GRANGER-HUNTER IMPROVEMENT DISTRICT

ANDERSON WATER TREATMENT PLANT PROJECT

Volume II
BID SET
TECHNICAL SPECIFICATIONS

November **2024**

GRANGER-HUNTER
IMPROVEMENT DISTRICT

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GRANGER-HUNTER IMPROVEMENT DISTRICT
ANDERSON WATER TREATMENT PLANT
TECHNICAL SPECIFICATIONS

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SECTION 01010
SUMMARY OF WORK

PART 1 GENERAL

1.1 SECTION INCLUDES

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1.2 CONTRACT DESCRIPTION

A. This project consists of the furnishing and installing all labor and materials for the construction of the Anderson Water Treatment Plant including site work and yard piping. In particular the contract consists of the following:

1. Provide construction of the water treatment plant, including the construction of the new building including water proofing, drainage, and final site grading as required.

2. Provide all site civil, mechanical piping, HVAC, plumbing, structural, architectural, electrical, instrumentation, and all other ancillary work associated with the new facility.

3. Install Owner-partially procured filter system equipment and appurtenances. Review equipment schedules in the General sheets and coordinate with Owner. Reference Volume IV Filter System Procurement Executed Contract Set.

4. Coordinate all sewer, water, and other utility tie-ins and assist with commissioning of new facilities.

5. Coordinate with APCO, Inc. for controls and integration—supply and installation of CP-1. See Volume I – Attachment A for detailed scope and fee.

6. The site must be secured at all times. If the contractor removes the existing fences

(chain link, wrought iron, vinyl, etc.) then the permanent fence needs to be installed immediately or temporary fencing installed to provide a site that is continuously secured at all times.

1.3 REGULATORY REQUIREMENTS AND PERMITS

A. Comply with all Federal, State, and local laws, regulations, and ordinances applicable to work.

B. Reference in Contract Documents to local codes shall mean the codes in effect in the State of Utah, Salt Lake County, West Valley City, and the Utah Division of Drinking Water.

C. Contractor shall apply for, pay for, and execute all permits applicable to the work.

D. Other standards and codes that apply to the work are designated in the Specifications.

1.4 WORK BY OWNER

A. Normal day-to-day operations of the water treatment plant and water distribution system will be ongoing. Construction shall not isolate or interrupt the existing water transmission and distribution activities, including, but not limited to, Owner's staff operation, maintenance, and repair except as specifically described herein.

B. Wherever existing systems and equipment are scheduled to be taken out of service, Contractor shall coordinate with the Owner and provide several days of advance notice. The Owner will operate all valves and equipment to shut off and isolate the system from the flow stream.

1.5 CONTRACTOR USE OF SITE AND PREMISES

A. Limit use of site and premises to allow:

1. Access by property owners.
2. Work by Owner.
3. Work by Contractor.

B. Construction Operations: Limited to construction and staging areas indicated by owner.

1.6 WORK SEQUENCE

A. Construct Work in a manner to meet the requirements of Section 1.2 above during construction period, coordinate construction schedule and operations with Engineer:

B. Submit a proposed work sequence plan with schedule at preconstruction meeting for approval. Contractor's plan may differ from the suggested work sequence plan if the Contractor has different solutions than those suggested, but update monthly.

C. Proposed Work sequence should include the sequence of work that will be performed including:

- Winter 2025 – Begin installation of site piping.
- Spring 2025– Begin construction on WTP Building.
- Summer 2025--Begin installation of new filtration equipment and piping.
- Fall 2025 – Complete interior building finishes.
- Winter 2026 – Startup and commissioning of new filtration equipment.
- Spring 2026 – Substantial completion and final completion.

1.7 PROJECT CONSTRUCTION SIGN

A. Contractor shall provide a single project sign that complies with Granger-Hunter Improvement District, Utah Division of Drinking Water State Revolving Fund, Bureau of Reclamation Water Smart, and West Valley City requirements. Submit final sign design for approval prior to construction.

1.8 ABBREVIATIONS

A. Wherever the following abbreviations are used, they shall have the meanings indicated:

AASHTO	American Association of the State Highway and Transportation Officials
ACI	American Concrete Institute
AGA	American Gas Association
AGMA	American Gear Manufacturers' Association
AI	The Asphalt Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron & Steel Institute
AITC	American Institute of Timber Construction
ANSI	American National Standards Institute
APA	American Plywood Association
API	American Petroleum Institute
APWA	American Public Works Association
AREA	American Railway Engineering Association
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASQC	American Society for Quality Control
ASTM	American Society for Testing and Materials
AWPA	American Wood Preservers Association
AWPI	American Wood Preservers Institute

AWS	American Welding Society
AWWA	American Water Works Association
CBM	Certified Ballast Manufacturers
CLFMI	Chain Link Fence Manufacturers Institute
CRSI	Concrete Reinforcing Steel Institute
DWTF	Drinking Water Treatment Facility
DIPRA	Ductile Iron Pipe Research Association
ETL	Electrical Test Laboratories
FHWA	Federal Highway Administration
IBC	International Building Code
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IPCEA	Insulated Power Cable Engineers Association
ISA	Instrument Society of America
ISO	Insurance Services Office
ITE	Institute of Transportation Engineers
MUTCD	Manual on Uniform Traffic Control Devices
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NEPA	National Environmental Policy Act
NFPA	National Fire Protection Association
NFPA	National Forest Products Association
OSHA	Occupational Safety and Health Act of 1970
PCA	Portland Cement Association
SAE	Society of Automotive Engineers
SEPA	State Environmental Policy Act
SSPC	Steel Structures Painting Council
UBC	Uniform Building Code, International Conference of Building Officials
UDDW	Utah Division of Drinking Water
UL	Underwriters' Laboratories, Inc.
UPC	Uniform Plumbing Code
WCLIB	West Coast Lumber Inspection Bureau
WCRSI	Western Concrete Reinforcing Steel Institute
WRI	Wire Reinforcement Institute
WWPA	Western Wood Products Association

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

END OF SECTION

SECTION 01014
WORK SEQUENCE

PART 1 GENERAL

1.1 OVERVIEW

A. The new WTP will be constructed at a site near Well #16. In general, construction of the new WTP is not expected to significantly impact the distribution of drinking water to the District and the District's storage tanks.

B. Well #16 is to remain in service throughout the project. GHID requires access to the Well.

1.2 WATER QUALITY OBJECTIVES

A. The backwash waste water quality from the new WTP must satisfy the following objectives before release to the sanitary sewer system:

1. The pH shall be between 6 and 9.

2. Chlorine residual shall be less than 10 mg/L.

B. Owner will notify Contractor immediately if the water quality objectives are violated.

C. If Contractor's actions result in a violation of the objectives or an imminent violation as determined by Owner and/or Engineer, Contractor shall mitigate any damages, suspend certain aspects of work if deemed necessary by Owner and Engineer, and fully cooperate with Owner and Engineer to bring facility into compliance with the water quality objectives at no cost to Owner.

D. Penalties and any and all related costs, including but not limited to legal and engineering expenses, imposed on or incurred by Owner as a result of any bypass or water quality objective violation caused by the actions or inactions of the Contractor, its employees, subcontractors or agents, are to be borne in full by the Contractor.

1.3 MAJOR WORK ELEMENTS

A. Site Work

1. The site shall be cleared and graded to allow construction of the new facility.

2. Dewatering may be required and dewatering activities shall be taken into consideration as part of the site work.

3. Yard piping is included as part of the site work and the sequence of installation for yard piping shall be taken into consideration given the variety of piping systems and associated bury depths. Consideration shall also be given to the

numerous existing utilities. Yard piping includes but is not limited to a large diameter chlorine contact chamber, sewer line and manholes, storm drain line and catch basins, backwash waste line, raw water line and bypass valves and vaults, and others.

4. One stormwater system is included as part of the site work.

5. Fencing around the site is included as part of the site work.

6. Improvements to the access road and paving is included as part of the site work.

7. Electrical conduit should be placed after the yard piping.

B. Water Treatment Plant

1. Pipelines and Bypass Valve Vaults

a. Prior to leaving each well site, raw water from each well will be dosed with sodium hypochlorite to pre-oxidize the water for iron and manganese removal and breakpoint chlorination for ammonia reduction.

b. Raw water will be pumped by the Well #16 and #18 pumps into the transmission line to the site (transmission line improvements to the site by Owner and others under separate contract) and then into the WTP.

c. Raw water transmission line enters the site where there is a bypass/isolation valve in the WTP bypass valve vault to direct water to the WTP or to divert the water directly into the distribution system and bypass the site. The bypass valve vault in the WTP provides the capability to bypass the WTP which still receives the benefit of additional contact time through the transmission pipelines on the site.

d. Treated water leaves the WTP through the bypass valve vault and enters the distribution system. Following the pipe loop, the water goes into the distribution system.

e. Future pretreatment or post-treatment processes may tie into the raw water and/or filtered water pipelines. Area for future expansion is included in the site design.

2. Horizontal Pressure Filter System

a. From the bypass valve vault in the WTP, the water will continue to flow under pressure to the horizontal pressure filter system. The filter system includes two (2) horizontal pressure filters with 3-isolated filter cells each. The filter cells are backwashed in sequence using water from other in-service cells and/or the distribution system.

b. Each filter cell contains GreensandPlus(TM) filter media with an anthracite cap. The contractor shall precondition the media with sodium hypochlorite according to the filter manufacturer's instructions.

The chlorinated water used for preconditioning may need to be dechlorinated by the contractor prior to discharge into the sanitary sewer system.

3. Water Treatment Plant Building

   a. In addition to the treatment equipment, the WTP Building will include an electrical control room, restroom, mezzanine, laboratory area, monorail crane, and traveling bridge crane. The mezzanine will include space for mechanical equipment and storage.

C. Disinfection Systems

1. Chlorine (as sodium hypochlorite) can be added as disinfectant at each well and also directly upstream or downstream of the horizontal pressure filters at dosing points inside the bypass valve vault.

2. The dose of chlorine is based on the flowrate as well as feedback readings from an online chlorine residual analyzer. This system shall be fully functional and operational and permitted by Utah Division of Drinking Water prior to introducing any water to the distribution system.

3. The chlorine as liquid sodium hypochlorite is produced by onsite sodium hypochlorite disinfection system (OSHGS) from electricity, water and a brine solution. OSHGS are located at each well and inside the WTP.

4. New OSHGS will be provided in the WTP.

D. Electrical, Instrumentation and Control Systems

1. Permanent (Rocky Mountain Power) and temporary (the District's already purchased Emergency Generator) electrical power shall be provided for the facility and maintained. Contractor is responsible for coordinating with Rocky Mountain Power and the Owner to establish both temporary (during construction) and permanent electrical power supply to the site.

2. A Supervisory Control and Data Acquisition (SCADA) System will be included as part of the facility by others. This system will allow automated and remote control/monitoring of the facility and must be functional prior to plant start-up. Contractor is responsible for coordinating with the Owner's integrator and with the filter system manufacturer for electrical, controls, and SCADA.

3. Electrical conduit should be placed after the yard piping.

1.4 SUBMITTALS

A. Provide detailed outage and time schedule plan for each work item that may impact plant operation. Provide long-range and short-range plans, as appropriate for coordinating work with Owner.

B. Submit in accordance with Section 01300.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 GENERAL

A. Owner will continue to pump water from the wells into the distribution system throughout the construction period and until the new facility becomes fully operational. During this time Contractor shall be responsible for minimizing impacts to the operation of the wells, transmission and distribution lines caused by construction and related activities. Power must be maintained in order to keep the wells operational. All planned work that will have a direct or potential impact to the existing operations shall be scheduled and coordinated with the Owner at least two weeks prior to the start of work.

