signal generators (minimum +/- 0.1% accuracy) , AC current meters, torque wrench, and other specialized test equipment shall be provided by the Contractor for use during testing.
5. If the equipment is determined not to be ready for testing, the test will be cancelled and rescheduled for a later date.
6. Faulty and/or incorrect hardware or software operation of major portions of the system may be cause for suspension, cancellation, or restarting of the area of testing, at no additional cost or extension in Contract time.
7. During the Operational testing period, under the supervision of the System Integrator, the Owner's Representative shall have unlimited and unrestricted access to the usage and testing of all hardware and software in the system.
8. The System Integrator shall pay all expenses incurred by his personnel including labor, material, transportation, lodging, daily subsistence, and other associated incidental costs during field testing.
9. Acceptance and witnessing of the tests does not relieve or exclude the Contractor from conforming to the requirements of the Contract Documents.
10. All modifications to documentation as a result of the tests shall be corrected and completed before the delivery of "as-built" documentation.
11. Copies of the completed and witnessed field testing forms shall be included in the Operation and Maintenance Manual.

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12. The various contractors on this project (General Contractor, Electrical Contractor, Testing Company, and System Integrator) shall assume the lead role in testing activities as listed below. The Contractor shall obtain assistance of suppliers and/or manufacturers representatives for any major equipment testing.

a. Electrical Contractor:

- 1) Pre Energization Tests
  - a) Visual Mechanical Tests
  - b) Wire Insulation and Continuity Tests.
  - c) Panelboard Tests
  - d) Breaker Tests
- 2) Operational Tests.
  - a) Generator Tests
- 3) Commissioning.

b. System Integrator:

- 1) Pre-Operational Tests
  - a) Visual Mechanical Tests
  - b) Control panel pre-operational test
  - c) MCC pre-operational test
  - d) Motor Tests.
  - e) PLC I/O point to point tests.
  - f) Instrumentation switch tests
  - g) Instrumentation transmitter tests.
- 2) Operational Tests.
- 3) Commissioning

c. Testing Company

- 1) Grounding System Tests
- 2) Breaker Device Tests
- 3) Set all breakers and protective devices per approved SSCS.

d. General Contractor

- 1) Test Scheduling
- 2) Operational Tests.
- 3) Commissioning.

e. Owner Representative (software systems)

- 1) Operational Tests.
- 2) Commissioning.

- B. Electrical Field Tests – The following test shall be performed within each test category. Complete test forms for each electrical panel, instrument, and/or device. Provide separate form for each component to be tested.

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1. Pre-Energization Inspections and Tests:
  - a. Visual and Mechanical Inspection Tests
  - b. Wire Insulation and Continuity Tests
  - c. Grounding System Tests
  - d. Panelboard Tests
  - e. Breaker Tests
  - f. Post all approved arc flash labels
2. Pre-Operational Tests:
  - a. MCC Pre-operational Tests:
  - b. Control Panel Pre-operational Tests:
  - c. Motor Testing:
  - d. Generator Testing (if generator is furnished)
  - e. Harmonic Measurement: (Required for systems with VFDs)
  - f. Instrumentation Switch Calibration Tests
  - g. Instrument Transmitter Calibration Tests
  - h. PLC I/O point tests.
  - i. Communication Tests
    - 1) The Contractor shall verify that all communications via radio, telephone, wireline, fiber optic, or other are functional and ready for operational testing. Revise all configurable parameters without additional cost to the Owner as required for an optimally functional system.
    - 2) Verify that all components of the communication system operate together under all operating and power restart conditions. If faults occur, investigate source of problem and correct. Revise all configurable parameters without additional cost to the Owner.
    - 3) Change setpoints from SCADA and confirm that corresponding field setpoint changes correctly. Check every I/O point on every screen, trend, and database.
3. Operational Tests:
  - a. After all the previous tests in this subsection are complete, the test forms are completed and signed-off, the Contractor shall conduct operational testing.
  - b. Representatives from the General Contractor, Electrical Contractor, System Integrator, and Owner's Representative shall be present during testing. Operational testing shall be performed by Contractor in the presence of the Owner's Representative.
  - c. During operational testing the Contractor shall follow the instructions of the Owner. The Owner may place restrictions on operation that must be followed by the Contractor during testing. Any accidents or fines caused by actions of the

Contractor where warnings or restrictions were placed, shall be remedied or paid by the Contractor.

d. Alarm Tests

- 1) Generate the digital and/or analog signals at the primary device to verify that each PLC I/O point is functional and properly programmed. Verify that all parameters (i.e., setpoints, enable/disable toggle bits, timers, etc.) for the alarms operate according to the Specifications. Multiple alarm states (i.e., LO, LO-LO, HI, HI-HI, etc.) shall be checked.

e. Operational Control Tests

- 1) Generate the digital and/or analog signals at the primary device by raising or lowering the actual measured process. Inject signal into the terminals or utilize a "force" function within the device only as necessary. Verify that each control system is functional and properly configured and programmed.
- 2) Each line of control logic in the Control Strategies section shall be checked. When the complete control strategy has been checked, it shall be signed and dated by testing person and person witnessing test.
- 3) Verify that all parameters (i.e., setpoints, runtimers, totalization, etc.) operate according to the Specifications.
- 4) Verify that all data, setpoints, alarms are being received at SCADA correctly and that all I/O points on screen are true and accurate representations of field information.

f. Other Tests

- 1) Force a power failure and power fail/restart of PLC and all other systems. Check the effects of each failure on each piece of equipment and automatic recovery.
- 2) Force a PLC communication error. Demonstrate error detection, alarming, and recovery.
- 3) Perform additional operational testing that has not already been witnessed.
- 4) Perform any additional operational testing as necessary to confirm robust and error free operation under all operational conditions.

4. Trial Period

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- a. Station/Equipment shall be activated to automatically run for 5 days, 24 hours per day Monday through Friday.
- b. During the trial period the Owner's Representative will test all modes of operation and will look for errors and malfunctions. A punchlist will be generated to be completed by Contractor and re-tested prior to Commissioning.
- c. If equipment failure occurs during the trial period, the Contractor shall repair or replace the defective equipment and shall begin another trial period, Monday through Friday.
- d. This test shall be repeated until all new equipment functions acceptably and without failure for consecutive days.

C. Commissioning:

- 1. Commissioning shall not commence until Operational testing and System Training are complete with documentation submitted and with prior approval.
- 2. The Owner may delay Commissioning for a period up to 30 days, during which time all testing documentation will be reviewed and preparation for operation will be made. Costs for project delays during this review may not be forwarded on to the Owner.
- 3. Commissioning period
  - a. The new equipment shall be activated by the Contractor to operate in full automatic for 10 consecutive days, 24 hours per day. Commissioning shall only start on Mondays or Tuesdays.
  - b. During Commissioning, the Owner will monitor and run the station in normal automatic mode. If equipment failure occurs during Commissioning, the Contractor shall repair or replace the defective equipment and shall begin another commissioning period after repairs are complete.
  - c. Parallel, existing and/or back-up systems shall remain in place and functional during commissioning period. Demolition of parallel, existing or back-up systems shall not begin until commissioning is completed.
  - d. This test shall be repeated until the new equipment functions acceptably for a consecutive commissioning period.
  - e. Warranty will begin at the start of a successful commissioning period. However, if major hardware failure occurs during commissioning, the warranty and commissioning will restart once the problem has been identified and repaired.

3.03 WARRANTY:

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A. Provide warranty per Electrical Specifications [Electrical General, Warranty].

1. The completion of the above tests does not relieve the Contractor from any warranties specified in the Electrical Specifications or other sections.
2. Warranty shall begin on the start date of a successful Commissioning period.

3.04 FINAL ACCEPTANCE:

A. Final Acceptance per Electrical Specifications [Electrical General].

## **SECTION 16600**

### **TEST FORMS**

#### Index of Forms:

PC	Power Conductor Test Form
CC	Control Conductor Test Form
IC	Instrumentation Conductor Test Form
FIBER	Fiber Optic Conductor Test Form
GS	Grounding System Test Form
VM	Electrical Equipment Visual and Mechanical Inspection Form
PB	Panelboard Test Form
MCO	MCC Operational Test Form
CPO	Control Panel Operational Test Form
BD	Breaker Device Test Form
GCL	Generator Field Check List
GPT	Generator Performance Test Form
GSLD	Generator Sound Level Data Form
MOTOR	Motor Test Form
HM	Harmonic Measurement Test Form
IOP	Programmable Logic Controller I/O Point-to-Point Test Form
ISC	Instrumentation Switch Calibration Test Form
ITC	Instrumentation Transmitter Calibration Test Form

### **END OF SECTION**

**SECTION 16905**  
**CONTROL PANELS**

**PART 1: GENERAL**

**1.01 SCOPE OF WORK**

- A. Provide and install Control Panels per Drawings.
- B. Provide complete wired and tested panel with all devices installed per the contract Drawings and as stated herein.
- C. Provide all necessary hardware, conduit, wiring, fittings, and devices to connect the control panel to equipment provided under other Sections.

**1.02 REFERENCES**

- A. Electrical Specifications [Electrical General].
- B. Electrical Specifications [Low Voltage Wire & Data Cable]
- C. Electrical Specifications [PLC & OI Hardware]
- D. Electrical Specifications [PLC & OI Application Programming]
- E. Electrical Specifications [Instrumentation]

**1.03 SUBMITTAL REQUIREMENTS**

- A. Provide submittals and Drawings as specified in Electrical Specifications [Electrical General, Submittal Requirements].
- B. Submit shop construction Drawings for the Control Panel. The following Drawings shall be provided as a minimum:
  - 1. Scaled drawings of the Control panel elevation, baseplan. The dimensions and locations of the cutouts shall be dimensioned from the bottom left corner of the door(s).
  - 2. Scaled drawings of the backpan including all mounted components and wireways.
  - 3. Wiring diagrams for AC and DC power distribution, I/O for each card in the PLC and communications block diagrams.
  - 4. Interconnection diagrams per Electrical Specifications [Electrical General].
- C. Calculations for environmental controls. Environmental controls (including air conditioners, exhaust fans, heaters and circulation fans) shall maintain interior panels temperatures within ratings of all internal equipment given the intended installation location.
  - 1. Design and install environmental control systems to meet

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requirements herein and prevent premature failure of panel internal components.

2. Environmental controls may be shown in the Drawings and shall be considered the minimum level required. Additional components or systems shall be provided to meet internal temperature requirements.
3. Environmental control systems shall prevent and control intrusion of dust and bugs through the use of filtration systems.
4. Environmental control systems shall maintain humidity below that of the external ambient air and without condensation within panel.

#### 1.04 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. Provide operating instructions as specified in Electrical Specifications [Electrical General].

### **PART 2: PRODUCTS**

#### 2.01 ENCLOSURE

1. The enclosure for the control panel shall be (at minimum) sized as shown in the Contract Drawings.
2. Arrangement: Where so indicated, the instruments mounted in the panels shall have the nominal size and general arrangement shown. Panel layouts and nameplates shall conform to the approved submittal.
3. Assembly: Mount all equipment on 12 ga. painted white backpan(s) that is bolted to rear (and sides) of the enclosure. Use drill and tap method for machine thread screws for all internal components on mounting panels. Provide extra mounting bolts through the rear of the structure if equipment weight exceeds backpanel mounting stud capacity.
4. Hardware: Provide door latch and accessories as detailed in the Contract Drawings or as required to meet NEMA area ratings.
  - a. Provide one or two single point latches for panels up to 36" height.
  - b. Provide 3 point latching mechanisms for panels over 36" height consisting of rotating handle with latch, extension bars with plastic wheels at ends and guide slots at top and bottom of door, or as otherwise shown on drawings.
  - c. Hinges, pins, bolts and screws shall be of 316 stainless steel only.
5. When physical size requirements for individual components are different than that detailed on the Control Panel backpan drawing, the wiring diagrams and specifications herein shall supersede the elevation



drawing and the Contractor shall furnish additional panel width as needed to fit the electrical equipment. Deviations with sufficient evidence for the change shall be submitted for approval. The Contractor is required to provide for all equipment including spares and spaces as shown in the wiring diagrams.

6. Enclosure shall be Saginaw Floor Mounted Type 12 Enclosure SCE-72EL6018LPPL or equal.

## 2.02 CONTROL PANEL CIRCUIT BREAKERS

- A. Furnish circuit breakers and accessories as required per Drawings and application.
  1. Copper busbar systems, up to 480VAC, 115A, 1, 2 or 3 phase as needed for application
  2. Trip rating per Drawings or as needed for protected device. Trip curves as selected by System Integrator.
    - a. B curve magnetic trip point: 3 to 5 times the rated current, typically used for computers and electronic equipment with very low inrush loads (PLC wiring).
    - b. C curve magnetic trip point: 5 to 10 times the rated current, typically used for small transformers, pilot devices, etc.
    - c. D curve magnetic trip point: 10 to 20 times the rated current, typically used for transformers or loads with very high inductive loads.
  3. Quantity of pins and feed in lugs as required.
  4. Auxiliary contact, shunt trip as required in Drawings.
  5. Din rail mounted, 18mm width per pole, finger safe pressure plate terminals.
- B. Motor applications:
  1. UL489 for branch circuit protection up to 40A, 1 to 3 pole.
  2. 5 kAIC interrupting capacity @ 480 VAC
  3. Alltech, Eaton FAZ, or equal.
- C. Control circuit transformers and other Non-motor applications:
  1. UL1077 supplementary protection up to 63 amps, 1 to 2 pole, AC or DC.
  2. Used where a UL489 protective device is upstream powering the circuit (from a panelboard or other source).

3. Used within control circuits for power supplies, control power transformers, relays and PLC I/O points.
4. Used in place of fuses that are applied as supplementary protection.
5. Eaton FAZ, or equal.

## 2.03 FUSES AND FUSE HOLDER

- A. Fuses shall not be used in branch or control circuits unless specifically shown in the drawings. Circuit breakers shall be furnished and utilized where possible.
- B. Fuses used in circuits 200 VAC and above shall be time- delay, 13/32" x 1-1/2", and have an interrupting rating of 10,000 AIC at 500 VAC. Fuses shall be Bussman type FNQ or approved equal. Fuse holders shall feature open fuse indication lights and shall be rated 30A at 600 VAC. Fuse holders shall be Bussman Optima Series OPM or equal.
- C. Fuses used in 120 VAC shall be time-delay, 1/4" x 1-1/4", and have a rating of 250 VAC. Fuses shall be Bussman type MDA or approved equal. Fuse-holders shall be of the same manufacturer, series and color as the adjacent terminal blocks and have blown fuse neon indicators. Fuse holders shall be Entrelec ML 10/13.SFL, Allen Bradley 1492-H4 or equal.
- D. Fuses used in signal and 24 VDC circuits shall be fast acting, 5mm x 20mm and have a rating of 250 VAC. Fuses shall be Bussman type GMA or approved equal. Fuse-holders shall be of the same manufacturer, series and color as the adjacent terminal blocks and have blown fuse LED indicators. Fuse holders shall be Entrelec M 4/8.SFDT, Allen Bradley- 1492-H5 or equal
- E. Fuses shall be sized in conformance with the NEC.

## 2.04 TERMINAL BLOCKS AND ACCESSORIES

- A. General
  1. Terminal blocks to be spring cage-clamp type, 5 spacing, 300 volt, minimum rating of 20 amps, and mounted on DIN rail. DIN rail shall be same type as used for the relays. Install extra DIN rail on each type of terminal strip with 10% spare terminals for future additions.
    - a. Provide larger terminal as necessary based on gauge of connected wiring. Those terminals with 10 gauge larger gauge wiring or more than one 12 gauge wire should be evaluated and changed.
  2. Provide terminal blocks with "follower" plates that compress the wires and have wire guide tangs for ease of maintenance. Terminal blocks that compress the wires with direct screw compression are unacceptable. All power, control and instrument wires entering and leaving a compartment shall terminate on terminal blocks with wire numbers on terminals and on both ends of the wires.

3. Provide end clamps, separators, din rails, and jumpers to complete terminal block system. See example PLC I/O drawing for additional information. Engineer can provide on request if not available in plans.
4. Terminal Tags and Markers: Each terminal strip shall have a unique identifying alphanumeric code at one end ( i.e.: TB1, TB2, etc. ) or as shown in drawings.
5. Plastic marking tabs shall be provided to label each terminal block. These marking tabs shall have a unique number/letter for each terminal which is identical to the "elementary" and "loop" diagram wire designation. Numbers on these marking strip shall be machine printed and 1/8" high letters minimum.
6. Terminal blocks are grouped based upon purpose. The following terminal block designations shall be used to ensure uniformity of panels in all facilities:
  - a. • TB-1 24 VDC Power (+) Bus
  - b. • TB-2 24 VDC Common (-) Bus
  - c. • TB-3 120 VAC L1 Bus
  - d. • TB-4 120 VAC L2 Bus
  - e. • TB-5 Discrete Inputs
  - f. • TB-6 Discrete Outputs
  - g. • TB-7 Analog Inputs
  - h. • TB-8 Analog Outputs
  - i. • TB-9 110VAC Instrument Source Bus
  - j. • TB-10 UPS loads
7. Terminal blocks shall be physically separated into groups by the level of signal and voltage served an by PLC I/O card. Power and control wiring above 100 volts shall have a separate group of terminal blocks from terminal blocks for wiring below 100 volts, intermixing of these two types of wiring on the same group of terminal blocks is not allowed.
8. Terminal blocks shall be gray in color unless otherwise shown on the drawings.
9. Provide a ground terminal or connection point for each grounding conductor.
10. Provide a separate signal, common, and/or neutral terminal for every wire and PLC or remote device connection at minimum.

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- B. Terminal blocks shall be cage-clamp, screwless, DIN EN 50022 rail, 600 volt rating except for pull apart terminal blocks in MCC cubicles. Terminal blocks shall be Wago, Phoenix or equal:
1. Numbers shall be assigned to all blocks except grounding blocks. Fuse blocks shall be assigned unique tag numbers such as FU1, FU2. No two fuses shall be assigned the same tag number. Numbers shall be machine printed on WAGO plastic inserts. Fuse blocks shall also be provided with markers identifying the current rating of the fuse.
  2. Each terminal shall have a unique identifying alphanumeric code at one end (i.e.: 101, 102, etc.). Terminal numbers shall be assigned starting lowest number at one end, incrementing sequentially to higher numbers (i.e: 1,2,3,4....). These terminals shall have a unique number/letter for each terminal which is identical to the "elementary" and "loop" diagram wire designation. Numbers on this marking strip shall be machine printed on WAGO plastic inserts.
  3. Terminal blocks shall be physically separated into groups by the level of signal and voltage served. Power and control wiring above 100 volts shall have a separate group of terminal blocks from terminal blocks for wiring below 100 volts, intermixing of these two types of wiring on the same group of terminal blocks is not allowed.
  4. As a minimum, provide a ground terminal or connection point for the power system grounding conductor, for each terminal block group.
  5. Provide a separate common or neutral terminal for every two (maximum) inputs and/or outputs.
- C. MCC – Motor Starter Cubicle Terminal Blocks
1. MCC cubicle terminal blocks shall be pull apart as supplied standard by MCC manufacturer.
- D. Power – Power terminal Blocks
1. Backpan mounted termination blocks shall be rated for 600V (min). The power termination blocks shall be rated to accept Copper or Aluminum cable and rated as shown on Contract one-line diagrams. Termination blocks shall be insulated with molded plastic covering and finger safe cover. Each termination block shall be provided with quantity and size of primary and secondary cable connections as required per installation. The power termination blocks shall be Erico UD, UDJ, BD, TD, or SB series or equal.
  2. Unmounted termination blocks shall be constructed of aluminum and suitable for use with Aluminum and copper wire. Size and quantity of cable connections shall be as required for installation. Termination blocks shall be insulated with molded high-dielectric strength plastic covering and eliminate the need for tape insulation of electric connection. The termination block shall have removable access plugs over the wire entry and hex screw ports. Provide NSI Polaris IPL or

IPLD Series terminal blocks or equal.

E. PANEL GROUND

1. Each electrical enclosure shall have a copper ground bus. Screw type fasteners shall be provided on all ground busses for connection of grounding conductors. Ground bus shall be a Challenger GB series, ILSCO CAN series or equal.
2. A 12ga. copper ground wire shall be attached between the ground bar and the panel enclosure, and between the ground bar and the mounting panels. The ground connection to the enclosure and panel shall be made by sanding the paint finish off a small area, drilling a hole for a 0.25 inch bolt and mounting a 0.25-20 bolt to the panel to serve as grounding stud. The grounding stud shall be attached with a nut and flat washers on both sides of the enclosure/panel, and with an inside tooth star lock washer next to the panel surface. The star lock washer shall be on the inside surface of the enclosure, and the front surface of the mounting panel. The grounding wire shall be secured to the stud with a nut and inside tooth star lock washer. These grounding points shall be located within 12 inches of the bottom to the grounding bar. Each terminal strip rail shall be individually grounded by means of a #12 AWG wire to the ground bus.
3. Components within the panel shall be grounded according to the manufacturer's recommendations.

2.05 POWER SUPPLIES

A. Uninterruptible Power Supply (UPS)

1. The UPS shall be installed within the control panel and power all process related 120 VAC devices and DC power supplies.
2. The UPS capacity/size shall be as shown in the contract Drawings. The battery capacity shall be such that it may provide nameplate power for 10 minutes (min) from a fully charged battery(s).
3. The UPS shall provide surge protection and filtering: 0.3% IEEE surge let-through, zero clamping response time to meet UL 1449. The inverter shall provide true sine wave output.
4. When the Utility power voltage is outside of a preset range (approx.  $<100 < V < 130$  VAC) then the UPS shall power the load from storage batteries and a solid state inverter.
5. The power supply shall be wired into the control panel power circuit per the contract Drawings.
6. The UPS operating ambient temperature range shall be 32 deg F to 122 deg F minimum.
7. The inverter shall be self resetting and continuously on-line regardless

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of the Utility power existence. Configure the UPS to restart automatically upon restart of utility power without operator intervention. The rectifier/charger shall recharge and maintain float charge on the batteries automatically.

8. The UPS shall be of a readily available commercial manufacturer. Provide American Power Conversion Smart UPS, Marathon Vault Series, or equal.