B. Contractor's means and methods shall be implemented such that the existing infrastructure shall remain in continuous satisfactory operation during the entire construction, startup and commissioning periods. Work shall be scheduled and conducted by Contractor such that it shall not impede any process, create potential hazards to operating equipment and plant personnel, or reduce the quality of the finished water. In performing the work shown and specified, Contractor shall plan and schedule the work to meet both the constraints outlined in this section and operating requirements.

C. Contractor has the option of providing additional temporary facilities that can eliminate a constraint, provided it is done without additional cost to the Owner, presents no safety hazards, and provided that all requirements of these Specifications are fulfilled.

D. Contractor shall be responsible for coordinating all shutdowns with the Owner and Engineer. Contractor shall, whenever possible, combine discrete shutdown procedures identified in this section or by Contractor into a single shutdown when the duration of the shutdowns or the work requirements allow such combining to occur on a unit process or work area. The intent of combining procedures is to minimize the impacts upon operations and processes by limiting the number of shutdowns required.

E. Contractor shall not shut off or disconnect any operating system unless approved by the Owner, in writing. All operations and shutdowns shall be executed by the Owner unless otherwise noted. Contractor shall seal Owner-operated gates and valves to prevent

unnecessary leakage. After Contractor's work has been completed, Contractor shall remove the seal to the satisfaction of the Engineer.

F. Contractor shall be responsible for providing all temporary pipelines, valves, pumps, meters, backflow preventers, spare parts, supports, electrical, power, controls, any other appurtenances, and labor required for the installation and operation of temporary bypass lines, pumping systems, processes, or conveyance systems required to maintain operations of the plant during construction activities, including those items deemed appropriate and/or necessary by the Owner and Engineer for satisfactory operation of the facility.

G. Contractor shall be responsible for washing down and cleaning and disinfecting all tanks, adsorbers, vessels, pipelines, and other work areas. It is the responsibility of the Contractor to remove all washdown, cleaning, and stormwater that accumulates in the work areas. Contractor shall also be responsible for removal and disposal of all construction debris from work areas, basins, pipelines and job site in general.

H. Contractor's schedule shall include a period for water testing of all the processes in the new WTP (using potable water) for the Owner to become oriented with the components, troubleshoot operations, determine likely operating conditions, and ensure compliance with all regulatory requirements. This testing period shall be no less than 48 hours but the Owner may decrease the testing period at the Owner's discretion. During the testing period, the Contractor shall make personnel available to troubleshoot and remedy items that are found to be deficient according to the Contract Documents. During the testing period the water shall be temporarily sent to the detention basin or storm drain system. At the completion of the testing period and after the results of water analyses have indicated compliance with all regulatory requirements, an operating permit has been issued by the Utah Division of Drinking Water, and at the discretion of the Owner, water shall be sent to the District's distribution system.

1. Contractor shall notify Owner two weeks prior to beginning of the test and demonstration period.

3.2 WTP ON-SITE WORK SEQUENCE

A. The Contractor shall submit a detailed plan for the Work, portions of which are listed herein, for general review and consideration by the Owner and Engineer. In all cases, operation of existing plant equipment and processes must be maintained to maintain compliance with the Owner's Water Quality Objectives.

B. Some work elements may be done simultaneously. Not all construction activities are noted. Coordinate construction schedule to incorporate the listed Major Work Elements items as a minimum.

C. Planned Outages

1. Contractor shall notify the Owner and Engineer in writing at least two weeks in advance of any requested planned outage, unless otherwise noted.

2. Operating processes, systems, individual equipment items, piping, or controls shall be isolated, dewatered, decommissioned, de-energized, or depressurized only during scheduled, planned outages. The treatment plant manager, or designated representative, shall have the right to cancel or terminate an outage at no cost to the Owner when in his opinion the potential for a safety hazard or violation of the discharge permit exists. However, this does not relieve the contractor of the responsibility to maintain a safe working environment and to maintain treatment plant operations.

3. If requested by the Owner or Engineer, the Contractor shall send a representative to meet with plant and Engineer's staff to plan activities during the requested outage.

4. Outages shall not be permitted on Fridays, weekends, or Holidays. Shutdowns shall not occur on consecutive days unless previously approved by the Engineer and accepted by the Owner.

D. Monitoring for Water Quality Objectives compliance when unit processes are out of service, being temporarily modified, or otherwise impacted during construction shall be the responsibility of the Owner. If Contractor's construction activities impact Owner's ability to sample for compliance, Contactor shall provide assistance as necessary, including but not limited to labor, tools, equipment, and temporary structures.

E. Contractor's schedule shall include critical work elements generally noted herein and a sequence to:

1. Comply with water quality objectives of the finished water and the backwash wastewater.

2. Maintain the highest possible level of treatment during construction.

3. Continuously maintain water quality monitoring and control functions.

4. Ensure the availability of adequate electrical power.

5. Ensure the availability of support systems at all times during the completion of this contract.

F. Suggested schedule considerations for Contractor:

1. Dewatering of the site may be necessary in order to allow construction of certain components. Schedule allowance for dewatering should be provided by the Contractor.

2. It is expected that a majority of the on-site work can be completed without interrupting the existing transmission and distribution processes. Therefore, critical on-site work elements will generally be determined by Contractor to efficiently stage and complete the work.

3. Final tie-in to the new off-site pressurized transmission and distribution lines is expected to be a critical period in the transition of flow to the new WTP. Contractor shall submit schedules and work plans for this transition period for

review and approval by the Owner at least four weeks prior to the start of the transition. The transition period may not commence until all testing and check-out procedures at the new WTP have been completed and approved.

4. Other critical tie-ins are the final tie-in of the new gravity sewer line to the existing gravity sewer line.

5. For the installation of the filters, it is noted that neither the roof structure nor the bridge crane is designed to support vessels. For installation of the filter system media, it is noted that the bridge crane may be used to load media if scheduled correctly by Contractor.

6. Well #16 must remain in service during the irrigation season (April 1 through October 31). All major outages (new transformer, relocation of the generator) shall be scheduled during the non-irrigation season.

END OF SECTION

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SECTION 01019
CONTRACT CONSIDERATIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Application for Payment.

B. Change procedures.

1.2 RELATED SECTIONS

A. Document EJCDC - C-700 (General Conditions. Contract sum/price including allowances).

B. Section 01025 – Measurement and Payment

C. Section 01300 - Submittals: Schedule of Values.

D. Section 01600 - Materials and Equipment.

E. Section 01700 - Contract Close-out.

1.3 APPLICATIONS FOR PAYMENT

A. Submit three copies of each application on EJCDC C-620. Contractors Standard Form or electronic media printout will be considered acceptable.

B. Content and Format: Utilize Schedule of Values for listing items in Application for Payment. For each item, provide a column for listing: Item Number, Description of Work, Unit Price, Quantity, Amount, Previous Applications, Work in Place under this Application, Authorized Change Orders, Total Completed to Date of Application, Percentage of Completion, Balance to Finish, and Retainage.

C. Revise schedule to list approved Change Orders with each Application for Payment.

D. Payment Period: Payment period shall be established by Owner in conformance with the Agreement and the General Conditions.

E. Waiver of Liens: The Contractor shall provide a Waiver of Lien to the Owner as part of the Application for Payment.

F. Prepare Application for Final Payment as specified in Section 01700.

G. When Engineer requires substantiating information, submit data justifying dollar amounts in question.

1.4 CHANGE PROCEDURES

A. The Engineer will advise of minor changes in the Work not involving an adjustment to Contract Price or Contract Time by issuing supplemental instructions on EJCDC Form 940 Work Change Directive.

B. Contractor will submit the name of the individual authorized to receive change documents and be responsible for informing others in contractor's employ or subcontractors of changes to the work.

C. The Engineer may issue a Notice of Change which includes a detailed description of a proposed change with supplementary or revised Drawings and specifications, and a change in Contract Time for executing the change. Contractor will prepare and submit an estimate within ten (10) days.

D. The Contractor may propose changes by submitting a request for change to the Engineer, describing the proposed change and its full effect on the Work. Include a statement describing the reason for the change, and the effect on the Contract Price and Contract Time with full documentation. Document any requested substitutions in accordance with Section 01600 Materials and Equipment.

E. Stipulated Sum/Price Change Order: Based on Contractor's request for a Change Order as approved by the Engineer.

F. Unit Price Change Order: For pre-determined unit prices and quantities, the Change Order will be executed on a fixed unit price basis. For unit costs or quantities of units of work which are not pre-determined, execute Work under a Work Directive Change. Changes in Contract Price or Contract Time will be computed as specified for Time and Material Change Order.

G. Work Directive Change: Engineer may issue a directive, on EJCDC 940 Work Change Directive signed by the Owner, instructing the Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order. Document will describe changes in the Work, and designate method of determining any change in Contract Price or Contract Time. The Contractor shall promptly execute the change.

H. Time and Material Change Order: Submit itemized account and supporting data after completion of change, within time limits indicated in the Conditions of the Contract. Engineer will recommend to the Owner the change allowable in Contract Price and Contract Time as provided in the Contract Documents.

I. All change orders and work directive changes must be approved by the Owner and funding agencies prior to commencing the change.

J. Maintain detailed records of work done on Time and Material basis. Provide full information required for evaluation of proposed changes, and to substantiate costs for changes in the Work.

K. Change Order Forms: EJCDC 941 as provided herein.

L. Execution of Change Orders: Engineer will issue Change Orders for signatures of parties as provided in the Conditions of the Contract.

M. Promptly revise progress schedules to reflect any changes in contract time, revise sub-schedules to adjust time for other items of work affected by the change and resubmit.

N. Revise project record documents per the changes.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

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SECTION 01025
MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Description of Work

B. Authority

C. Payment

D. Defect Assessment

E. Non-Payment for Rejected Products

F. General Description of Measurement and Payment

1.2 DESCRIPTION OF WORK

A. Bid schedule includes all disciplines for furnishing and installing all labor and materials for the construction of the water treatment plant including site work, yard piping, and Well #16 upgrades, and related improvements.

1.3 AUTHORITY

A. Take all measurements and compute quantities to estimate percent complete of each item listed in the schedule of values. The Engineer will verify measurements and quantities and percent complete.

1.4 PAYMENT

A. Payment Includes: Full compensation for all required labor, products, tools, equipment, plant, transportation, services and incidentals; erection, application or installation of an item of the Work; overhead and profit.

1.5 DEFECT ASSESSMENT

A. Replace the Work, or portions of the Work, not conforming to specified requirements.

B. If, in the opinion of the Engineer, it is not practical to remove and replace the Work, the Owner will direct one of the following remedies:

1. The defective Work may remain, but the unit sum will be adjusted to a new sum at the discretion of the Engineer.

2. The defective Work will be partially repaired to the instructions of the Owner, and the unit sum will be adjusted to a new sum at the discretion of the Engineer.

C. The individual specification sections may modify these options or may identify a specific formula or percentage sum/price reduction.

D. The authority of the Engineer to assess the defect and identify payment adjustment, is final.

1.3 NON-PAYMENT FOR REJECTED PRODUCTS

A. Payment will not be made for any of the following:

1. Products wasted or disposed of in a manner that is not acceptable.

2. Products determined as unacceptable before or after placement.

3. Products not completely unloaded from the transporting vehicle.

4. Products placed beyond the lines and levels of the required Work.

5. Products remaining on hand after completion of the Work.

6. Loading, hauling and disposing of rejected Products.

7. Removing rejected materials and/or work and replacing with materials and/or work in compliance with these specifications.