B. DC Power Supply (PS)

1. The DC power supply shall utilize a switching power stage, rectifier and voltage regulator. The power supply case shall be DIN rail mountable.
2. The power supply shall operate on 120V AC and provide DC output voltage and current as shown in the Contract Drawings.
3. The power supply shall be wired and fused per manufacturer instructions and Contract Drawings. Power supply output shall include self resetting overcurrent protection.
4. Power supplies below 101 Watts output power shall be Class 2 rated.
5. The power supply shall provide 2% voltage regulation for a change of 10% load to 100% full load.
6. The DC power supply shall be IDEC PS5R Series, Phoenix Contact Quint Power, Genesis Automation GDA, or equal.

2.06 MISCELLANEOUS COMPONENTS

- A. Wireway: Manufactured from light gray rigid PVC suitable for continuous use at temperatures up to 50 deg C. Wireway shall be 2" height, width as required with 0.5" slot spacing with removable covers. Provide Panduit type "F" or equal.
- B. LED Strip Light: The LED light shall be an "under cabinet" style with multiple LED lamps and acrylic diffuser. Lamp shall be switched on/off from integral switch or PIR motion sensor. Light housing shall be capable of magnet mount to top or side of enclosure or will include mounting tabs for mounting to brackets. Lamp shall be powered from 120VAC or from 24~48 VDC or shown in the contract drawings. LED Strip Light shall be Stego 02540, or equal.
- C. Circulation Fans: The control panel temperature shall be maintained 10 deg. F below lowest internal device's temperature rating. The fans shall be 4" or 6" unless otherwise noted on Contract Drawings. The Contractor shall calculate the heat generation of all internal components and determine if the fans submitted will meet the cooling requirements of the internal components. Circulation fans shall include louver with filter and bug screen for outdoor installations.
- D. Forced Air Heater: The control panel temperature shall be kept above 50 deg. F through the use of a resistive forced air heater when the panel is

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located outdoors. The heater shall contain a fan, heating elements, and thermostat within a single self contained unit. The wattage of the heater shall be as calculated by the supplier using the manufacturers sizing method to meet the temperature requirements. The heater shall be Hoffman D-AH series, or equal.

- E. Thermostats: The air circulation fans shall be controlled by adjustable thermostat. The thermostat shall be mounted near the top of the panel and easily accessible by a technician. The thermostat shall be capable of control of a heater or cooling fan(s) by selecting the proper contact logic. The thermostat range shall be adjustable from 30 to 140 deg F. Thermostat shall be Hoffman A-TEMxx, or equal.

### **PART 3: EXECUTION**

#### **3.01 WORKMANSHIP**

- A. All work in this Section shall conform to the codes and standards specified in Electrical Specifications [Electrical General, Workmanship].

#### **3.02 FABRICATION**

- A. Equipment Mounting:

1. Mount all equipment using manufacturers mounting tabs/holes or brackets where possible. Where not possible, construct custom brackets to panel mount or backpan mount components as shown in the Contract Drawings.
2. Equipment or laptop shelves shall be provided where shown on the Contract Drawings. Equipment shown on shelves shall not be placed on the bottom of the panel after field installation.
3. All nuts, bolts, screws, washers and hinges used in the panel shall be stainless steel. All components shall be mounted using bolts or screw fasteners only which are drilled and tapped into the backpan. Pop rivets shall not be allowed within panel except for enclosure support arms.

- B. Environmental:

1. Control panel environmental accessories including fans, louvers, filters, bugscreens, air conditioners, etc. shall be provided as noted in the Drawings and as necessary for a complete environmental solution.
2. Panels environmental controls shall be designed during shop drawing submittal and fabricated to maintain temperatures 10 degrees F below lowest internal equipment maximum temperature rating.
3. Contractor shall provide [additional] fans, louvers, screens, sunshades, air conditioners, etc. as necessary to prevent equipment malfunction or premature failure. Provide associated wiring and thermostats as needed.

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4. Environments:

- a. NEMA 4X rated panels shall be cooled/heated with closed loop type conditioning systems to include air conditioners, internal panel circulation fans and resistive heaters.
- b. NEMA 3R rated outdoor panels shall be cooled/heated with open loop type conditioning systems to include air conditioners, exhaust fans and louvers, internal panel circulation fans and resistive heaters. All exhaust fans and louvers shall include filters and bugscreens.
- c. NEMA 12 or 1 rated indoor panels shall be cooled/heated with open loop type conditioning systems to include air conditioners, exhaust fans and louvers, internal panel circulation fans and resistive heaters. All exhaust fans and louvers shall include filters and bugscreens.

C. Wiring:

1. Panel Wiring: All wiring shall be installed in wireways between terminal blocks, PLC, and devices. Reference Contract Drawings for control panel power distribution diagram and control panel elementary diagrams.

3.03 INSTALLATION

A. Wiring:

1. Install all equipment per Electrical Specifications [Electrical General].
2. All internal and field wiring shall be per Electrical Specifications [Low Voltage Wire].
3. Panel Wiring: All wiring shall be installed in wireways between terminal blocks and devices. Reference Contract Drawings for Control panel power distribution diagram and control panel elementary diagrams.
4. Field Wiring: Wireways shall be provided for field wiring. Reference Contract Drawings for control panel power distribution diagram and control panel elementary diagrams.

B. Cleaning:

1. The Contractor shall clean the inside of the control panel of any dust or debris remaining at the completion of installation and testing.
2. The Contractor shall exercise care when using a vacuum cleaner or compressed air such as not to damage any component within the panel.
3. Many electrical and computer components are open for ventilation.



Falling debris can penetrate the openings and cause equipment failure. Equipment with debris inside shall be removed, cleaned and/or replaced.

3.04 FIELD ASSISTANCE

- A. Provide testing as specified in Electrical Specifications [Factory and Field Testing].

3.05 WARRANTY

- A. Provide warranty as specified in Electrical Specifications [Electrical General, Warranty].

3.06 FINAL ACCEPTANCE

- A. Final Acceptance per Electrical Specifications [Electrical General].

**END OF SECTION**

## **SECTION 16910**

### **PLC HARDWARE**

#### **PART 1: GENERAL**

##### **1.01 SCOPE OF WORK**

- A. Providing and installing Programmable Logic Controller (PLC) Hardware and all supporting hardware, wiring and devices as specified in Electrical Specifications.

##### **1.02 REFERENCES**

- A. Electrical Specifications [Electrical General]
- B. Electrical Specifications [Low Voltage Wire and Data Cable]
- C. Electrical Specifications [PLC Application Programming]

##### **1.03 SUBMITTAL REQUIREMENTS**

- A. Provide submittals per Electrical Specifications [Electrical General, Submittal Requirements].
- B. Submit documentation showing the number and type of I/O modules required to meet the I/O requirements specified herein. Include complete manufacturer's part and model numbers.
  - 1. PLC I/O points are determined by the P&ID drawings. The Contractor shall count and total the PLC I/O points per PLC controller and per type of I/O required based on the P&ID diagrams. Provide 25% spare I/O points per I/O type per PLC.
- C. Submit calculations showing that the power supply meets the specified requirements and the requirements of the devices powered.
- D. Submit shop drawings showing physical backpan layout of equipment in Control Panel.
- E. Submit PLC communications block diagram showing I/O module order and slot location.
- F. Submit hardware Operations and Maintenance Manual per Electrical Specifications [Electrical General].

#### **PART 2: PRODUCTS**

##### **2.01 GENERAL**

- A. Provide PLC modules from a single family of products, using the same software and interchangeable I/O cards, that can be configured for a range of applications from small, uncomplicated sites to large, complex sites with a variety of equipment.

- B. Size the PLC enclosure such that local I/O modules and supporting hardware required to meet the ultimate point count, as specified herein, will fit into the space of a single enclosure.

## 2.02 MECHANICAL

- A. Provide modular PLC consisting of I/O slot card cage, and plug-in processor, power supply, and I/O modules.
- B. Provide I/O modules with removable terminal strips so that I/O modules can be removed without disconnecting field wiring.

## 2.03 PLC COMPONENTS

- A. The following components (Modicon M340, no equal) shall be provided to complete the PLC systems. Only major components are listed. Multiples of some components are required - see Contract drawings.

- 1. Processor Modbus Serial, Ethernet (M340 P34 2020)
- 2. Flash Memory card Compact Flash 8Mb min (BMX RMS 008MP)
- 3. USB Cordset Mini B USB port cable (BMX XCA USB H0••)
- 4. Power Supply BMX CPS •0•0 as required
- 5. Digital Input Module (16-DC) BMX DDI 1602
- 6. Digital Output Module (16-DC) BMX DDO 1602
- 7. Analog Input Module (4-20mA) BMX AMI 0810
- 8. Analog Output Module (4-20mA) BMX AMO 0410
- 9. Rack (12 slot) BMX XBP 1200
- 10. Protective Covers BMXXEM010

## 2.04 ISOLATION/INTERFACE RELAYS

- A. Provide output isolation relays on all digital outputs that operate devices external to the control panel and on spare outputs or as otherwise shown in the drawings. The relay coil connection shall be on one side of the relay base and form-C output contacts on the other.
- B. Relays shall be 6A SPDT, coil voltage as required, indicating, plug in style as manufactured by Allen Bradley 700-HLT1U1 or equal. Provide jumper bars for common buss connections, Allen Bradley 700-TBJ20G, or equal.

## 2.05 ETHERNET SWITCH

- A. The unmanaged Ethernet switch shall have 8 ports with automatic uplink detection and OPC monitoring capability. Ports shall be auto-sensing 10/100/1000 Base-Tx with RJ-45, 8 pin female connectors, meeting IEEE 802.3 standards. Case shall be ventilated steel with provisions for wall or DIN rail mounting. Switch shall be suitable for power from 10 - 30 VDC. Switch shall be N-TRON 1008TX-N, no equal.
- B. The unmanaged fiber optic Ethernet switch shall have 2 SC fiber optic ports and 8 copper ports with automatic uplink detection. Ports shall be auto-sensing 10/100 Base-Tx with RJ-45, 8 pin female connectors, and one 10/100 base FX, meeting IEEE 802.3 standards. Case shall be ventilated steel with

provisions for wall or DIN rail mounting. Switch shall be suitable for power from 10 - 30 VDC. Switch shall be N-TRON 110FX2-SC, or equal.

### **PART 3: EXECUTION**

#### **3.01 WORKMANSHIP**

- A. All work in this Section shall conform to the codes and standards specified in Electrical Specifications [Electrical General, Workmanship].

#### **3.02 INSTALLATION**

- A. Fabrication
  - 1. Mount, wire and Ground PLC per manufacturer's recommendations.
  - 2. Organize equipment on control panel backpan per Backpan Layout detail in Contract drawings.
  - 3. Locate and install PLC(s) per Contract drawings.
- B. Wiring
  - 1. Terminate status, control and analog wiring on terminal blocks.
  - 2. Label and wire PLC to terminal blocks per Electrical Specifications [Wire, Fuses & Terminal Block] and Example I/O Wiring Diagram in the drawings.
  - 3. All spare I/O points shall be wired to terminal blocks.
  - 4. Install communication cables to connect the PLC to external devices.
  - 5. Bundle and tie down wires in a neat and orderly manner.
  - 6. Terminate drain wire of shielded cables at backpan terminal block only.

#### **3.03 FIELD ASSISTANCE**

- A. Provide testing as specified in Electrical Specifications [Factory and Field Testing].

#### **3.04 WARRANTY**

- A. Provide warranty per Electrical Specifications [Electrical General, Warranty].
- B. Perform the following services during the warranty period:
  - 1. Repair or replace damaged modules returned for service within 24 hours.
  - 2. Determine and report the cause of failure of modules returned for service.
  - 3. Resolve design or implementation problems discovered.