1.6 GENERAL DESCRIPTION OF MEASUREMENT AND PAYMENT

A. Measurement and Payment for the bid items listed in Schedule A shall be on the basis of the description in the Technical Specifications and Drawings. Unless the work to be done is so specifically called out to be measured and paid for Schedule A, payment for such work shall be included in other applicable items, and there shall be no separate measurement and payment for the work.

B. Items listed in Document 00410 – Bid Form as lump sum (L.S.) shall include all work for the complete installation as generally described in the Drawings and the Technical Specifications.

C. Payment shall be made at the contract bid price listed in the Bid Form.

D. Partial payment for unit price bid items and lump sum bid items only partially completed at the end of monthly pay periods shall be made based upon the Engineers interpretation of the percentage of work completed. Partial payment for materials delivered and stored will be considered, if said materials have been submitted to the Engineer for review per Section 01300, and supporting invoices and documentation have been provided.

E. Quantities indicated in the Bid Form are for bidding and contract purposes only, unless specified otherwise in the Technical Specifications.

F. If the actual work requires more or fewer quantities than those quantities indicated in the Bid Form, the Contractor shall provide the required quantities.

G. Payment includes: Full compensation for all required labor, products, tools, equipment, materials, transportation, services and incidentals, erection, application or installation of an item of the work, including mobilization, demobilization, supervision, overhead and profit.

H. Final payment for work governed by unit prices will be made on the basis of the actual measurements and quantities accepted by the Engineer multiplied by the unit price for work which is incorporated in or made necessary by the work unless specified otherwise.

1.7 Bid Schedule

SCHEDULE OF BID ITEMS – WTP AND RELATED FACILITIES

1. Item #1 – Permits.

   A. Measurement shall be in the form of a lump sum, for the job, complete.

   B. Payment covers cost of coordinating with City staff and completing necessary paperwork, signatures, and related requirements to obtain and pay for the West Valley City building permit and all necessary permits for the project. Verification of payment shall be submitted with Application for Payment.

2. Item #2 – Furnish the Filter System in Accordance with Volume IV.

   A. Basis of Measurement: Lump Sum

   B. Basis of Payment: See the Executed Contract Documents in Volume IV.

3. Item #3 – All Work as shown and specified in Volumes I, II, III, IV including acceptance of Filtration Equipment System Assignment, and installation of Filtration Equipment System.

   A. Basis of Measurement: Lump Sum

   B. Basis of Payment: Unless otherwise itemized separately in the Unit Price Schedule, Payment will be made at the contract lump sum price for all project improvements, complete and operational, based on agreed upon Schedule of Values submitted by the Contractor. Included in this item are all costs to manufacture, furnish, construct, install, etc. all components of this project and associated site improvements and shall include coordination with the Owner, vendors, and other Contractors noted in the Contract Documents; progress meetings, project administration, submittals, equipment, materials, labor, assembly, testing, startup, training, commissioning, and all other items of expense for a complete and functional systems per the Contract Documents.

   C. Includes all disciplines and dewatering in accordance with specification Section 02140.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01039
COORDINATION AND MEETINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Coordination.

B. Field engineering.

C. Progress Meetings.

1.2 COORDINATION

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

B. Coordinate space requirements and installation of mechanical and electrical work which are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable. Utilize spaces efficiently to maximum accessibility for other installations, for maintenance, and for repairs.

C. Coordinate completion and clean up of Work of separate Sections in preparation for Substantial Completion.

D. Coordinate startup with the Owner, Engineer, and state agencies.

E. Verify that utility requirement characteristics of operating equipment are compatible with building utilities. Coordinate work of various sections having independent responsibilities for installing, connecting to, and placing in service, such equipment.

F. After Owner’s assumption of the completed project, coordinate access to site for correction of defective Work and Work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

1.3 FIELD ENGINEERING

A. The Contractor will locate and protect survey control and reference points. Replacement of survey control and reference points will be at the contractor’s expense.

B. Control datum for survey is that established by Owner provided survey.

C. Verify set-backs and Easements, confirm drawing Dimensions and elevations.

1.4 PROGRESS MEETINGS

A. The Engineer will schedule and administer meetings as needed by Owner and Contractor throughout progress of the Work.

B. Attendance Required: Job superintendent, major Subcontractors and suppliers, Owner, and Engineer, as appropriate to agenda topics for each meeting.

C. Agenda:
1. Review minutes of previous meetings.
2. Review of Work progress.
3. Field observations, problems, and decisions.
4. Identification of problems which impede planned progress.
5. Review of submittals schedule and status of submittals.
6. Review of off-site fabrication and delivery schedules.
7. Maintenance of progress schedule.
8. Corrective measures to regain projected schedules.
9. Planned progress during succeeding work period.
10. Coordination of projected progress.
11. Maintenance of quality and work standards.
12. Review Cleanup and restrictions.
13. Effect of proposed changes on progress schedule and coordination.
14. Other business relating to Work.
15. Contractor site safety concerns
16. Change Order, WCD, and RFI Logs

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01063
HEALTH AND SAFETY

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This section specifies procedures for complying with applicable laws and regulations related to safety and health of the worker and the public. It is not the intent of the Owner or the Engineer to develop and/or manage the safety and health programs of Contractors or in any way assume the responsibility for the safety and health of their employees. It is required that all Contractors adhere to applicable Federal, State, and local safety and health standards.

B. This section describes the Accident Prevention Program that is a subset of the Safety Program.

1.2 REFERENCES

A. Comply with and enforce on-the-job site current applicable local, State, and Federal Health and Safety Standards, including, but not limited to, the following:

Reference	Title
29 USC *651* et seq.	Federal Occupational Safety and Health Act
29 CFR 1910	OSHA General Health and Safety Standards
29 CFR 1926	OSHA Construction Safety and Health Standards
	Utah Occupational Safety and Health Act
SARA Title III	Emergency Planning and Community Right-to-Know

1.3 DEFINITIONS

A. A hazardous substance is defined as follows:

1. A substance classified as “dangerous waste” in accordance with local codes and 49 CFR 173.127 or that in sufficient quantities would be classified as “dangerous wastes.”
2. A solid waste, or combination of solid wastes, that, because of its quantity, concentration, or physical, chemical, or infectious characteristics, may 1) cause or significantly contribute to an increase in mortality or increase in serious, irreversible, or incapacitating reversible illness; or 2) pose substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed or otherwise managed.
3. Asbestos material.

4. Polychlorinated biphenyls (PCBs), polynuclear aromatic hydrocarbons (PHAs), explosives, radioactive materials, and other materials designated as hazardous by regulating agencies having jurisdiction over such matters.

B. A contaminated substance is defined as follows:

1. A substance containing materials in sufficient quantities as hydrocarbons, PCBs, diesel fuels, gasoline, heavy metals, solvents, and other types of fuel oils present in the soil, water, or air.
2. An element, compound, mixture, solution, or substance designated under Section 102 of CERCLA and/or applicable parts of MTCA.
3. A hazardous waste having the characteristics identified under or listed pursuant to Section 3001 of Solid Waste Disposal Act (i.e., RCRA) except those suspended by an act of Congress.
4. A toxic pollutant listed under Section 307 (a) of the Federal Water Pollution Control Act (FWPCA).
5. A hazardous air pollutant listed under Section 112 of the Clean Air Act.
6. An imminently hazardous chemical substance or mixture with respect to which the EPA administrator has taken action pursuant to Section 7 of the Toxic Substance Control Act.

C. Confined space is defined as follows:

1. It is large enough and so configured that a person can bodily enter and perform assigned work.
2. It has limited or restricted means of entry or exit.
3. It is not designed for continuous employee occupancy.

D. *Permit-Required Confined Space*. A confined space that has one or more of the following characteristics:

1. Contains or has potential to contain a hazardous atmosphere.
2. Contains material that has potential for engulfing an entrant.
3. Is shaped inside in such a way that someone entering could be trapped or asphyxiated.
4. Contains other recognized serious safety or health hazards.

1.4 SUBMITTAL PROCEDURES

A. The following submittals shall be provided in accordance with Section 01300, Submittals:

1. *Accident Prevention Program for the Contractor.* This program shall outline the anticipated hazards and safety controls necessary to safeguard Contractor's employees. The public and other personnel shall be specific to the job and site, meet federal, state and local jurisdictional requirements. The program will be reviewed for compliance with this Section prior to the start of work.

2. *Revisions.* Revise the accident prevention program prior to the start of work to accommodate changes requested by the District and/or regulatory agencies or jurisdiction. Post a copy of the accepted program at the Contractor's job site office, and each of the subcontractor's offices. Three additional copies shall be provided to the Engineer.

3. Health and Safety equipment and/or training material as specified in this section.

1.5 QUALITY ASSURANCE

A. Ensure that subcontractors receive a copy of this Specification section. The Contractor is responsible for ensuring compliance with the Accident Prevention Program.

B. Coordinate with the Engineer to obtain approval to disconnect or reconnect utilities.

C. Coordinate with the Engineer and Owner regarding the shutdown and safety tagout/lockout of pressurized systems, electrical, mechanical, pneumatic, hydraulic, etc. systems, and other equipment and utilities.

D. Maintain good housekeeping in work areas.

E. Ensure that all health and safety submittals are reviewed and approved by a Certified Safety Professional (CSCP) and/or Certified Industrial Hygienist (CIH).

F. Provide a qualified health and safety supervisor, with responsibility and full authority to coordinate, implement and enforce the Contractor's accident prevention program for the duration of this Contract. The name and telephone number of the safety supervisor shall appear in the accident prevention program.

1.6 SPECIAL CONSIDERATIONS

A. This paragraph describes certain minimum precautions for consideration in developing an Accident Prevention Program. It supplements the regulatory requirements. Failure to comply with safety and health regulations may result in work suspension until adequate safety and health measures are implemented.

1. Hazard Communication

a. Provide a written Hazard Communication Program and emergency management plan addressing the potential hazardous substances on site.

b. Prior to commencing work, provide a list and corresponding Material Safety Date Sheets (MSDS) for hazardous chemicals to be used on site. If no hazardous chemicals are to be used, provide statement to that effect.

2. Confined Space

   a. The nature of work under this Contract may expose workers to permit-required confined spaces having possible toxic and oxygen fluctuation conditions.

   b. Prior to execution of work in confined spaces, submit a written confined space safety program that meets the requirements 29 CFR 1910.146 and applicable Utah regulations.

3. Other Site Safety Considerations. Supply to Engineer for review prior to commencing work on this Contract, a comprehensive written Accident Prevention Program covering the Contractor's activities on site. As a minimum, the program shall include the following:

   a. Respiratory Protection

   b. Accident/Injury Reporting

   c. Emergency Plan (SARA Title-ifi—Community Right-to-Know)

   d. Personal Protective Equipment

   e. Fall Restraint and Fall Arrest

   f. Fire Safety and Prevention

   g. Hand and Power Tools

   h. Welding and Cutting

   i. Electrical

   j. Vehicles and Other Motorized Equipment

   k. Tagout/Lockout Hearing Conservation

4. Special Hazards

   a. Infectious Disease. Sewers carry a wide spectrum of disease-producing organisms. Submit a written hazard communication and biological blood borne pathogen program detailing the preventive measures to be taken by the Contractor to provide an appropriate work environment for its employees as well as other employees on site. These may include, but are not limited to the following:

      - Instruction in appropriate measures to avoid contamination.
      - A preventative inoculation program (tetanus/diphtheria, etc.) available to all personnel.
      - Clothing to protect against infection, including rubber boots with full sole and heel steel insert-liners, safety glasses or goggles, and gloves.

- Facilities for workers to clean up and wash.

b. Sodium Hypochlorite (NaOCl). Sodium hypochlorite is used as a disinfectant in water treatment as well as a membrane cleaning chemical. Ingestion of NaOCl can cause irritation of the membranes of the mouth and throat, stomach pain, and possible ulceration. Inhalation may cause burns, cough, and pulmonary edema. In small concentrations, NaOCl can cause irritation, burning, and blistering of the skin and irritation and burning of the eyes. At a minimum, provide a written hazard communication program detailing the preventive measures to be taken by the Contractor to provide an appropriate work environment for its employees as well as other staff on site.

   Sodium Bisulfate ($NaHSO_4$) Sodium Bisulfate is used as a neutralizing agent for the sodium hypochlorite (when used in membrane cleaning. It is an acid salt. Sodium Bisulfate is very irritating to the skin and can cause severe eye damage if contact occurs. Also, swallowing the chemical can cause symptoms, such as diarrhea, vomiting, and low blood pressure. At a minimum, provide a written hazard communication program detailing the preventive measures to be taken by the Contractor to provide an appropriate work environment for its employees as well as other staff on site.

c. Process Safety Management. Waste treatment plants must comply with the provisions of the Process Safety Management Regulations, 29 CFR 1910.119. This project may affect the regulated processes. Submit a written Process Safety Management Plan. At a minimum, the plan should cover the following:

   - Process Safety Information
   - Operating Procedures
   - Management of Change
   - Contractors or Subcontractors
   - Review of Hot Work Permits
   - Process Hazard Analysis
   - Safe Work Practices
   - Pre-startup Safety Review
   - Mechanical Integrity
   - Emergency Planning and Response
   - Training
   - Compliance Audits

d. Contaminant Gases. Contaminant gases that may be encountered include but are not limited to Hydrogen Sulfide, Methane, Carbon Monoxide, Carbon Dioxide, Chlorine Gas and Sulfur Dioxide. Provide a

written Emergency Management Plan to address these and other potential hazardous substances on site.

e. Fall Protection. Work activities on this project may expose employees to fall hazards. Contractor must provide a written Fall Protection Plan for each fall hazard encountered throughout the project.

1.7 UTILITIES

A. Take appropriate precautions in working near or with utilities and dangerous substances during the performance of work in order to protect the health and safety of the worker, the public, property, and the environment.

PART 2 NOT USED

PART 3 EXECUTION

3.1 SAFETY AND HEALTH COMPLIANCE

A. Occasionally, the Owner may audit the Contractor's Accident Prevention Program. The Owner reserves the right to stop that portion of the Contractor's work that is determined to be a serious health and safety violation. Ongoing work that is considered a safety or health risk by the Owner shall be corrected immediately.

1. Ensure that necessary air monitoring, ventilation equipment, protective clothing, and other supplies and equipment as specified are available to implement the Accident Prevention Program.

2. Notify the Engineer and Owner immediately of accidents resulting in any serious injury or immediate or probable fatality to any employees or public, or which result in hospitalization of any employees.

3.2 ACCIDENT PREVENTION PROGRAM REVISIONS

A. In the event that involved regulatory agencies or jurisdictions determine the Accident Prevention Program or associated documents, organizational structure, or Comprehensive Work Plan to be inadequate to protect employees and the public:

1. Modify the Program to meet the requirements of said regulatory agencies or jurisdictions, and;

2. Provide the Engineer and the Owner with the revisions to the Program within 7 days of the notice of deficiency.

END OF SECTION

SECTION 01090
REFERENCE STANDARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Quality assurance.

B. Schedule of references.

1.2 RELATED SECTIONS

A. General Conditions.

1.3 QUALITY ASSURANCE

A. For products or workmanship specified by association, trade, or Federal Standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

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

C. Maintain copy at job site during submittals, planning, and progress of the specific work, until Substantial Completion.

D. Should specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.

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

1.4 SCHEDULE OF REFERENCES

AA	Aluminum Association 818 Connecticut Avenue, N.W. Washington, DC 20006
AASHTO	American Association of State Highway and Transportation Officials 444 North Capitol Street, N.W. Washington, DC 20001

ACI	American Concrete Institute Box 19150 Reford Station Detroit, MI 48219
AGC	Associated General Contractors of America 1957 E Street, N.W. Washington, DC 20006
AIA	American Institute of Architects 1735 New York Avenue, N.W. Washington, DC 20006
AISC	American Institute of Steel Construction 400 North Michigan Avenue Eighth Floor Chicago, IL 60611
AISI	American Iron and Steel Institute 1000 16th Street, N.W. Washington, DC 20036
ANSI	American National Standards Institute 1430 Broadway New York, NY 10018
ASTM	American Society for Testing and Materials 1916 Race Street Phildelphia, PA 19103
AWS	American Welding Society 550 LeJeune Road, N.W. Miami, FL 33135
AWWA	American Water Works Association 6666 West Quincy Avenue Denver, CO 80235
CDA	Copper Development Association 57th Floor, Chrysler Building 405 Lexington Avenue New York, NY 10174
CRSI	Concrete Reinforcing Steel Institute 933 Plum Grove Road Schaumburg, IL 60195

DEQ	Utah Department of Environmental Quality Utah Division of Drinking Water P.O. Box 144830 Salt Lake City, Utah 84114-4830
EJCDC	Engineers' Joint Contract Documents Committee American Consulting Engineers Council 1015 15th Street, N.W. Washington, DC 20005
EJMA	Expansion Joint Manufacturers Association 25 North Broadway Tarrytown, NY 10591
FS	Federal Specification General Services Administration Specifications and Consumer Information Distribution Section (WFSIS) Washington Navy Yard, Bldg. 197 Washington, DC 20407
ICBO	International Conference of Building Officials 5360 S. Workman Mill Road Whittier, CA 90601
IEEE	Institute of Electrical and Electronics Engineers 345 East 47th Street New York, NY 10017
ML/SFA	Metal Lath/Steel Framing Association 221 North LaSalle Street Chicago, IL 60601
NAAMM	National Association of Architectural Metal Manufacturers 221 North LaSalle Street Chicago, IL 60601
NCMA	National Concrete Masony Association P.O. Box 781 Herndon, VA 22070
NEMA	National Electrical Manufacturers' Association 2101 'L' Street, N.W. Washington, DC 20037
NFPA	National Fire Protection Association Battery March Park Quincy, MA 02269

PCA	Portland Cement Association 5420 Old Orchard Road Skokie, IL 60077
PS	Product Standard U. S. Department of Commerce Washington, DC 20203
SSPC	Steel Structures Painting Council 4400 Fifth Avenue Pittsburgh, PA 15213
UDOT	Utah Department of Transportation 4501 South 2700 West Salt Lake City, UT 84114

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01300
SUBMITTALS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Web-based administration of submittals Submittal procedures.

B. Construction progress schedules.

C. Proposed products list.

D. Shop drawings.

E. Product data.

F. Samples.

G. Manufacturers' instructions.

H. Manufacturers' certificates.

I. Spare parts and maintenance materials

1.2 RELATED SECTIONS

A. Section 01400 - Quality Control: Manufacturers' field services and reports.

B. Section 01700 - Contract Close-out: Contract warranty and manufacturer's certificates and close-out submittals.

C. Section 01730 – Operation and Maintenance Data.

1.3 WEB-BASED ADMINISTRATION OF SUBMITTALS

A. Contractor shall pay for and utilize a web-based Cloud Construction Administration Software (Software) throughout the construction process to aid the project communication and submittal review process.

B. Contractor shall be responsible for all costs and fees associated with the software through the duration of the Contract.

C. Contractor shall be responsible for all startup and setup required for the successful operation of the software. The Contractor shall provide assistance to and coordinate assistance as required throughout the project to the Engineer, the Owner, and their designated representatives to successfully apply the software and its application to the Project. The Engineer, Owner and their representatives are responsible for their own

hardware, web access, and internal operating systems necessary to access the Cloud web-based software website.

D. The use of Construction Administration Software does not eliminate the Contractors' responsibilities for maintaining (in a safe place at the site) one record hard copy of all Drawings, Specifications, Addenda, Change Orders, Work Change Directives, Field Orders, and written interpretations and clarifications in good order and annotated to show changes made during construction under the General Conditions.

E. The items below provide a general list of documents intended to be stored, transmitted and accessed with the Web-based Cloud Construction Administration Software:
   1. The items below provide a general list of documents intended to be stored, transmitted and accessed with the Web-based Cloud Construction Administration Software:
   2. Submittals including Shop Drawings – Contractor is required to include the submittal transmittal (an example is attached at the end of this section) with contractor's stamp per the documents with every submittal.
   3. Submittal Log Maintenance
   4. Requests for Information – A written request for information, requiring a written response, to Owner, Engineer, or Contractor, initiated by Owner, Engineer, or Contractor
   5. Electronic copies of executed Field Orders
   6. Electronic copies of executed Work Change Directives
   7. Electronic copies of executed Change Orders
   8. Contractor's Applications for Payment
   9. Electronic copies of executed Recommendation of Payment
   10. American Iron and Steel Compliance Documentation

F. At the end of each three-month period during the construction process, the Contractor shall deliver to the Engineer as a required submittal, one electronic progress copy of all information exchanged through the Web-based Cloud system by all parties using the system for the project.

G. Prior to Final Completion of the project, the Contractor shall deliver to the Engineer as a required submittal, three complete electronic copies of all information exchanged through the Web-based Cloud system by all parties using the system for the project. The information shall be on set(s) of flash drives or other suitable electronic storage media agreeable to the Engineer and the Owner. The information must be readily reviewable in standard operating system software generally and publicly available to the Owner and Engineer. The Engineer shall review the submitted electronic information for completeness and format and respond to the Contractor as to the acceptability of the submittal and/or any modifications or resubmittal that is required to be made and/or resubmitted by the Contractor.

H. In the event that the Web-based Cloud system becomes unavailable, unusable, or otherwise unsuitable for continued use for this project at the sole discretion of the Engineer, the Contractor is responsible for delivering all electronic information

previously transmitted for the project through the Construction Administration Software in an acceptable electronic format to the Engineer and/or paper copies of that information acceptable to the Engineer and Owner.

I. The Owner and Engineer reserve the right to require paper copies and transmittal procedures of any documents they deem necessary. Examples of such paper copies that are currently intended to be transmitted in hard-copy are: fully executed contracts, pay requests, change orders, control system drawings, all over-sized submittals (larger than 8-1/2" x 11" sheets), motor control center submittals, rebar submittal drawings, final Operations and Maintenance information, and the Contractor's final record drawing information.

J. For Hard (Paper Copy) Submittals and Samples:
   1. Contractor shall utilize the Construction Administration Software to assist tracking, posting, review, and return of review comments for all Hard (Paper Copy) Submittals and Samples.
      a. For Samples, contractor shall submit one sample to Engineer (which will be retained).
      b. For Paper Copies of Submittals (where deemed necessary by Engineer), submit four (4) copies to be retained by Engineer, plus the number required to be returned to the Contractor.