#### **3.05 FINAL ACCEPTANCE**

- A. Final Acceptance per Electrical Specifications [Electrical General].

### **END OF SECTION**

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**SECTION 16931**  
**SECURITY SYSTEM**

**PART 1: GENERAL**

1.01 SCOPE OF WORK

- A. To be designed by Contractor similar to other City installations.
- B. Johnson Controls is preferred vendor.
- C. Work includes that specified in Electrical Specifications [Electrical General].

1.02 SUBMITTAL REQUIREMENTS

- A. Provide submittals and drawings as specified in Electrical Specifications [Electrical General, Submittal Requirements].
- B. Provide installation, operation and maintenance manuals.
- C. Provide programming manuals.

1.03 OPERATION AND MAINTENANCE INFORMATION

- A. Submit hardware Operations and Maintenance Manual per Electrical Specifications [Electrical General].

**PART 2: PRODUCTS**

2.01 SECURITY ALARM SYSTEM

- A. The Security Alarm Panel shall be surface wall-mounted, NEMA rated enclosure as shown in the electrical drawings and details and as specified herein.
- B. The security alarm system shall monitor alarm zone inputs and provide alarm locally and to remote reporting service upon breach of those inputs.
- C. The alarm system shall be enabled/disabled through Operator password input to the keypad.
- D. The security alarm panel shall consist of a base module, communications module, access module, zone alarm I/O modules, battery system, auxiliary relays, and remaining necessary panel components for system operation as described herein and shown in the plans.
- E. The security alarm panel shall supervise quantity of zones as defined in the P&IDs and shall be programmable by keypad. Each zone shall be programmable for latching or momentary conditions and have an LED status indicator.

- F. The security alarm panel shall be capable of dialing telephone number(s) to transmit alarms to a central operator.
- G. The Security Alarm Panel shall have the following minimum features:
  - 1. Have an assignable alarm zones for instant, delayed or motion alarms. Provide I/O capacity minimum to incorporate individual alarm I/O as shown in the electrical drawings and capability to expand to 64 alarm contacts minimum.
  - 2. The input power shall be 120 VAC, 60 Hz to a wall pack power supply. Providing a secondary voltage to the alarm mother board and auxiliary daughter boards. The panel shall contain backup battery power with battery charger and batteries. Batteries shall provide a minimum of 4 hours of backup power to the complete system.
  - 3. System shall provide status outputs (form C, 120 vac dry contact) defined as "alarm active" and "alarm set" for connection to the station control system.
  - 4. System shall accept a dry contact input from station control system for alarm toggle to turn the alarm on and off remotely through the station control system.
  - 5. Central station-based access control and reporting of alarm conditions, programming and monitoring of the security alarm system.
  - 6. Keypad display and operator interface.
- H. Provide Gemini X255 system or equal.

## 2.02 BASE MODULE

- A. The Base Module shall be the primary control unit for the security alarm system and shall interface with all other modules, devices, and provide communication with the central station-monitoring console.
  - 1. Arm/Disarm function that shall have the following features:
    - a. Up to 16 LCD and/or LED keypads, and automatic, automatic no-dial, or secure arming functions.
  - 2. Primary power shall be 120 Volts AC, 60 Hz, using 16.5 VAC, 50 VA, class 2 plug-in transformer. Backup battery power shall be a 12 VDC, 7 AH, sealed lead-acid rechargeable battery system with internal battery charger.
  - 3. Communications with Central Station includes Base Module RS-485 Port. The Base Module shall support alarm points which includes:
    - a. 16 total LCD and/or LED keypads.
    - b. Eight Expansion Modules.

- c. Programmable alarm codes.
- d. Programmable access and arming.
- 4. Module shall have telephone line features such as dedicated and dial line settings, and RJ31X jack connection.
- 5. Annunciation shall include a local bell drive with 12 VDC at 1.25 Amp maximum, audible keypad beeper, and audio sensor annunciate Watch Mode & Entry/Exit.
- 6. Base Module shall be UL Listed and approved.
- 7. Base Module shall be Sonitrol to match Owner Standard.

## 2.03 ACCESS MODULE

- A. The Access Module shall add central station-based access control to the security alarm system. The Base Module shall interface and control the Access Module. The Access module shall have the minimum features:
  - 1. General features shall include:
    - a. Access control for up to 10,000 users, with 256 Access Levels.
    - b. 128 programmable Time Shifts & Time Periods per property.
    - c. Programmable outputs to control equipment, such as HVAC and lighting.
    - d. 8,000 event local buffer memory.
  - 2. There shall be 16 programmable (N.O., N.C. or both), supervised, hard-wired Alarm Loops featuring:
    - a. Four programmable door inputs.
    - b. 10 programmable, general-purpose alarm inputs.
    - c. One tamper input.
    - d. One global free-exit input (for fire evacuation).
    - e. Programmable alarm codes.
    - f. Assignable to any of eight separate arming zones.
  - 3. Auxiliary Outputs shall feature:
    - a. Six, 100mA, programmable hard-wired outputs.
    - b. One auxiliary output per access controlled door (four total).

- c. Two auxiliary outputs for general control.
- 4. Communications Access Module shall be RS-485 Port.
- 5. Access Module shall be UL Approved.
- 6. Access Module shall be Sonitrol to match Owner Standard.

## 2.04 SMART AUDIO MODULE

- A. The Smart Audio Module shall screen out common environmental sounds through the continuous scanning its audio channels. The Smart Audio Module shall analyze sounds according to a predetermined set of audio standards and when a noise is determined to be a possible intrusion, the central station shall be contacted. The Base Module shall interface and control up to eight SmartAudio or ListenIn Modules. The Audio Module shall be mounted locally inside Base module chassis.
  - 1. Audio functions shall feature:
    - a. Eight audio detection circuits.
    - b. Audio detectors assignable to any of eight separate arming zones.
    - c. Sensitivity adjustable from central station.
    - d. 16 audio sensor inputs (two per audio detection circuit).
    - e. Programmable audio sensor self-test at system arming and disarming.
    - f. Balanced audio output to Base Module.
  - 2. Communications Smart Audio Module shall be RS-485 Port.
  - 3. Smart Audio Module shall be Sonitrol Smart Audio Module to match Owner Standard.

## 2.05 LCD KEYPAD AND DISPLAY

- A. LCD keypad shall have the following minimum features:
  - 1. LCD type display with Wiegand or similar communication compatible with alarm system main control module.
  - 2. Operating temperature of 0 to 122 degrees F.
  - 3. Display shall be Alphanumeric LCD display with English description of alarm zone or other diagnostic information. Keypad shall have silicone rubber keys with numeric digits and shortcut keys for setting alarm and programming.



## 2.06 AUDIO SENSORS

- A. Determine all sensor placement locations, mounting necessary, and all environmental conditions that shall determine the working coverage area and distance for each audio sensor. Provide interface of sensors with the Smart Audio Module. The Audio Sensors shall have the following minimum features:
  - 1. Input power 12 VDC.
  - 2. Constructed with ABS plastic housing.
  - 3. Tamper switch rated to 500mA at 30 VDC.
  - 4. Coverage area shall be approximately 50 feet in front, 40 feet to each side and 15 feet to the rear.
- B. Audio Sensors shall be Sonitrol plus AudioSensor to match Owner Standard.

## 2.07 SECURITY DOOR SWITCHES

- A. Provide interface of all switches with the Smart Audio Module and determine all switch placement locations and all switch mounting as necessary.
- B. Security Door Switch
  - 1. Each security steel door switch shall have a wide gap magnetic sensor with S.P.D.T. contacts mounted an ABS in housing. Security door switch shall be Sentrol 1076 with color matching door.
    - a. Each security door switch shall be a recessed hermetically sealed magnetic reed switch with S.P.D.T. contacts. The reed shall be plotted in the contact housing with a polyurethane based compound and contact and magnet housing shall snap-lock into a  $\frac{3}{4}$ " or 1" diameter hole. Contact and the magnet plastic housings shall be constructed from one piece of thick walled ABS plastic for maximum strength and durability. Housings shall be off-white in color. The magnet shall be made of Alnico
      - 1) The Rare Earth Magnet shall be made of neodymium iron boron.
    - b. Security door switches shall be designed for use in steel doors and shall have snap-lock insulation bushing for tight fit and maximum gap in steel. Magnetic switch shall be an A type contact, closed loop two wire suitable for security alarm systems, and shall be rated at 100 VAC, 0.5A maximum, 7.5 Watts maximum.
    - c. Security door switch shall be Sentrol R1078C series or equal.
- C. Overhead Door Magnetic Security Switch

1. Each overhead door security switch shall be designed specifically for panel or sectional style overhead doors. Contact shall have an integrated mounting bracket that is adjustable to fit most door channel widths. The contacts shall be constructed with a rugged extruded aluminum housing potted with a polyurethane potting compound, which shall make the unit corrosion resistant. Magnetic switch shall be an A type contact, closed loop two wire suitable for security alarm systems, and shall be rated at 100 VAC, 0.5A maximum, 7.5 Watts maximum.
2. Security overhead door switch shall be Sentrol 2315 series or equal.

## 2.08 ALARM SIREN

- A. Alarm siren shall meet the following requirements:
  1. 12 VDC, 1.9 Amps and with sound output of 112 dBA at 10 ft.
  2. Polycarbonate housing with rust proof screw, "potted" electronics condensation drainage holes making siren corrosion resistant.
  3. Alarm siren shall be protected against foam injection, removal of cover or prying from the wall, and provide a "hold-off" circuit which activates the siren from internal battery if external wiring is cut.
  4. Tone Module: Wail – Conventional Siren.
- B. Alarm Siren shall be Sentrol AS 395 series or equal.

## 2.09 SECURITY ALARM PANEL ZONES

- A. The sensors shall be connected to 16 distinct zones as submitted and approved.
- B. See Contract Drawing P5 for the Security Alarm System Block Diagrams.

## 2.10 CARD READER

- A. Card Reader shall be outdoor rated, compatible with door mullions. Reader shall recognize card formats up to 85 bits. Card reader shall be HID ProxPoint Plus to match Owner standard.

## 2.11 PROXIMITY DEVICE

- A. Handheld proximity device shall be small enough to fit on a key ring, contain a programmable ID number and be compatible with card reader. Provide thirty (30) HID ProxKey II devices to match Owner standard.

## 2.12 ELECTRIC STRIKE PLATE

- A. Electric strike shall be provided with 12/24V dual voltage solenoid, adjustable keeper and adjustable fail-safe/fail-serve. Electric Strike shall be Von-Duprin 5100 series to match Owner standard.

## 2.13 MOTION DETECTORS

- A. Motion detector shall suitable for indoor use and use dual technology to detect motion. Provide Gemini GEM-DT or equal.

## 2.14 LIGHT BEAMS

- A. Light beams shall detect the intruders by emitting a light from one unit to be received by a similar unit. In the event the beam of light between the devices is broken, the alarm output shall trigger.
- B. Features:
  - 1. Capable of outdoor ranges up to 500 ft with automatic gain control.
  - 2. Twin infrared transmitters and receivers to reduce the potential for alarms from small animals, blowing debris and falling leaves.
  - 3. Light beams operate by only triggering an alarm when both beams are broken simultaneously.
  - 4. Adjustable beam interruption time 50 to 500 mSec.
  - 5. Viewfinder and voltage meter jacks to aid in installation setup.
  - 6. Power input from 10.5 to 30 VDC, 50mA.
  - 7. Form C alarm output contact, 1 A, 30 VDC.
  - 8. Wall or pole mounting.
  - 9. Adjustable beam alignment up to +/- 10 degrees from horizontal.
  - 10. Suitable for outdoor installation in full sun with operational temperature range from -13 to 131 deg F.
- C. Light beams shall be Optex AX-500PLUS or equal.

## PART 3: EXECUTION

### 3.01 WORKMANSHIP

- A. All work in this Section shall conform to the codes and standards specified in Electrical Specifications [Electrical General, Workmanship].
- B. Requirements of Electrical Specifications Sections apply to design, documentation construction, configuration and testing and assembly the alarm systems.
- C. Perform work to remedy non-compliant installations after inspection.

### 3.02 INSTALLATION

- A. Wire control panels in field utilizing terminal blocks for all field connections in main panels.
- B. Make final connections at field devices and adjust for proper operation.
- C. Test entire system for operation. Each remote trip function shall be tested to produce alarm and be noted on display.
- D. See electrical symbols and abbreviations drawing for symbol definition.
- E. All work shall conform to local codes and 1999 National Electric Code.

### 3.03 FIELD ASSISTANCE

- A. Testing, checkout and start-up of the security system shall be performed under the technical direction of a factory trained authorized manufacturer representative.
- B. Document the setup and configuration of parameters within the security system for review and as-built documentation.
- C. Provide 1 hour of "System Setup" Training on operating and maintenance procedures.

### 3.04 WARRANTY

- A. Provide warranty as specified in Electrical Specifications [Electrical General, Warranty].

## **END OF SECTION**

## **SECTION 16932**

### **ACCESS CONTROL SYSTEM**

#### **PART 1: GENERAL**

##### **1.01 SCOPE OF WORK**

- A. Labor, materials, equipment, tools, safety gear, test equipment, incidentals, services, and transportation for a complete electro-mechanical installation as shown on the Drawings, included in these Specifications, or as can be reasonably implied from project descriptions.
- B. To be designed by Contractor similar to other City installations.
- C. Johnson Controls is preferred vendor.
- D. The Access Control System scope of work includes:
  - 1. Provide and install miscellaneous access control devices, conduits, junction boxes, field interconnection wiring, and associated hardware.
  - 2. Program, configure and test system for operation.
- E. The Access Control scope of work includes:
  - 1. Providing and installing Access Control of rating shown on Contract Drawings.
  - 2. Submittal data and drawings.
  - 3. Startup assistance.
  - 4. Field testing.
  - 5. Training
  - 6. Operation and maintenance manuals.
  - 7. Warranty of all components and technical support.
- F. Work includes that specified in Electrical Specifications [Electrical General].

##### **1.02 SUBMITTAL REQUIREMENTS**

- A. Provide submittals and drawings as specified in Electrical Specifications [Electrical General, Submittal Requirements].

##### **1.03 OPERATION AND MAINTENANCE INFORMATION**

- A. Submit hardware Operations and Maintenance Manual per Electrical Specifications [Electrical General].

#### **PART 2: PRODUCTS**

##### **2.01 ACCESS CONTROL SYSTEM (ACS)**

- A. General

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1. The ACS shall be capable of performing and integrating multiple security functions including the configuration, management and monitoring of cardholder access, hardware units (controllers), events, alarms, visitors, tenants, as well as real-time tracking and reporting.

B. System Architecture

1. The ACS shall be highly scalable and include provisions for future growth.
2. The ACS shall be based on an open architecture to support multiple access control hardware manufacturers. The ACS shall be able to integrate with multiple non-proprietary interface modules and controllers, access readers, and other third party applications.
3. The ACS shall be both a multi-user and a multi-tasking environment.
4. The ACS shall be an IP enabled solution. All communication between the hardware controllers shall be based on standard TCP/IP protocol.

C. System Design Guidelines

1. The ACS shall be compatible with multiple 32-bit operating systems. The ACS client and server modules shall run on Windows XP Professional with Service Pack 3 or Windows Server 2003 with Service Pack 1.
2. The ACS shall be designed using the latest and most advanced design tools.
  - a. The core client/server software shall be built using Microsoft .NET and the C# (C-Sharp) programming language.
  - b. The ACS database server(s) shall be built on Microsoft's SQL Server 2005, including SQL 2005 Express Edition.

D. System Scalability and Capacity

1. The ACS shall be capable of supporting a wide range of configurations. The ACS shall be capable of supporting small access control configurations that consist of a single door and one reader. The ACS shall also be highly scalable to support configurations consisting of a multitude of doors with facilities spanning multiple geographic areas.
2. The ACS shall be upgradeable one entity at a time, for example: 1 credential at a time, 1 door at a time, 1 cardholder at a time, etc.
3. The ACS shall support an unlimited number of Access Server modules. Each Access Server shall support several hundred hardware controllers.
4. The ACS shall support an unlimited number of logs and historical transactions with the maximum allowed being limited by the amount of

hard disk space available.

E. System Security and Encryption

1. Communication between the hardware controllers and server shall be encrypted. The encryption method shall use a 128-bit AES encryption algorithm (at a minimum).

2.02 SERVER SOFTWARE

A. Overview

1. The SSM shall be responsible for receiving, processing and responding to requests from the CSA. The SSM shall consist of a Configuration Server and an Access Server. Several Access Server modules shall be supported per Configuration Server.
2. The SSM shall automatically launch at computer startup, irrespective of whether a user is logged onto the machine or not.

B. Configuration

1. The Configuration Server shall be the central database that contains all the system information and component configuration.
2. The Configuration Server shall support the configuration and management of the following components.
  - a. Door Controllers (hardware units)
  - b. Input and Output (IO) modules (hardware units)
  - c. Doors
  - d. Elevators
  - e. Areas
  - f. Dynamic Graphical Maps
  - g. Cameras
  - h. Schedules
  - i. Access rules
  - j. Cardholders and cardholder groups
  - k. Credentials
  - l. Events/Actions
  - m. Alarms
  - n. Users and user groups
  - o. Security Partitions
  - p. Macros
  - q. Scheduled tasks
  - r. Custom events
  - s. Custom output behavior
  - t. Input – Output (IO) linking
  - u. Custom fields
3. At system startup, the Configuration Server shall download all the configuration information to each Access Server under its control.

4. The Configuration Server shall authenticate users and give access to the ACS based on predefined user access rights or privileges.
5. The Configuration Server shall continuously monitor the following:
  - a. Server application connections
  - b. Controller connections

C. Access

1. The Access Server shall be the server that synchronizes all hardware units under its control. The Access Server shall also be able to validate and log all access activities and events when the controllers are online.
2. The Access Server shall maintain the communication link with the hardware controllers under its control. It shall also continuously monitor whether the controllers are online or offline.
3. Synchronization of hardware units shall be transparent to users and shall occur in the background.
4. The Access Server shall support doors and controllers located within one or more facilities.
5. The Access Server shall download information on the following entities to make the appropriate access decisions:
6. Hardware door controllers and IO Modules
  - a. Doors
  - b. Elevators
  - c. Zones (input points)
  - d. Areas
  - e. Cardholders
  - f. Cardholder groups
  - g. Credentials
  - h. Access rules
  - i. Schedules
7. The Access Server shall store all access events associated with the doors, areas, zones (input points), elevators, and controllers under its direct control.
8. When the information available is not sufficient to make a decision, e.g. the cardholder is unknown; the Access Server shall automatically send a request to the Configuration Server for an update.

D. Monitoring

1. In the event of a malfunction or failure, the Server Monitoring Service shall restart the failed service. As a last resort, the Server Monitoring Service shall reboot the PC should it be unable to restart the service. It



shall also offer the capability to manually start and/or stop one or more of the hardware units.

2. The Server Monitoring Service user interface (UI) shall be accessible from the system tray. The Server Monitoring Service UI shall provide the user with the following:
  - a. A real-time list of hardware units running on a PC
  - b. The status of the hardware units (started or stopped)
  - c. A log of status-related events and associated timestamps
  - d. Telnet console to log onto a hardware unit

E. Web Client

1. The Web Client shall allow users and operators to perform configuration, management, and reporting activities.
2. Web Client shall be accessible through Microsoft Internet Explorer.
3. The Web Client shall be a truly thin client. It shall not require the download of any ACS-specific files or executable on the client workstation.
4. Functionality available through the web client includes.
  - a. Configuration and management of cardholders and cardholder groups
  - b. Configuration and management of credentials
  - c. Configuration and management of access rules
  - d. Badge printing over the network
  - e. Assignment of access rules to doors and areas
  - f. Visitor management including visitor check-in and check-out and reporting
  - g. Advanced reporting

F. Software Compatibility List (SCL)

1. The ACS shall interface with IP-enabled hardware access controllers, interface modules, and IO modules.
2. The ACS shall have an open architecture that supports the integration of third party IP-based door controllers. Through these door controllers, the ACS shall interface with industry standard access control readers.

3. The ACS shall have an open architecture that supports the integration of third party IP-based IO hardware modules. Through IO modules, the ACS shall interface with multiple input points and connect to multiple output relays.
4. The ACS shall simultaneously support mixed configurations of access control hardware from multiple vendors.
5. The ACS shall support multiple types of hardware devices:
  - a. Single-reader controllers
  - b. 2-reader controllers
  - c. 1- to 64-reader controllers
  - d. Integrated readers and door controllers
  - e. Power-over-Ethernet (PoE) enabled door controllers
6. The ACS shall support multiple hardware configurations:
  - a. IP edge devices (door controllers and IO modules)
  - b. Multidrop configuration using the RS-485 configuration protocol
7. The ACS shall support a minimum of the following IP-enabled controllers. For a description of the capabilities of the controller, refer to the controller's A&E specification, or equal.
  - a. Specialty Sensors Technologies Inc.
    - 1) ACIM102A door controller
    - 2) ACIM102B door controller
    - 3) ION168 IO module
  - b. HID Corporation
    - 1) VertX V2000 reader interface/network gateway
    - 2) iCLASS EdgeReader integrated reader and controller (PoE)
    - 3) iCLASS EdgePlus door controller (PoE)
    - 4) VertX V1000 network gateway
8. The ACS shall support most industry standard card readers that output card data using the Wiegand protocol.
9. The ACS shall support HID Clock-and-Data readers.

G. Hardware

1. System shall be installed on SCADA Historical Data Server or other as defined during construction.

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## **PART 3: EXECUTION**

### **3.01 WORKMANSHIP**

- A. All work in this Section shall conform to the codes and standards specified in Electrical Specifications [Electrical General, Workmanship].
- B. Requirements of Related Electrical Sections apply to design, documentation construction and assembly of Access Control System.
- C. Perform work to remedy non-compliant installations after inspection.

### **3.02 INSTALLATION**

- A. All work shall conform to local codes and National Electric Code.

### **3.03 FIELD ASSISTANCE**

- A. Provide 1 hour of "System Setup" Training on operating and maintenance procedures.

### **3.04 WARRANTY**

- A. Provide warranty as specified in Electrical Specifications [Electrical General, Warranty].

**END OF SECTION**

## **SECTION 16933**

### **VIDEO MONITORING SYSTEM**

#### **PART 1: GENERAL**

##### **1.01 SCOPE OF WORK**

- A. Providing and installing video monitoring and control system.
- B. To be designed by Contractor similar to other City installations.
- C. Johnson Controls is preferred vendor.