1.4 SUBMITTAL PROCEDURES

A. Except for samples or when exception is previously agreed to by Engineer, all submittals shall be submitted electronically via the web-based cloud system. Each submittal shall be attached as a single file less than 10 megabytes in portable document format (*.pdf). If the single file is greater than 10 megabytes, multiple files may be submitted, although the number of files shall be minimized. The term "submittal" as used herein shall be understood to include detail design calculations, shop drawings, fabrication and installation drawings, erection drawings, lists, graphs, operating instructions, catalog sheets, data sheets, samples, and similar items.

B. The first page of each electronic submittal shall be the transmittal attached to this section. Each transmittal shall note the governing technical specification. On the transmittal, the CONTRACTOR shall note all deviations from the governing technical specifications and/or drawing and shall reference the appropriate paragraph of the section or page of the drawing. If the reason for the deviation from the specifications is not readily apparent, a written explanation shall be included immediately following the transmittal.

If there are no deviations, the statement shall be noted as such. Any submittal not accompanied by a transmittal and compliance statements will be rejected.

Submittals shall be carefully reviewed by an authorized representative of the Contractor prior to submission to the Engineer.
The transmittal of each submittal shall be dated, signed, and certified by the Contractor as being correct and in strict conformance with the Contract Drawings and the

Specifications, unless approved otherwise by the Engineer. Any non-certified submittals shall be returned to the Contractor without action taken by the Engineer, and any delays caused thereby shall be the total responsibility of the Contractor.

C. The submittal information shall follow the specification.

D. The transmittal (and the PDF document file) shall be numbered as follows:

05500-1 (05500-1.pdf) means the first submittal from Section 05500.
05500-2 (05500-2.pdf) means the second submittal from Section 05500.

Resubmittals shall be indicated by a letter following the submittal number. The letter "A" shall always be implied with the first submittal:

05500-2B (5500-2B.pdf) means the second submittal from Section 5500 is being re-submitted.

When the submittal information is greater than 10 megabytes and multiple PDF files are being submitted, they shall be named according to the following examples:

05500-1 Part 1 of 2.pdf
05500-2B Part 1 of 2.pdf

E. A separate transmittal form (and separate PDF document file) shall be used for each specific item or class of material or equipment for which a submittal is required. Combining of items will be permitted only when the items taken together constitute a manufacturer's package or are so functionally related that expediency indicates review of the group or package as a whole. Partially complete re-submittals will not be reviewed by the Engineer and returned to the Contractor.

F. The Engineer will respond to submittals electronically with a comment sheet in portable document format (*.pdf).

G. The Engineer's review of Contractor's submittals shall not relieve the Contractor of the entire responsibility for the correctness of details and dimensions. The Contractor shall assume all responsibility and risk for any misfits due to any errors in Contractor-submitted submittals. Any fabrications or other work performed in advance of the receipt of approved submittals shall be entirely at the Contractor's risk and expense. The Contractor shall be responsible for the dimensions and the design of adequate connections and details.

H. Engineer's review of Shop Drawings and Samples, Standard Specifications and descriptive literature submitted by Contractor will be only for general conformance with design concept, except as otherwise provided, and shall not be construed as:
1. Permitting any departure from the Contract Requirements
2. Relieving Contractor of the responsibility for any error in details, dimensions or otherwise that may exist in such submittals

3. Constituting a blanket approval of dimensions, quantities, or details of the material or equipment shown; or
4. Approving departures from additional details or instructions previously furnished by Engineer. Such check or review shall not relieve Contractor of the full responsibility of meeting all the requirements of the Contract Documents

I. Coordinate and group submission of related items.

J. Revise and resubmit submittals as required, identify all changes made since previous submittal in the transmittal sheet or in a cover letter.

K. The Contractor shall be responsible for submitting complete and accurate information in accordance with the Contract Documents.

L. Distribute copies of reviewed submittals to concerned parties. Instruct parties to promptly report any inability to comply with provisions.

M. Schedule submittals to expedite Project.

N. Review of submittals will not commence until after the Notice to Proceed has been issued to the Contractor.

1.5 CONSTRUCTION PROGRESS SCHEDULES

A. Submit initial progress schedule in duplicate within 15 days after date established in Notice to Proceed for Engineer review. Submit progress schedule no later than Preconstruction Conference.

B. Revise and resubmit as required.

C. Submit revised schedules with each Application for Payment, identifying changes since previous version.

D. Show complete sequence of construction by activity, identifying Work of separate stages and other logically grouped activities. Indicate the early and late start, early and late finish, float dates, and duration.

E. Indicate estimated percentage of completion for each item of Work at each submission.

F. Indicate submittal dates required for shop drawings, product data, samples, and product delivery dates.

1.6 PROPOSED PRODUCTS LIST

A. Within 15 days after date of Notice to Proceed, compile and submit complete list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.

B. For products specified only by reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.

C. Apply Contractor's stamp, signed or initialed certifying that review, verification of Products required, field dimensions, adjacent construction Work, and coordination of information, is in accordance with the requirements of the Work and Contract Documents.

1.7 SHOP DRAWINGS

A. Shop drawings are required for all mechanical and structural installations. These drawings shall show adequate dimensions to review submittals for fit.

B. Submit the number of opaque reproductions which Contractor requires, plus four copies which will be retained by Engineer.

C. After review distribute in accordance with Article on Procedures above and for Record Documents described in Section 01700 - Contract Close-out.

1.8 PRODUCT DATA

A. Submit the number of copies which the Contractor requires, plus three copies which will be retained by the Engineer.

B. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information unique to this Project.

C. After review, distribute in accordance with Article on Procedures above and provide copies for Record Documents described in Section 01700 - Contract Close-out.

D. Indicate product characteristics that vary from these Specifications.

1.9 SAMPLES

A. Submit samples in accordance with the following requirements when requested in individual sections or as requested by the Engineer.

B. Submit samples to illustrate functional and aesthetic characteristics of the Product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.

C. Submit samples of finishes from the full range of manufacturers' standard colors, textures, and patterns for Owner's selection.

D. Include identification on each sample, with full Project information.

E. Submit the number or samples specified in individual specification Sections; one of which will be retained by Engineer.

F. Reviewed samples which may be used in the Work are indicated in individual specification Sections.

1.10 MANUFACTURER'S INSTRUCTIONS

A. When specified in individual specification Sections, submit manufacturers' printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, in quantities specified for Product Data.

B. Identify conflicts between manufacturers' instructions and Contract Documents.

1.11 MANUFACTURER'S CERTIFICATES

A. When specified in individual specification Sections, submit manufacturers' certificate to Engineer for review, in quantities specified for Product Data.

B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference date, affidavits, and certifications as appropriate.

C. Certificates may be recent or previous test results on material or Product, but must be acceptable to Engineer.

1.12 SPARE PARTS AND MAINTENANCE MATERIALS

A. Provide products, spare parts, maintenance and extra materials in quantities specified in individual specification Sections.

B. Deliver to project site; obtain receipt prior to final payment.

PART 2 PRODUCTS

2.1 WEB-BASED CLOUD CONSTRUCTION ADMINISTRATION SOFTWARE

A. Software Packages (or Approved Equivalent):
1. Newforma Project Cloud
2. Procore Cloud-Based Construction Software
3. Primavera Submittal Exchange/Oracle

B. The items below provide a general list of features required of the Web-based Cloud Construction Administration Software:
1. 100% web-based cloud with unlimited users' interface – no client software required, accessible from any internet connected device)
2. Auditing – records for all actions performed on each document with a time stamp and user details
3. Process Flow and Project Team Setup – defined organizational structure
4. Customizable – add fields or completely new documents (submittal transmittals)
5. Central Repository for drawings, specification, schedules, submittals, RFIs, and

Change Order, or any other custom document category

6. Print or exportable to PDF or similar file
7. Attach or upload any file type (PDF, JPEG, CAD, DWG, DWFX)
8. Reporting logs for Submittal
9. Collaborative Review of submittals – comments from several users incorporated on one electronic file; software shall provide ability for simultaneous review by multiple reviewers.
10. Email Notifications and alerts for outstanding documents
11. Document Reporting and History
12. Automatic Workflow Process
13. Complete hosted solution with 24 hours, 7 days a week access, redundant servers, daily tape backup.

PART 3 EXECUTION

Not used

END OF SECTION

SECTION 01400
QUALITY CONTROL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Quality assurance and control of installation.

B. References.

C. Field samples.

D. Construction Observation and testing laboratory services.

E. Manufacturers' field services and reports.

1.2 RELATED SECTIONS

A. Section 01300 - Submittals: Submission of Manufacturers' Instructions and Certificates.

B. Section 01600 - Material and Equipment: Requirements for material and product quality.

1.3 QUALITY ASSURANCE/CONTROL OF INSTALLATION

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

B. Comply fully with manufacturers' instructions, including each step in sequence.

C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

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

E. Perform work by persons qualified to produce workmanship of specified quality.

F. Secure Products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion or disfigurement.

1.4 REFERENCES

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

B. Should specified reference standards conflict with Contract Documents, request clarification for Engineer before proceeding.

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

1.5 FIELD SAMPLES

A. Install field samples at the site as required by individual specifications Sections for review.

B. Acceptable samples represent a quality level for the Work.

C. Where field sample is specified in individual Sections to be removed, clear area after field sample has been accepted by Engineer.

1.6 CONSTRUCTION OBSERVATION AND TESTING LABORATORY SERVICES

A. The Owner and Engineer shall provide observation during construction.

B. The Owner's Representative will oversee observation of all tests run in the field.

C. The Contractor shall provide adequate samples of all aggregate materials, native or imported, used for construction to a lab for sieve analysis and proctor results and provide these results to the Engineer. The Contractor shall be responsible for the cost of these materials and lab analysis. Additional samples shall be provided at no cost to the Owner for any materials that exhibit a noticeable change in physical appearance.

D. The Contractor shall be responsible for providing the equipment and manpower to assist the Representative in taking tests.

E. The Contractor shall provide the equipment and manpower to conduct all acceptance (leak, pressure, etc.) tests on underground utilities as required in the specifications.

F. Reports will be submitted to the Engineer, in duplicate, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents and the proctor results.

G. Cooperate with the Engineer; furnish samples of materials, mix designs, equipment, tools, storage and assistance as requested.

1. Notify the Engineer and independent firm 48 hours prior to expected time for operations requiring services.

2. Make arrangements with independent firm and pay for additional samples and tests required for Contractor's use.

H. Retesting required because of non-conformance to specified requirements shall be performed by the same independent firm on instructions by the Representative. Costs for retesting shall be borne by the Contractor.

I. All special inspections and testing will be provided by the Owner. Contractor shall notify Owner's representative at least 48 hours prior to the scheduled time of any special inspection for observation purposes.

1.7 MANUFACTURERS' FIELD SERVICES AND REPORTS

A. When specified in individual specification Sections, require material or Product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust and balance of equipment, as applicable, and to initiate instructions when necessary.

B. Individuals to report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

C. Submit report within 15 days of observation to Engineer for review.

1.8 PROJECT LIMITS

A. Confine all equipment, tools, and materials to the easements and project sites shown on the plans.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01500
CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Temporary Water Service

B. Temporary Sanitary Facilities

C. Temporary Electricity

D. Barriers

E. Water Control

F. Dust Control

G. Erosion and Sediment Control

H. Pollution Control

I. Security

J. Noise Control

K. Tree and Plant Protection

L. Protection of installed Work

M. Access Roads

N. Parking

O. Progress Cleaning

P. Removal of Utilities, Facilities, and Controls

1.2 RELATED SECTIONS

A. Section 01700 - Contract Close-out: Final cleaning.

1.3 TEMPORARY WATER SERVICE

A. Provide, maintain and pay for suitable quality water required for construction operations.

1.4 TEMPORARY SANITARY FACILITIES

A. Provide and maintain required facilities and enclosures. Fixed or portable chemical toilets shall be provided by the Contractor, wherever needed, for the use by employees. Toilets at construction job sites shall conform to the requirements of Subpart D, Section 1926.51 of the OSHA Standards for Construction. Existing facilities shall not be used.