##### **1.02 REFERENCES**

- A. Electrical Specifications [Electrical General]
- B. Electrical Specifications [Low Voltage Wire & Data Cable]
- C. Electrical Specifications [Control Panel]

##### **1.03 SUBMITTAL REQUIREMENTS**

- A. Provide submittals per Electrical Specifications [Electrical General, Submittal Requirements].
- B. Computer with recording device.
- C. Cameras, software, cabling, special installation requirements.
- D. Camera communications block diagram.

##### **1.04 OPERATION AND MAINTENANCE INFORMATION**

- A. Submit hardware Operations and Maintenance Manual per Electrical Specifications [Electrical General].

#### **PART 2: PRODUCTS**

##### **2.01 VIDEO CAMERA**

- A. Video camera shall be 5.0 MP high-quality, Ethernet IP POE, high-resolution color video camera with a manual variable focus lens and auto-iris, gain and white balance. It shall provide quality video in a wide variety of lighting conditions.
  - 1. Camera shall be suitable for outdoor pole mounting with rain and sunshield protection.
  - 2. 13 image/sec at full resolution
  - 3. 3-9 mm Lens with 28 – 84 degree field of view.
  - 4. Pole mounting bracket and junction box.
- B. Aviglon HD Bullet Camera 5.0-H3-BO1-IR or equal.

##### **2.02 NETWORK VIDEO RECORDER NVR SYSTEM**

- A. Provide NVR system meeting the following minimum requirements.
  - 1. 8 video input channels with RJ-45 POE connectors

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2. 8 channel license with 5 viewing clients.
  3. 10MB/s Recording Rate
  4. 4TB minimum hard drive
  5. Continuous 1080P recording on all channels minimum up to 10MB/s aggregate.
  6. Rack mountable bracket
- B. Avigilon HD Video Appliance VMA-AS1-8P4, or equal.
- 2.03 NETWORK VIDEO SYSTEM ACCESSORIES
- A. Keyboard: USB with 10 ft cord.
  - B. Mouse: Optical wheelmouse.
  - C. Video Monitor, 24" 1080p resolution, HDMI.
  - D. HDMI cable as required
- 2.04 SECURITY DESK
- A. The security desk shall be made from sheet steel and painted gray with oven dried enamel paint.
    1. Slanted writing surface with 4 compartment organizer above that can hold monitor.
    2. Adjustable legs from 36" to 42.5" height.
    3. Dimensions: 30" D x 36" W top surface.
  - B. Acceptable products: Uline H-2058 or equal.
- 2.05 CAMERA POLES
- A. The camera poles shall be as shown in the contract document details.

## **PART 3: EXECUTION**

### **3.01 WORKMANSHIP**

- A. All work in this Section shall conform to the codes and standards specified in Electrical Specifications [Electrical General, Workmanship].

### **3.02 FABRICATION**

- A. Install Computer loaded with camera monitoring software prior to shipment to project site.
- B. Mount, wire and ground computer, power supplies, hubs, etc to survive shipping and installation. Remove computer and other devices for shipment as necessary for security or physical protection reasons as deemed required by manufacturer.

- C. Organize equipment on control panel backpan per Backpan Layout detail in Contract drawings.
- D. Locate and install control panel per Contract drawings.

### 3.03 WIRING

- A. Terminate CAT 5 cabling using RJ-45 plug connectors.
- B. Terminate RG6 cabling with BNC type or appropriate connectors.
- C. Terminate power cabling above grade using wire nuts within the pole.
- D. Label and wire terminal blocks per Electrical Specifications [Wire, Fuses & Terminal Blocks].
- E. Bundle and tie down wires in a neat and orderly manner.

### 3.04 INSTALLATION

- A. Install camera poles per installation details.
- B. Install equipment per Electrical Specifications [Electrical General, Installation].

### 3.05 FIELD ASSISTANCE

- A. Factory test camera system prior to shipment to project site (un-witnessed).
- B. Configure system per Owner Representative's requirements after installation.
- C. Confirm video storage and retrieval of historical archive.

### 3.06 TRAINING

- A. Provide 2 hours training on use, configuration, set-up and troubleshooting of the cameras and systems.

### 3.07 WARRANTY

- A. Provide warranty per Electrical Specifications [Electrical General, Warranty].
- B. Perform the following services during the warranty period:
  - 1. Repair or replace damaged modules returned for service within 24 hours.
  - 2. Determine and report the cause of failure of modules returned for service.
  - 3. Resolve design or implementation problems discovered.

### 3.08 FINAL ACCEPTANCE

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- A. Final Acceptance per Electrical Specifications [Electrical General].

**END OF SECTION**

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## **SECTION 16940**

### **INSTRUMENTATION**

#### **PART 1: GENERAL**

##### **1.01 SCOPE OF WORK**

- A. The major components in the instrumentation scope of work are:
  - 1. Furnish, configure, test, commission, and warrant instrumentation as shown in the P&IDs, plans, and/or listed in specification section.
  - 2. Include necessary piping, valves, pressure reducers, mounting brackets or flanges, supports, and anchors to complete installation.
  - 3. Provide sunshades for instrumentation for all instruments that are exposed to direct sunlight.
- B. System Integrator selection of instrumentation shall be per manufacturer's recommendation for the application and per specifications. If a manufacturer's recommendation or installation instructions are inconsistent with the Contract installation details or specifications, then the Contractor shall submit an RFI describing the inconsistency. If the inconsistency is due to substitution from the first named equipment, then the responsibility of coordination and any additional cost shall be borne by the Contractor.
- C. Provide all devices, valves, tubing, fittings, wiring, terminal blocks, calibration consumables, initial calibration equipment, accessories, sunshades and enclosures as specified herein and as shown on Contract Drawings.
- D. The Contractor shall furnish all tools, calibration equipment, calibration materials, specialized parts and incidentals necessary to integrate the instrument to the application.
- E. Contractor shall furnish labor for installation, verification, start-up, calibration, testing and commissioning. Contractor shall prove proper function of instrument prior project completion.

##### **1.02 REFERENCES**

- A. Electrical Specifications [Electrical General]
- B. Electrical Specifications [Factory and Field Testing]

##### **1.03 SUBMITTALS AND DRAWINGS**

- A. Submit shop documents and drawings for approval in accordance with this subsection and as specified in Electrical Specifications [Electrical General, Submittal Requirements].
- B. Submit Operating Instructions (O&M Manuals) for each instrumentation device prior to equipment installation.

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## 1.04 OPERATING AND MAINTENANCE INFORMATION

- A. Provide operating instructions as specified in Electrical Specifications [Electrical General, Operating and Maintenance Instructions].

## PART 2: PRODUCTS

### 2.01 QUALITY

- A. Electrical Specifications [Electrical General, Quality].
- B. All equipment shall be designed and constructed so that in the event of a power interruption, the equipment specified hereunder shall resume normal operation without requiring a manual reset.
- C. Signal transmission from remote or field electric and electronic devices shall be 4-20 mA, sourced by a 24 VDC supply internal to the instrument or from a 24 VDC power supply located within the panel that is to receive the signal. Nonstandard transmission methods such as impulse duration, pulse rate, and voltage regulated will not be permitted except where specifically noted.
- D. Transmitters or devices located in Class 1, Division 1 hazardous areas shall be rated for hazardous location installations per NEC and UL. Explosion proof enclosures and raceways or current/spark limiting devices located inside or outside of the classified area shall be furnished to comply with code requirements.
- E. Outputs of equipment that are not of the standard signals as outlined, shall have the output immediately converted to 4-20 mA signals for remote transmission.

### 2.02 INSTRUMENT IDENTIFICATION

- A. All major instrumentation and equipment items or systems specified in this Division and/or on the P&IDs are identified by tag numbers. Tag field equipment with assigned instrumentation tag number and functional description.
- B. Tags shall be laminated phenolic material having engraved letters approximately 3/16 inch high extending through the black face into the white layer; firmly secured to panels.
- C. Attach tags to equipment with a 4" long, 20-gage stainless steel wire leash for small devices, or two stainless steel screws for larger instruments; however, such permanent attachment shall not be on an ordinarily replaceable part or in an area that will be subject to unintended overuse fatigue. Make the tag plainly visible.

### 2.03 LEVEL COMPONENTS

- A. Ultrasonic Level Transmitter:
  - 1. The ultrasonic level transmitter shall utilize non-contacting ultrasonic

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signal reflection technology to provide level monitoring for up to 50 ft range.

2. The transmitter shall feature advanced echo processing algorithms that can be configured to ignore selected echos.
3. The transmitter shall be capable of controlling two pumps in a lead/lag configuration or using outputs for high and low level alarm outputs.
4. The transducer level element (LE) shall have the following features:
  - a. Corrosion resistant plastic body, completely submergence rated.
  - b. Rated for Class 1, Div. 1 hazardous atmospheres.
  - c. Operating temperature of -40 to 200 deg F.
  - d. Beam angle (degrees) as required for the application and to avoid obstructions.
  - e. Beam range as required for the application.
5. The level indicating transmitter (LIT) shall have the following features:
  - a. NEMA 4X / IP65 enclosure.
  - b. Ground isolated 4-20 mA output, max load of 750 ohm.
  - c. Two 5 amp at 120V AC, SPDT relays.
  - d. Integral 4 button keypad for configuring parameters.
  - e. Integral 1.5" x 4" (min) backlit LCD display.
  - f. Operating temperature range from -40 to 140 deg. F.
6. The calibration of the level transmitter and cable length shall be as shown in the instrument schedule.
7. Provide one hand held or integral programming interface with each transmitter provided.
8. The ultrasonic level/flow transmitter shall be Endress and Hauser Prosonic S FMU90, Siemens Hydromat 200, or equal

B. Float Switch

1. Tilting float level switches shall be a mercury free float switch, whose specified weight is less than that of the process liquid displaced, to actuate switches as the level changes. The non-mercury hermetically sealed snap action switch is actuated by a steel ball rolling back and forth within a switching tube in plastic float housing. The SPDT switch shall be rated 16A at 250 VAC shall be integrally mounted in the float and connected to a control box by a PVC jacketed waterproof electric cable with three finely stranded No.17 conductors. The weight shall be integrally mounted so that no metals shall contact the process liquid. Tilting type level switch shall be MJK Model 7030, or equal.

C. Chemical Leak Sensor

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1. Non-tilting level switch vertical buoyancy sensor shall consist of a hermetically sealed reed switch that is approximately 1" diameter x 2.1" high. The entire switch shall be submersible rated. The switch shall be actuated by magnets mounted inside the float cylinder. The float shall be non-tilting and shall detect liquid level changes without any movement of the switch housing. The switch shall be cord-hung and fabricated of polypropylene. The switch shall be rated for 0.25 amp at 120 VAC and shall be capable of normally open or normally closed contact configuration simply by rotating the cylindrical float end for end. The float switch shall be Omega LVN-140, Gems or equal.

## 2.04 PRESSURE COMPONENTS

### A. Gauge, Absolute, or Differential Pressure Transmitter:

1. The pressure indicating transmitter shall be a loop powered, two wire, 4-20 mA signal transmitting device with signal derived from the applied sensor pressure. Transmitter shall be capable of driving 0 to 500 ohm loads with 24 VDC supply.
2. The transmitter shall have the following features:
  - a. Programmable 4-digit Liquid Crystal Display (LCD) process indicator.
  - b. HART programming with programming selections for square root extraction, output calibration, and adjustable dampening 0.0 to 36.0 seconds, minimum.
  - c. Integral microprocessor based circuitry with RFI filtering and shielding.
  - d. The transmitter shall have accuracy of +/- 0.1% of span over a range of minimum 10 to 1 turndown. Elevated zero setting capable of 0-30% upper calibration limit.
  - e. Operating temperature range shall be -40 to 185°F (minimum). Process wetted materials shall be compatible with fluid being measured with minimum hastalloy or ceramic diaphragm and 316 stainless steel wetted parts.
  - f. Process connection shall be as follows:
    - 1) Low solids content - 1/2" MNPT with calibration valve.
    - 2) High solids content - 1-1/2" or 2" flange with flushing ring and valve.
    - 3) And as required per installation detail.
  - g. The transmitter shall be scaled as shown in the instrument schedule.

3. Provide mounting bracket per mounting requirements shown in Contract drawings.
4. The gauge pressure transmitter shall be Endress and Hauser Cerabar M PMC 71, Rosemount Smart 3051, or equal.

B. Calibration Valve:

1. Calibration valve for use with gauge transmitters shall have the following features:
  - a. Stainless steel body with integral blocking valve and calibration valve and port.
  - b. Calibration port shall be 1/4" FNPT with 1/4" MNPT x 1/2" FNPT adapter.
  - c. Valve shall have a non-rotating stem tip and a fully backseated bonnet.
  - d. Process and transmitter connections shall be 1/2" MNPT. Include 1/2" stainless steel close nipple as required.
2. Calibration valve shall be Hex HB59, Anderson Greenwood, or equal.

C. Pressure Switch:

1. Each pressure switch shall be SPDT rated minimum of 15 amps @ 120VAC. Pressure switch shall consist of a pressure sensing mechanism and the switch itself enclosed in a NEMA rated housing. Pressure switch shall be diaphragm type with stainless steel wetted parts and mechanical snap action switch. Switch shall have two setpoint adjustments (trip & reset setpoints) with setpoint indicator calibrated in engineering units. Pressure switch shall be UL listed. The pressure switch shall be Static-O-Ring 66 Series, Ashcroft B series; ASCO or equal.

D. Pressure Gauge:

1. The pressure gauge shall be 1% accurate with C-type bourdon tube. The bourdon tube, socket and connection tube of the gauge shall be 316 stainless steel. The case and bezel ring shall be constructed of type 304 stainless steel. The dial shall be 3-1/2" in diameter with a black pointer and a white gauge face with black print. The gauge shall be filled with liquid glycerin. A bottom mount process connection shall include a snubber as a separate component. The process connection shall be 1/2" stainless steel. The pressure gauge shall be Ametek gauge model 1535, Ashcroft 1009, or equal.

## 2.05 FLOW COMPONENTS

A. Magnetic Flow Meter:

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1. The magnetic flow meter shall consist of a flow tube FE and a converter FIT, complete with interconnecting cables.
2. The magnetic flow meter shall be of the low frequency electromagnetic induction type and shall produce a DC pulse signal directly proportional and linear to the flow rate, with the duration not less than 100 milliseconds. Complete zero stability shall be an inherent characteristic of the metering system. Meters requiring field zero adjustment will not be acceptable. The meter accuracy shall not be affected by changes in fluid pressure, temperature, viscosity, or conductivity.
3. Accuracy
  - a. The maximum error of the complete metering system including flow element and flow indicating transmitter shall be 0.30% of actual flowrate (in specified units) and readout over the range of full scale velocity settings from 1 to 30 feet per second. Variations in temperature, voltage, and frequency within the ranges listed herein shall not affect the overall measuring accuracy.
  - b. The flow meter shall not require more than three diameters of straight pipe length from the center of the meter to upstream or downstream obstructions to obtain specified accuracies.
  - c. Lack of straight pipe or obstructions to straight length pipe requirements shall not cause overall flowmeter inaccuracies to exceed more 0.5% of actual flowrate over the range of full scale settings from 1 to 30 feet per second.
4. Flow Element (FE)
  - a. The flow element shall be based on a pipe spool with ANSI class 150 flange connections or be flangeless construction as required by mechanical drawings. Class 300 flanges shall be provided where shown or when the pressure and temperature of the process fluid exceeds the rating of a 150 lb flange. The flow element size shall be as shown in the mechanical drawings and listed in the Instrumentation Schedule. Flange type and bolt pattern shall be coordinated with the mechanical Contractor prior to submittal.
  - b. The flow element shall have Hastalloy C4 coil and grounding electrodes.
  - c. Stainless steel grounding rings shall be provided at both ends of the flow element for all flowmeter applications. Grounding rings shall be manufactured from stainless steel, 2 mm thickness with grounding tab for electrical wire connection, and fit within the flange bolt circle. Grounding ring shall be self centering within pipe.

- d. The flow element internal liner material shall be Teflon, polyurethane or hard rubber, unless recommended otherwise by the manufacturer for the application and approved.
  - e. Nema rating as defined in the Instrumentation Schedule.
5. Flow Indicating Transmitter (FIT)
- a. The electronic flow indicating transmitter shall be mounted remotely from flow tube as shown on Contract drawings.
  - b. The electronic transmitter shall be provided in a NEMA rated enclosure per the Instrumentation Schedule.
  - c. The transmitter shall be interchangeable with all sizes of flow elements and shall be field replaceable (without replacing flow element) in the event of transmitter failure.
  - d. The transmitter shall be microprocessor controlled, utilizing digital signal processing with automatic zero correction to provide a linear 4-20 mA signal proportional to flow rate.
  - e. The transmitter shall incorporate a high impedance amplifier of 100,000 Megohms or greater, eliminating the need for electrode cleaning systems.
  - f. The transmitter shall contain a self test mode to allow the operator to manually simulate the output 4-20 mA signal to any value between 0% and 100% to check out any driven devices in the loop.
  - g. Rate indicator and totalizer: An alphanumeric LCD backlit display shall be provided to continuously display the flowrate and totalizer with units and all programming functions.
  - h. All programming configuration of the Flowmeter shall be completed through the transmitter's pushbutton interface. A communication device shall not be necessary to configure the flow transmitter.
  - i. PC based software shall be available and included for configuration and troubleshooting. Connection to flowmeter shall be via computer USB port and include interface cables as required.
  - j. The transmitter shall be designed for operation from a power source of 120 volts AC, with a power consumption of less than 20 watts. The flow element shall be powered from the transmitter.
  - k. The transmitter shall operate continuously without fault in an ambient temperature range from 14 to 140 °F. The flowmeter shall be suitable for operation in direct sunlight without the use

of a sunshade. If a sunshade becomes required after installation for any operational reason, one shall be furnished and installed free of charge.

I. The following configurable parameters shall be provided at a minimum:

- 1) Field adjustable flow signal dampening.
- 2) Low flow cutoff (forces zero flow signal) between 0.0-5.0% of full scale rate.
- 3) Empty pipe detection (forces zero flow signal) if the pipe is not full.
- 4) Selection for forward/reverse/both flow directions.

6. Flow Indicating Transmitter (FIT) I/O Interface

a. Network Communication

- 1) The transmitter output(s) shall be integral to the magnetic flowmeter transmitter electronics; and must be located within the transmitter housing. Using an external signal converter is not acceptable.
- 2) Protocols
  - i Ethernet Schneider Automation Modbus TCP
  - ii No equal.
- 3) The transmitter output selected must be supported by add-on instructions (AOI), add-on profiles (AOP), that can be imported to the Programmable Logic Controller specified in the is project. AOIs and AOPs include device drivers, instructions and pre-engineered PLC code.

b. Flow Signal: 4-20 mA signal proportional to the flow. The signal shall be field configurable for the flow calibration specified and others within the flow tube accuracy range. The flow signal shall be capable of measurement for forward and reverse flows combined by offsetting zero to mid scale (12 mA).

7. If the flow indicating transmitter (FIT) is shown in the Contract drawings to be mounted remotely from the flow element (FE), the manufacturer shall provide all cabling between flow element and flow indicating transmitter.

8. All mounting hardware and/or devices necessary to complete the installation shall be provided by the manufacturer at no additional cost to the Owner.

9. The meter shall be hydraulically calibrated at a facility located in the United States and the calibration shall be traceable to the National Bureau of Standards. A certified copy of the calibration test results shall be submitted to the Owner prior to shipment of the meter.
10. The magnetic flowmeter shall be Endress and Hauser Promag 400L, or equal.

B. Flow Switch:

1. The flow switch shall be vane operated to actuate 5A SPDT snap action switch. Motion of the vane shall actuate the switch by action of a magnet linked to the switch inside the sealed stainless steel switch body. Flow switch shall be W.E. Anderson Dwyer Flowtect V4 or equal.

## 2.06 ANALYTICAL ELEMENTS

A. Chlorine Residual:

1. Description: Direct sensing chlorine analyzer to monitor a continuous flow of process water to determine free chlorine residual level.
2. The microprocessor based analyzer shall continuously display the chlorine residual with range as shown on the Instrumentation Schedule.
3. The measuring cell shall provide continuous on-line measurement of residual levels from 0-5 mg/l to 0-20 mg/l. The display shall be capable of 0.01 mg/l resolution (min) for the lower scale range.
4. Operating temperature: 32° F to +122° F. Provide sunshade when exposed to direct sunlight.
5. Analyzer Electronics.
  - a. The analyzer shall be controlled by microprocessor based electronics powered from 120 VAC. Analyzer shall be protected from voltage fluctuations commonly found in water/wastewater applications. Additional external noise filtering shall be provided as necessary for a robust and operational system. System lock-ups or microprocessor malfunctions will be grounds for rejection throughout the warranty period.
  - b. Analyzer electronics shall be enclosed in a NEMA 4X polycarbonate enclosure.
  - c. User interface shall include a membrane keypad and backlit LCD display.
  - d. Alarm conditions shall be identified through the display.
  - e. The system shall have one isolated 4-20 mA output which represents chlorine residual and scaled by the user during



commissioning from a selected list of ranges from 0-0.1 to 0-50 mg/l. Output signal shall be configurable to desired span without recalibration of the sensor

- f. Three (3) user configurable alarm relays shall be provided for low residual, high residual and diagnostic conditions.

- 1) Relay contacts shall be rated 5 amperes at 110 V.

6. Probe

- a. Membraned amperometric sensor probe with electrolyte fill liquid. Maximum pressure or flow at probe shall not be exceeded.
- b. The probe shall include temperature sensor for temperature compensation in chlorine measurement.
- c. The pH sensor shall include the flow thru cell and sensor for online measurement.
- d. Include flow cell and associated valves, pressure regulators, tees, strainers and piping for complete installation in the intended location. Installation of flow cell piping shall maintain liquid on probe surface even when flow is shut off.

7. Spare Parts.

- a. One year supply of consumable materials as recommended by manufacturer.
- b. On spare electrode, complete unit with plug-in to transmitter.

- 8. Chlorine Analyzer shall be Hach CLF10sc with flowcell and SC200 controller to match existing.

## 2.07 TEMPERATURE DEVICES

A. Room Temperature Transmitter:

- 1. The temperature indicating transmitter shall provide display of temperature and provide linear output signal derived from the temperature of the integral or remote RTD measuring sensor.
- 2. Temperature Transmitter
  - a. Loop powered, two wire, 4-20 mA, capable of driving 0 to 500 ohm loads from 24 VDC supply.
  - b. 3-1/2 digit, 0.37"H, Light Emitting Diode (LED) display.
  - c. Zero and span adjustments for display and temperature transmitter.