B. The Contractor shall establish a regular collection of all sanitary and organic wastes. All wastes and refuse from sanitary facilities provided by the Contractor, or organic material wastes from any other source related to the Contractor's operations, shall be disposed of away from the site in accordance with all laws and regulations pertaining thereto. Disposal of all such wastes shall be at the Contractor's expense.

1.5 TEMPORARY ELECTRICITY

A. Temporary power will be the responsibility of the contractor until permanent power is installed at the WTP. Permanent power already exists at Well House #16. The existing generator must be relocated on the site.

1.6 BARRIERS

A. Provide barriers to prevent unauthorized entry to construction areas, to allow for Owner's use of site, to protect public safety, and to protect existing facilities and adjacent properties from damage from construction operations.

B. Provide protection for plant life designated to remain. Replace damaged plant life.

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

1.7 WATER CONTROL

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

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

1.8 DUST CONTROL

A. This item shall consist of furnishing and applying water required in construction and for dust control, in accordance with the requirements of these specifications.

B. Water, when required, shall be applied at the locations and in the amounts required to properly compact the work. The equipment used for watering shall be of ample capacity and of such design as to assure uniform application of water in the amounts required.

C. In watering of subgrades, the Engineer may direct the Contractor to apply water in such quantities that the subgrade shall be compacted at a moisture content in excess of "optimum moisture." In no case will the Contractor be required to apply water in excess of three percent (3%) of optimum moisture.

D. The Contractor shall also apply water during the course of the work to control dust, maintaining all embankment and base courses in a damp condition.

E. The Contractor shall provide sufficient equipment to apply water as directed for controlling dust caused by construction activities. If dusty conditions continue to exist due to insufficient or inadequate watering practices or lack of watering equipment, it shall cause the closing down of those operations affected until remedied. Watering shall be done on Saturdays, Sundays, and Holidays at the same frequency and amounts as specified for work days at the Contractor's expense.

F. Watering equipment shall consist of water-tight tanks mounted on trucks, adequately powered, and capable of applying water as required. The water shall be applied under pressure from the tank through a spray apparatus as directed. The spray apparatus shall be equipped as to provide uniform, unbroken spread of water over the surface being watered. A suitable device for positive shut-off and for regulating the flow of water shall be located so as to permit positive drive control from the cab.

1.9 EROSION AND SEDIMENT CONTROL

A. Plan and execute construction by methods to control surface drainage from cuts and fills, from borrow and waste disposal areas. Prevent erosion and sedimentation.

B. Minimize amount of bare soil exposed at one time.

C. Provide temporary measures such as berms, dikes, and drains, to prevent water flow.

D. Construct fill and waste areas by selective placement to avoid erosion of surface silts or clays.

E. Periodically inspect earthwork to detect evidence of erosion and sedimentation; promptly apply corrective measures.

1.10 POLLUTION CONTROL

A. Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations.

B. Equipment and fuel storage shall be kept secured. Waste oil and waste fluids shall not be stored or changed at any construction site.

1.11 SECURITY

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

1.12 NOISE CONTROL

A. Construction involving noisy operations, including starting and warming up of equipment, shall be restricted to the hours between 7:00 a.m. and 5:00 p.m. on weekdays. Noisy operations shall be scheduled to minimize their duration and to ensure their completion by 5:00 p.m.

B. Notification of special circumstances or emergency conditions that require work beyond the hours specified above shall be provided as follows:
   1. The Contractor shall notify the Engineer 48 hours in advance of any proposed extended work hours for preauthorization. Notification shall include a written request for authorization to perform work specified and the circumstances that warrant this request. This notification shall include any additional measures to mitigate noise generated by this construction activity if deemed necessary by the Engineer.
   2. If an emergency situation occurs that warrants extended hours, the Contractor shall notify the Engineer immediately upon determining the need for this work.

1.13 TREE AND PLANT PROTECTION

A. CULTIVATED AREAS AND OTHER SURFACE IMPROVEMENTS: All landscaped areas and other surface improvements which are damaged by actions of the Contractor shall be restored to a condition equal to or better than it was prior to construction. Areas shall not be cleared until related construction activities require the work.

1.14 PROTECTION OF INSTALLED WORK

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

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

1.15 ACCESS ROADS

A. Construct and maintain temporary roads accessing public thoroughfares to serve construction area.

B. Extend and relocate as Work progress requires. Provide detours necessary for impeded traffic flow in excess of two hours.

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

D. Provide and maintain access for emergency vehicles.

E. Provide means of removing mud from vehicle wheels before entering streets.

1.16 PARKING

A. Do not allow construction personnel to park in any way which may affect the access of emergency vehicles or District personnel or the adjacent HOA.

B. Arrange for temporary surface parking to accommodate construction personnel.

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

1.17 PROGRESS CLEANING

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

B. Remove waste materials, debris, and rubbish from site periodically and dispose off-site in approved solid waste facilities at no additional cost to owner.

C. Provide necessary containment and clean-up of all hazardous/dangerous materials on-site that result from Contractor's actions.

D. Dispose of all hazardous/dangerous waste in approved hazardous waste facilities that result from Contractor's actions.

1.18 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. Remove temporary above grade or buried utilities, equipment, facilities, materials, prior to Substantial Completion.

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

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

1.19 FIELD OFFICES AND SHEDS

A. Provide temporary office to house record drawings and space to hold project meetings. Provide secure office space on site for the Resident Project Representative.

B. Office for record drawings: Weather-tight, with lighting, electrical outlets, and heating equipment, and equipped with sturdy furniture and drawing display table. Adequate space shall be provided for seating for project update meetings. Provide a minimum of 250 square feet for meeting area. The record drawings and office space can be shared with contractor staff space meeting minimum requirements.

C. RPR office space: Provide office space with minimum square footage of 150 square feet. RPR office can be extension of record drawing space providing a separate secure entry exists. RPR space shall include desk, file cabinet, stable Wi-Fi connection, and separate/secure entry access.

D. Meeting space: Provide a space for holding construction meetings. Meeting space can be an extension of the RPR office space. Meeting space shall include a square (or rectangular) table and chairs for a minimum of 10 people to sit around, a television/monitor to use via casting during meetings that all meeting attendants can see, a stable Wi-Fi connection, and a separate secure/entry access.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01600
MATERIAL AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Products.

B. Transportation and handling.

C. Storage and protection.

D. Product options.

E. Substitutions.

1.2 RELATED SECTIONS

A. Section 01300 - Submittals.

B. Section 01400 - Quality Control: Product quality monitoring.

1.3 PRODUCTS

A. Products: Means new material, machinery, components, equipment, fixtures, and systems forming the Work. Does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work. Products may also include existing materials or components required for reuse.

B. Furnish products of qualified manufacturers suitable for intended use.

C. Do not use materials and equipment removed from existing premises, except as specifically permitted by the Contract Documents.

D. Provide interchangeable components of the same manufacturer, for similar components.

1.4 TRANSPORTATION AND HANDLING

A. Transport and handle products in accordance with manufacturer's instructions.

B. Promptly review shipments to assure that products comply with requirements, quantities are correct, and products are undamaged. Replace damaged products at no additional cost to OWNER.

C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

1.5 STORAGE AND PROTECTION

A. Store and protect products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather-tight, climate controlled enclosures.

B. For exterior storage of fabricated products, place on sloped supports, above ground.

C. Provide off-site storage and protection when site does not permit on-site storage or protection.

D. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to avoid condensation.

E. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.

F. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

G. Arrange storage of products to permit access for review. Periodically review to assure products are undamaged and are maintained under specified conditions.

1.6 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Any product meeting those standards or description.

B. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

1.7 SUBSTITUTIONS

A. Engineer will consider requests for Substitutions only within 30 days after date of Owner-Contractor Agreement.

B. Substitutions may be considered when a product becomes unavailable through no fault of the Contractor.

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

D. A request constitutes a representation that the Contractor:

1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.
2. Will provide the same warranty for the Substitution as for the specified product.

3. Has reviewed installation for fit with existing or new components or construction constraints.
4. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
5. Waives claims for additional costs or time extension which may subsequently become apparent.
6. Will reimburse Owner for review or redesign services associated with re-approval by authorities.

E. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.

F. Substitution Submittal Procedure:

1. Submit number of copies, as indicated in Section 01300, of request for Substitution for consideration. Limit each request to one proposed Substitution.
2. Submit shop drawings, product data, and certified test results attesting to the proposed product equivalence.
3. The Engineer will notify Contractor, in writing, of decision to accept or reject request.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

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SECTION 01620
OWNER-PROCURED EQUIPMENT COORDINATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Contract description of Owner-provided equipment

B. Coordination

C. Schedule

D. Payment

1.2 REFERENCES

A. Section 01010 – Summary of Work

B. Section 01014 – Work Sequence

C. Section 01039 – Coordination and Meetings

D. Volume III – Filter System Procurement Executed Contract Documents

1.3 CONTRACT DESCRIPTION OF OWNER-PROCURED EQUIPMENT

A. The Owner as "Buyer" has previously entered into a procurement contract with Kurita America, Inc., as "Seller" for a portion of the equipment for this work, which generally includes the Filter System and related equipment including tanks, piping, valves, instrumentation, and other related appurtenances. The procurement contract shall be assigned to the Contractor and the Contractor shall be required to coordinate with the Filter System Supplier and the Owner and will be responsible for installation as noted in the Drawings and startup of the equipment. This equipment has been procured through the Owner-Filter System Supplier Procurement Agreement, which is included in these Contract Documents. The contact information for the Seller's representative is below:

1. Adrian Williams
   Westech Engineering LLC
   801-290-6403
   awilliams@westech-inc.com

1.4 COORDINATION AND DELIVERY

A. Contractor is required to attend coordination meetings as required with Filter System Supplier, Owner, and Engineer at no additional cost to Owner.

B. Contractor shall coordinate with the Filter System Supplier and Owner as required during the course of this project during all work phases, including, but not limited to, scheduling for delivery, unpacking, warehousing, shutdowns, equipment installation, startups, testing, meetings, and demonstration period operation to minimize conflicts and to facilitate usage of water system by Owner.

C. Contractor will coordinate with Filter System Supplier and Owner to inspect all Packing Lists (Bill of Ladings) for completeness of orders during delivery and unloading of Owner-provided equipment.

D. Contractor shall provide storage for all goods from Filter System Supplier as outlined in the General Conditions and Procurement Documents, as required and as necessary, at no additional cost to Owner.

1.5 SCHEDULE

A. Contractor shall coordinate construction schedule with the schedule outlined in Filter System Equipment Procurement Documents.

1.6 PAYMENT

A. The Contractor is required to pay applicable use-taxes under State of Utah Tax Law.

B. Pay Applications for the Filter System Supplier Procurement Contract will be sent from the Filter System Supplier to the Contractor. The Contractor will review all Pay Applications from the Filter System Supplier. Payment for the Filter System Supplier Goods and Special Services will be paid by the Contractor to the Filter System Supplier, respectively.

C. Contractor will provide documentation regarding coordinated work, inspections, delivery inspections, etc. as requested by the Owner/Engineer to support or deny claims for payment.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

END OF SECTION

SECTION 01650
STARTING OF SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Starting systems

B. Demonstration and instructions

C. Testing, adjusting, and balancing

1.2 RELATED SECTIONS

A. Section 01400 - Quality Control

B. Section 01730 – Operation and Maintenance Manuals

C. Section 01700 - Contract Closeout

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 STARTING SYSTEMS

A. Coordinate schedule for start-up of various equipment and systems.

B. To minimize overwhelming the Owner's operating staff, the Contractor shall start-up no more than two major components per week. Major components are defined by the Treatment Process Codes in the Drawings. Contractor shall schedule component start-ups accordingly to meet the specified Contract Times.

C. Notify Owner and Engineer seven days prior to start-up of each item.

D. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or other conditions which may cause damage.

E. Verify that tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.

F. Verify wiring and support components for equipment are complete and tested.

G. Execute startup under supervision of responsible manufacturer’s representative and in accordance with manufacturers' instructions.

H. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.

I. Submit a written report in accordance with Section 01400 that equipment or system has been properly installed and is functioning correctly.

3.2 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate operation and maintenance of Products to Owner's personnel with a Demonstration or testing period.

B. Demonstration and plant commissioning activities shall be performed in accordance with this Section and Section 11100 of the Filter System Procurement Contract Documents.

C. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owners' personnel in detail to explain all aspects of operation and maintenance.

D. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at scheduled times, at equipment location. The demonstration period should be organized to provide a clear, concise summary of the equipment operation and maintenance.

E. Demonstrate the functional integrity of the mechanical, electrical, and control interfaces of the respective equipment and components comprising the facility or system as evidence of Substantial Completion.

F. If, during the Demonstration Period, the aggregate amount of time used for repair, alternation, or unscheduled adjustments to any equipment or systems that render the affected equipment or system inoperative exceed 10 percent of the Demonstration Period, the demonstration of functional integrity will be deemed to have failed. In the event of failure, a new Demonstration Period will recommence after correction of the cause of failure. The new Demonstration Period shall have the same requirements and duration as the Demonstration Period previously conducted.

G. Conduct the demonstration of functional integrity under full operational conditions.

H. Owner will provide operational personnel to provide process decisions affecting plant performance. Owner’s assistance will be available for only process decisions. Contractor

will perform all other functions, including, but not limited to, equipment operation and maintenance until successful completion of the Demonstration Period.

I. Owner reserves the right to simulate operational variables, equipment failures, routine maintenance scenarios, etc. to verify the functional integrity of automatic and manual backup systems and alternate operating modes.

J. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

K. Provide knowledgeable personnel to answer Owner's questions throughout the Demonstration Period.

L. Provide final field instruction on select systems and respond to any system problems or failures that may occur.

M. Provide all labor, supervision, utilities, chemicals, maintenance, equipment, vehicles, or any other item necessary to operate and demonstrate all systems being demonstrated.

3.3 TESTING, ADJUSTING, AND BALANCING

A. Required Attendance: Factory representatives for the individual systems such as prefilter/strainers, membrane units, chemical feed systems, pumping systems, electrical components, instruments, HVAC components, etc.; regulators and/or state inspection services as required; project engineer; and all District personnel.

B. The Owner may record the startup and training sessions. The recording produced shall be the sole property of the Owner. Any additional testing and training time required to provide a complete and properly functioning installation shall be provided at no additional cost to the Owner.

END OF SECTION

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SECTION 01700
CONTRACT CLOSEOUT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Close-out procedures.

B. Final cleaning.

C. Surface Restoration

D. Project record documents.

E. Warranties.

1.2 RELATED SECTIONS

A. Section 01019 - Contract Consideration

B. Section 01300 - Submittals

C. Section 01500 - Construction Facilities and Temporary Controls

1.3 CLOSEOUT PROCEDURES

A. Submit written certification that Contract Documents have been reviewed, Work has been reviewed, and that Work is complete in accordance with Contract Documents and ready for Engineer's review.

B. Provide submittals to Engineer that are required by governing agencies or other authorities.

C. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due.

1.4 FINAL CLEANING

A. Execute final cleaning prior to final review.

B. Clean equipment and fixtures to a sanitary condition.

C. Clean debris from drainage systems.

D. Clean site; sweep paved surfaces.

E. Remove waste and surplus materials, rubbish, and construction facilities from the site.

1.5 SURFACE RESTORATION

A. Restore any damaged surface to a condition equal to or better than it was prior to construction.

1.6 PROJECT RECORD DOCUMENTS

A. Maintain on site, one set of the following record documents; record actual revisions to the Work:

1. Contract Drawings.
2. Specifications.
3. Addenda.
4. Change Orders and other Modifications to the Contract.
5. Reviewed shop drawings, product data, and samples.
6. Manufacturer’s instructions for assembly, installation and adjusting.

B. Store Record Documents separate from documents used for construction.

C. Ensure entries are complete and accurate, enabling future references by owner.

D. Record information concurrent with construction progress, not less than weekly.

F. Specifications: Legibly mark and record at each Product section description of actual Products installed, including the following:

1. Manufacturer's name and product model and number.
2. Product substitutions or alternates utilized.
3. Changes made by Addenda and Modifications.

G. Record Documents and Shop Drawings: Legibly mark each item to record actual construction including:

1. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
2. Measured locations of utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
3. Field changes of dimension and detail.
4. Details not on original Contract Drawings.

G. Draw a line through the Engineer title block and seal on all documents submitted as Record Drawings. Make sure that each of these documents contains the names and dates of the people recording the record information.

H. Submit documents to Engineer with claim for final Application for Payment.

1.7 WARRANTIES

A. Provide duplicate notarized copies.

B. Execute and assemble transferable warranty documents from Subcontractors, suppliers, and manufacturers.

C. Submit prior to final application for Payment.

D. For items of Work delayed beyond date of Substantial Completion, provide updated submittal within 10 days after acceptance, listing date of acceptance as start of warranty period.

PART 2 PRODUCTS

Not used

PART 3 EXECUTION

Not used

END OF SECTION

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SECTION 01730
OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Quality Assurance

B. Format

C. Contents

D. Manual for Equipment and Systems

E. Instruction of Owner's personnel

F. Submittals

1.2 RELATED SECTIONS

A. Section 01300 - Submittals.

B. Section 01400 - Quality Control: Manufacturers' instructions.

C. Section 01600 - Material and Equipment.

D. Section 01650 – Starting of Systems.

E. Section 01700 - Contract Close-out: project record documents.

F. Individual Specifications Sections: Specific requirements for operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Prepare instructions and data by personnel experienced in maintenance and operation of described products.

1.4 FORMAT

A. Prepare data in the form of a reference manual.

B. Binders: Commercial quality, 8-1/2 x 11, three D side ring binders with durable plastic covers; 2 inch maximum ring size. When multiple binders are used, correlate data into related, consistent groupings.

C. Cover: Identify each binder with typed or printed title OPERATION AND MAINTENANCE INSTRUCTIONS; identify title of Project; Identify subject matter of contents.

G. Provide tabbed dividers for each separate product and system, with typed description of product and major component parts of equipment.

H. Text: Manufacturer's printed data, or typewritten data on 20 pound paper.

I. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

J. Contents: Prepare a Table of Contents for each volume, with each Product or system description identified, in three parts as follows:

1. Part 1: Directory, listing names, addresses, and telephone numbers of Engineer, Contractor, Subcontractors, and major equipment suppliers.
2. Part 2: Operation and maintenance instructions, arranged by system and subdivided by components. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following where applicable:

    a. Significant design criteria.
    b. List of equipment.
    c. Parts list for each component.
    d. Operating instructions.
    e. Maintenance instructions for equipment and systems.
    f. Maintenance instructions for finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.

3. Part 3: Project documents and certificates, including the following:

    a. Shop drawings and product data.
    b. Certificates.
    c. Photocopies of warranties (and bonds).

4. Part 4: Provide one (1) electronic format (Adobe Acrobat, .pdf) with searchable hyperlinks in a table of contents for each volume.

1.5 CONTENTS, EACH VOLUME

A. Table of Contents: Provide title of Project; names, addresses, and telephone numbers of Engineer, Subconsultants, and Contractor with name of responsible parties; schedule of products and systems, indexed to content of the volume.

B. For Each Product or System: List names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.

C. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete or clearly and neatly cross out inapplicable or extraneous information.

D. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.

E. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified in Section 01400.

F. Warranties: Bind in copy of each.

G. Bonds: Bind in photocopy of each.

1.6 MANUAL FOR EQUIPMENT AND SYSTEMS

A. Each Item of Equipment and Each System: Include description of unit or system, and component parts. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and model number of replaceable parts.

B. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications by label machine.

C. Include color coded wiring diagrams as installed.

D. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.

E. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and trouble shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions; cleaning and coating; etc.

F. Provide servicing and lubrication schedule, and list of lubricants required.

G. Include manufacturer's printed operation and maintenance instructions.

H. Include sequence of operation by controls manufacturer.

I. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

J. Provide control diagrams by controls manufacturer as installed.

K. Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

L. Provide a listing in Table of Contents for design data, with tabbed dividers and space for insertion of data.

M. Provide as a minimum manufacturer's operation and maintenance manual for (Engineer may request additional items be submitted as deemed necessary during the project at no additional cost to the Owner):

1. Filter System Equipment
2. Onsite Sodium Hypochlorite Generation System (OSHGS)
3. Chemical Storage Tanks
4. Chemical Metering Pumps and Components
5. Pumps and Motors
6. Valves
7. Bridge Crane
8. Painting and Coating systems
9. Instrumentation (e.g., flow meters, pressure switches, level sensors)
10. Doors
11. Safety equipment
12. Lighting
13. Control systems, panels and related components
14. Electrical Generator
15. HVAC units, climate control and ventilation systems

1.7 INSTRUCTION OF OWNER PERSONNEL

A. Before final inspection, instruct Owner's designated personnel in operation, adjustment, and maintenance of products, equipment, and systems, at agreed upon times.

B. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.

C. Prepare and insert additional data in Operation and Maintenance Manual when need for such data becomes apparent during instruction.

1.8 SUBMITTALS

A. Submit two (2) copies of preliminary draft or proposed formats and outlines of contents before start of Work. Engineer will review draft and return one copy with comments.

B. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit documents within ten days after acceptance.

C. Submit two (2) copies of complete volumes 15 days prior to final inspection. One copy will be reviewed and returned after final inspection, with Engineer comments. Revise content of all document sets as required prior to final submission.

D. Submit four (4) sets of revised final volumes in final form within 10 days after final inspection.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 02110
SITE CLEARING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Surface debris removal.

1.2 RELATED SECTIONS

A. Section 01500 – Construction Facilities and Temporary Controls

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

1.1 PROTECTION

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

B. Protect all trees from damage which are to remain.

C. Protect plant growth, and features designated to remain, as final landscaping or outside of construction limits.

D. Retain and protect bench marks, survey monuments, and existing structures and utilities from damage or displacement.

E. Protect roads, fences, and other items to remain during construction.

F. Protect all adjoining property.

G. Protect existing drainage ditches.

H. Prevent air pollution or dust from becoming a nuisance to the public, to neighbors, and to others performing work on or near the project site. Comply with governing regulations.

1.2 CLEARING

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

B. Limit clearing and construction operation to areas required for construction and designated by the ENGINEER and within rights-of-way or easements obtained by the OWNER.

1.3 REMOVAL

A. Remove debris from site. Open burning and burial in trenches is prohibited.

B. Top soil stockpile shall be separated from other soil materials to prevent contamination.

C. Dispose all materials at locations that are in compliance with all Federal, State, and Local Regulations.

D. Grade areas in which groundwater is encountered to drain.

1.4 OBSTRUCTIONS

A. Remove and replace fences, fence post, signs and any structures encountered during construction to a condition equal to or better than it was prior to construction.