- d. The transmitter shall have accuracy of +/- 0.5% of span over an operating temperature range of 0 to 150°F.
  - e. Furnish remote RTD for outdoor temperature measurement as required per plan.
3. The wall mount transmitter shall be Devar Model RTTI(-R) or equal.

## 2.08 EVENT, STATE OR POSITION DEVICES

### A. Position Switch:

- 1. Door switch – door intrusion switch shall have a wide gap magnetic sensor with S.P.S.T. contacts mounted in an aluminum housing with integral jacketed cable for wiring to a junction box. Switch contacts shall have 0.1A at 120VAC minimum capability. When attaching to a ferrous metal surface, space sensor components away from metal by minimum ¼" using plastic spacer in order to maintain magnetic gap. Intrusion door switches shall be Sentrol 151-6Z-12K or equal.
- 2. Overhead door switch – door intrusion switch shall have a wide gap magnetic sensor with S.P.D.T. contacts mounted in an aluminum housing with integral 3 foot stainless steel armored cable for wiring to a junction box. Switch contacts shall have 0.5A at 120VAC minimum capability. When attaching to a ferrous metal surface, space sensor components away from metal by minimum ¼" using plastic spacer in order to maintain magnetic gap. Intrusion door switches shall be Seco-Larm SM Series or equal.
- 3. Hatch or Vault – hatch or vault intrusion switch shall include a pre-wired factory sealed 5 foot cable for wet applications. Roller level switch shall be 316 stainless steel with roller and 1.19" to 3" radius adjustable lever arm. Switch shall have two independent sets of contacts that actuate with clockwise or counter clockwise lever movement. Tank hatch switch shall be Allen-Bradley Model 802MC-AY5 with 802MC-W2B lever or equal.
- 4. Valve Limit Switch – The valve mechanical position indicator shall to actuate the position limit switch(s). The limit switch shall have a rotating steel arm with end roller or plunger that can be adjusted to actuate the switch at the fully open or closed position of the valve. The switch shall have 10 amp S.P.D.T. contacts mounted in a water-tight housing. The limit switch shall be Allen Bradley 802T with 1.19" to 3" radius adjustable lever arm, or equal.

### B. Smoke Detector:

- 1. General
  - a. The smoke detector shall detect smoke produced by fire and signal an alarm system. The detector shall be housed in a flame retardant plastic housing and shall be unaffected by vibration. Detector shall be sealed against dirt, insects and

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back pressure

- b. Detector shall utilize photoelectronic sensor technology.
  - c. The detector/base shall be 120V, four-wire operation with built-in Form A and Form C dry contacts. Form A contact shall be rated for 2.0A at 30VAC/DC. Form C contact shall be rated for 2.0A at 30VAC/DC and 1.0A at 120VAC.
  - d. The detector shall have an operating temperature 32 to 120°F and an operating humidity of 10 to 93% relative humidity.
  - e. The detector shall have built-in test switch (magnetic proximity actuation) and 360 degree view angle of built-in alarm LEDs.
  - f. The detector shall be approved by UL and Factory Mutual and meet requirements of NFPA 72.
2. The fire alarm smoke detector shall be photoelectric type. The smoke detector shall be System Sensor 100 Series model 2151 with B114LP base, Gentex 8000 Series with 120VAC base, or equal.

## 2.09 MOTOR OR EQUIPMENT PROTECTION DEVICES

### A. Vibration Sensor / Transmitter:

- 1. Solid state, loop powered vibration transmitter providing a 4-20 mA output that is proportional to overall vibration in terms of velocity. The unit shall continuously monitor machinery health by sensing vibration and transmit signal into a PLC for trending, alarm and/or machine shutdown.
- 2. Installation: Mount the sensor into a tapped hole in the bearing housing or machine case using a stainless steel threaded 1/4"-28 UNF stud with Loctite 222. Prepare surface by grinding smooth and applying a machine oil coupling fluid. Connect electrical conduit directly to the top 3/4" NPT fitting and connect two wires into a 4-20 mA loop.
- 3. Specifications:
  - a. Dynamic Output: 4-20 mA proportional to full scale velocity
    - 1) 0-0.5 Inches per Second peak
  - b. Frequency Response: 2 Hz to 2,000 Hz
  - c. Buffered Output: Acceleration, 100 mV/g
  - d. Accuracy: ±5%
  - e. Two wire loop power: + 20 to + 30 Vdc
  - f. Maximum Load: 600 Ohms resistive
  - g. Grounding: Case Isolated

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- h. Environmental Operating Temperature: -20° C to +80° C
  - i. Sealed Epoxy Encapsulated 316L SS, NEMA 4, 4X, 12
  - j. Mounting: 1/4"-28 UNF Stud Mounted
  - k. Weight: 8 oz.
4. The Vibration sensor transmitter shall be Robert Shaw 570B, Hardy Instruments HI5701-VT, STI CMCP-420VT, or equal.

## 2.10 INSTRUMENTATION SUN PROTECTION

### A. Instrument Sunshade

- 1. Provide wall mount bracket or pole mounted sunshade where instruments are exposed to direct sunlight. Sunshades shall be fabricated from stainless steel. Sunshade shall be custom manufactured for the instrument protected and sized such that there is 3" free space around sides and front of instrument.

- B. Instruments shall be oriented facing either North or East to minimize direct sunlight exposure where ever possible.

## 2.01 INSTRUMENTATION SCHEDULE

- A. The Instrumentation Schedule spreadsheet (located at the end of this section) is intended to be a summary of instrumentation equipment required for this project. Not all instrumentation details are shown on the schedule. Some requirements may be shown in the Instrumentation Schedule such as enclosure rating and instrument span that are not described in the specifications. Both are required for a complete specification.
- B. If an instrument is shown in the P&IDs or on the site plan, then the device shall be provided whether or not it is shown on the Instrumentation Schedule.

## PART 3: EXECUTION

### 3.01 WORKMANSHIP

- A. Instrumentation work shall conform to workmanship standards specified in Electrical Specifications [Electrical General, Workmanship].
- B. The Contractor shall employ personnel who are skilled and experienced in the installation and connection of equipment defined in this section. Contractor qualifications are specified in Electrical Specifications [Electrical General].
- C. Verify that all equipment and materials fit properly.
- D. All instrumentation configuration, programming and calibration shall be completed prior to the start of field tests.
- E. Equipment without approved submittals shall not be installed.
- F. All equipment shall be properly stored indoors while awaiting installation.

Protect installed equipment from construction debris or mishaps. The Contractor will replace any equipment that is not in new condition at the time of installation and/or start-up.

- G. Perform work to remedy non-compliant installations after inspection.

### 3.02 INSTALLATION

- A. Install and supply all products necessary to provide an operational instrumentation system. This shall include the following:

1. Contract Drawings are intended to show the basic functional requirements of the instrumentation system. Insufficient detail does not relieve the Contractor from the responsibility to provide a complete and functioning system. If additional detail or clarification is required, the Contractor shall request such information prior to installation.
2. Provide relays, signal converters, isolators, boosters, power conditioners, circuit cards, and other miscellaneous devices as required for the compatible and functional interface.
3. Provide analog loop isolators where required to eliminate "ground loops."
4. The instrumentation and accessory equipment shall be installed in accordance with the manufacturer's instructions and located as shown on the Drawings or as approved. When manufacturer's installation literature specifies a particular location or orientation in a process line due to measurement accuracy considerations, the installation shall be in conformance with the manufacturer's instructions.

- B. Instrument installation methods.

1. Install instruments at the location shown on the Plans or approved. Instruments enclosures shall be NEMA rated for the installed location.
2. Install level and plumb.
3. All instruments shall be provided with floor stands or wall brackets as shown in installation details or as required for functional installation.
4. Mounting stands shall be custom manufactured of aluminum channel with base plate unless otherwise noted in installation detail.
5. Mounting channels (unistrut), and spacers shall be galvanized steel above ground outdoors and stainless steel below ground (wetwell), unless otherwise noted in installation details.
6. All screws, bolts and anchors shall be stainless steel.

- C. Wiring and raceway installation methods:

1. Terminal blocks shall be provided at all instrument cable junctions and

all wires shall be identified at such junctions.

2. Instrumentation wiring shall be run without splices between instruments, terminal boxes, or panels.
- D. Wiring, grounding, and shielding: The following practices shall be observed unless modified by manufacturer's standards.
1. Each electronic equipment chassis shall be grounded to power ground.
  2. Shielded twisted pair, shielded triad, or manufacturer supplied cables only shall be used for analog signals and communications signals.
  3. Drain wire of shielded cables used for analog inputs to the PLC shall be connected at the PLC unit only. Shield shall be isolated from ground at all other termination points including transmitters.
  4. Drain wire of shielded cables used for analog outputs from the PLC shall be connected at signal receiving device only. Shield shall be isolated from ground at all other termination points.
  5. If electrical interference noise is imposed on DC status and alarm signals, then they shall be re-routed or wire changed to shielded twisted pair cables.
  6. Each shield drain wire which is not connected to ground shall be cut off covered with a heat shrink insulating boot at cable jacket end. Shields shall be connected together at each transition from one cable to another for an effectively continuous shield circuit.

### 3.03 SUPPLIER SERVICES

- A. The Contractor shall be responsible for each supplier of equipment to provide the following minimum services for each type of instrument supplied. Each supplier shall provide a qualified instrumentation field technician to perform services listed herein. Contractor shall supply all calibration materials necessary to commission unit and shall not use any consumable materials that are intended to be furnished for the first period of use.
1. Advise and instruct Contractor on proper installation requirements.
  2. Inspect, calibrate, test, and place equipment in operation. Calibrate instruments to values as shown in the instrument index or as noted herein. If instrument spans are required to change (within instrument range) during startup for process reasons, the Contractor shall change them as directed by the Engineer.
  3. Programmable devices shall be programmed and tested prior to startup. Programming shall be adjusted or changed as directed by the Engineer at any time prior to final acceptance.
  4. Perform testing in the presence of Engineer.

5. Visit the project site as often as required and spend as much time as necessary to ensure accurate and operational instrumentation.
  6. Provide training as specified in FIELD ASSISTANCE.
- B. The Contractor shall coordinate with each supplier of instrumentation to confirm that primary elements are provided in a timely manner, meeting critical path scheduling. The Contractor shall coordinate process connection size, equipment size, and material type when applicable and oversee the installation, calibration, and acceptance testing.

#### 3.04 FIELD ASSISTANCE

- A. The instrument supplier shall provide a minimum of one (1) hour of field training to instruct Owner's personnel in the use, operation, calibration, programming, and maintenance on each type of "field" instrument.

#### 3.05 SPARE PARTS

- A. Provide spare parts as described in each products section herein and specified in Electrical Specifications [Electrical General, Spare Parts].
- B. Contractor shall supply all calibration materials necessary to commission unit and shall not use any consumable materials that are intended to be handed over to the Owner as defined in the instrument specifications.

#### 3.06 WARRANTY

- A. Provide warranty as specified in Electrical Specifications [Electrical General, Warranty].

#### 3.07 FINAL ACCEPTANCE

- A. Final Acceptance per Electrical Specifications [Electrical General].

### **END OF SECTION**