1.5 CLEANUP

A. Upon completion of the site work and project, clean the entire work area. Remove all excess excavated material, rocks, pipe, or debris of any type from the site and dispose at a site acceptable to Federal, State, and Local Regulations.

END OF SECTION

SECTION 02140
DEWATERING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Dewatering plan submittal requirements.

B. Permits for dewatering activities.

C. Performance requirements for trench and structure dewatering.

D. Verification of dewatering performance.

E. Dewatering discharge and monitoring requirements

F. Termination of dewatering.

G. Measurement and payment for trench and structure dewatering.

1.2 RELATED SECTIONS

A. Section 01010 - Summary of Work.

B. Section 01025 - Measurement and Payment.

C. Section 01400 - Quality Control.

D. Section 01500 - Construction Facilities.

E. Section 02205 - Soil Materials.

F. Section 02207 - Aggregate Materials.

G. Section 02223 - Trenching and Backfilling for Structures.

H. Section 02225 – Trenching and Backfilling for Pipelines

1.3 SUBMITTALS

A. Prior to the preconstruction conference the Contractor shall submit their dewatering plan to the Engineer and Owner to communicate the Contractors intent in regard to dewatering to achieve the required performance contained in these specifications. Submittal of a dewatering plan shall not be interpreted

as an acceptance or approval by the Owner or Engineer of the Contractor's dewatering plan. The dewatering plan shall include at a minimum:

1. Major components of the dewatering system including size, location, spacing and details of wells, well points, vacuum piping, sumps, interception trenches, pumps, and other major dewatering features the Contractor anticipates utilizing.

2. Details of scheduling of dewatering activities relative to trench excavation and pipe installation along the planned alignment and excavation and structure installation including backfilling and ceasing dewatering activities.

3. Contingency plans for equipment or power failure. The Contractor needs to provide a continuous, reliable source of power.

4. Procedures for verification that water levels have been lowered to the specified levels prior to trench excavation and pipe installation.

5. Location of dewatering disposal or discharge locations and the capacity to accept dewatering discharge. Provide a contingency plan for higher than anticipated flows when capacity of planned discharge and disposal locations may conceivably be exceeded.

6. Location and details of Best Management Practices (BMP's)

7. Agreements with entities accepting discharges

8. All permits obtained by the Contractor including any permit conditions and approvals for the discharge of water generated during the execution of the Work.

9. Other permits required for construction or operation of the dewatering system including the drilling of wells, temporary power drops, etc.

B. The dewatering plan shall be designed and sealed by a qualified professional engineer registered in the State of Utah. The Contractor will be responsible for selection and payment of the engineer to perform the dewatering system design.

1.4 REFERENCES

A. Utah Department of Environmental Quality, Division of Water Quality Storm Water Program.

B. Granger-Hunter Improvement District, 2022 Material and Construction Specifications for Water and Wastewater Systems.

1.5 PERMITS

A. Submit a short-term activity exemption application and plan.

Contact Utah Division of Water Quality – General Permit for Construction Dewatering and/or Hydrostatic Testing for details.

http://www.waterquality.utah.gov/UPDES/updes_f.htm

B. Dewatering discharge to or across adjacent canals, drains, right-of-way, and private property outside of the designated limits of construction shall not be allowed unless the Contractor has obtained written approval from agency or property owner having jurisdiction. Provide Agreements with dewatering plan submittal as described in Part 1.3 of this section.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 PREPARATION

A. Furnish, install and prepare for operation, all necessary machinery, appliances and equipment to maintain all trench and structure excavations free from water during construction.

B. Contractor shall provide temporary power sources for all dewatering equipment that requires a power source. The power source must provide continuous, reliable power.

3.2 TRENCH AND STRUCTURE DEWATERING

A. Dewater and dispose of water in such a manner that it does not cause injury to public or private property, or to cause a nuisance or a menace to the general public.

B. Comply with Utah Water Quality Standards, latest edition, for discharge of water to surface water.

C. The Contractor will be responsible for devising a system to achieve the required level of dewatering. It is anticipated that this system may incorporate wells, well points, interception trenches, sumps, etc. In addition, design and provide dewatering conveyance system to an approved disposal location. The

Contractor shall submit details of this plan as described in Part 1.3 of this Section.

D. Draw and maintain static water level to at least one foot (1') below the bottom of the excavation prior to excavating below the water table to maintain the undisturbed state of the foundation soils and allow placement of bedding material and backfill to the required density.

E. Remove all groundwater, seepage, stormwater and other water that accumulates in the excavation during construction. All trench and structure excavations shall be kept free of water during construction or until otherwise requested by the Contractor and approved by the Engineer.

F. Prevent softening of the bottom of excavations and the formation of "quick" conditions or "boils" during excavation. The occurrence of such conditions will require over-excavation and subsequent backfilling to soils meeting the requirements of Section 02222 and Section 02225 at no additional cost to the Owner.

G. Additional cost for trench bottom stabilization resulting from inadequate dewatering and non-compliance with the performance specifications included herein, as determined by the Engineer, will be incidental to the work.

H. Compact native soil at the bottom of the excavation prior to placing bedding in accordance with Section 02222 and Section 02225 of these specifications.

I. Maintain static water level at least one foot (1') below the bottom of the trench until the pipe is placed and the bedding is placed and compacted. Maintain static water level at least one foot (1') below the bottom of the excavation until the specified foundation and structure is placed in accordance with these specifications. Maintain water levels at least one foot (1') below the level of backfill during backfilling operations.

J. Control surface runoff to prevent entry or collection of water in excavations.

K. Install and operate a dewatering system so that adjacent structures or property are not endangered by the reduction in the groundwater level.

L. Monitor discharge from dewatering operations for changes in visual or odor components indicating the presence of contaminants including, but not limited to, gasoline and pesticides and other hazardous materials and toxins.

M. Cease dewatering operations and notify Engineer and regulatory agencies immediately upon observation of conditions that may indicate the presence of hazardous contaminants in the dewatering discharge or excavation.

3.3 VERIFICATION

A. Contractor's superintendent shall routinely observe conditions in excavations where dewatering is being performed on a daily basis to verify performance requirements are being met and that conditions in the excavation are in accordance with the Contract Documents.

B. Notify Engineer of any observations that may jeopardize the Work or is not in accordance with the Contract Documents.

C. Based on the verification performed by the Contractor and observations made by the Engineer in accordance with the General Conditions, the Engineer will determine if the performance requirements of the specifications as they relate to dewatering and construction of the improvements are generally being met. If the Engineer determines that the dewatering related Work is not being performed in accordance with the Contract Documents, the Contractor will be notified in accordance with the General Conditions and required to cease construction of the affected Work and revise and resubmit the described dewatering plan with appropriate adjustments to meet the requirements of the Contract Documents and implement any necessary changes to Contractor's dewatering approach and activities at no additional cost to the Owner.

3.4 DEWATERING DISCHARGE

A. Comply with all State & Federal requirements, including (at a minimum):

1. Dewatering discharge water quality and quantity.

2. Dewatering discharge monitoring and sampling at the frequency stipulated in the permits, at any locations required therein.

3. Submit monitoring and sampling report to the appropriate agencies.

B. The Contractor shall be fully responsible for complying with State and Federal water quality requirements. Contractor shall design a dewatering discharge system to achieve such requirements. It is anticipated that stilling basins, geotextile dams, straw bails, silt fences, or siltation channels will be required to meet performance stipulations of the reference permits. Such temporary facilities may be constructed on-site, and will be required to be removed after completion of the Work. Captured sediment must be retained and disposed of at a site furnished by the Contractor. Discharging directly into adjacent surface waters without treatment shall not be permitted.

C. Contractor will not be allowed to utilize the constructed pipelines at or near the structure excavation to convey dewatering flows. Dewatering down the pipe is prohibited. Contractor shall provide temporary, dedicated dewatering pipe when necessary with Contractor's dewatering plan.

D. Work required to comply with water quality and permit requirements are considered incidental and additional payment will not be made for this Work.

3.5 TERMINATION

A. Allow groundwater to return to static level after excavations are backfilled as necessary to prevent floatation of constructed improvements.

B. Prevent disturbance of the compacted backfill and prevent flotation or movement of installed pipelines or structure.

C. Remove or abandon all temporary improvements associated with the dewatering system in accordance with these specifications and any applicable state and federal rules and regulations.

D. Provide surface restoration as required to repair/replace any surface impacted by dewatering activities to a condition as good or better than preconstruction conditions at no additional cost to the Owner. Surface rehabilitation performed as a result of dewatering activities is considered incidental and no additional payment will be made.

E. Comply with any dewatering termination requirements of any State and Federal permits.

3.6 MEASUREMENT AND PAYMENT

A. Separate measurement and payment for the performance of dewatering as described in the Contract Documents will not be made. Performance of this work is considered incidental to other pay items and must be included therein.

END OF SECTION

SECTION 02205
SOIL MATERIALS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Excavated Soil Materials.

1.2 RELATED SECTIONS

A. Section 01400 - Quality Control.

B. Section 02207 - Aggregate Materials

C. Section 02211 – Rough Grading

D. Section 02222 - Excavation.

E. Section 02223 - Backfilling for Pipelines and Structures.

F. Section 02225 - Trenching for Pipelines.

1.3 REFERENCES

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

B. ASTM D2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

C. ASTM D3017 - Test Methods for Moisture Content of Soil and Soil-Aggregate Mixtures in place by Nuclear Methods (Shallow Depth).

D. AASHTO T-180 - Moisture-Density Relations of Soils Using a 10-lb Rammer and eighteen (18) inch Drop.

E. ANSI/ASTM D-1557 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb Rammer with an eighteen (18) inch drop.

1.4 SUBMITTALS

A. Not required.

PART 2 PRODUCTS

2.1 SOIL MATERIALS

A. Subsoil Type S1: Natural sand soils excavated from the site could possibly be utilized as structural/engineered fill but the fines content are higher than what is recommended for structural fill and larger gravel particles (+4 inch cobbles) should be screened prior to use. The natural soils will likely be more difficult to control the

optimum moisture content due to the higher fines content, particularly in wetter/colder seasons. The natural soils could be used as site grading fill and as fill in non-load bearing areas also. Again, these soils will likely be more difficult to work with due to the higher fines content. All fill material should be approved by the engineer prior to placement.

2.2 SOURCE QUALITY CONTROL

A. Inspection and testing will be performed under provisions of Section 01400.

B. Tests and analysis of soil material will be performed in accordance with AASHTO T-180, ASTM D2922, ANSI/ASTM D-1557, ANSI/ASTM D-698, and ASTM D3017. A minimum of five tests must be done.

C. If tests indicate materials do not meet specified requirements, change material and retest at no cost to Owner.

PART 3 EXECUTION

3.1 DISPOSAL OF MATERIAL

A. Material is to be disposed of off-site at a location selected by the Owner/Contractor.

END OF SECTION

SECTION 02207
AGGREGATE MATERIALS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Aggregate materials for imported structural fill, free draining granular backfill, stabilization fill, pipe bedding, base course, and drain rock.

1.2 RELATED SECTIONS

A. Section 01025 - Measurement and Payment.

B. Section 01300 - Submittals.

C. Section 01400 - Quality Control.

D. Section 02205 - Soil Materials.

E. Section 02223 – Backfilling and Compacting for Structures.

F. Section 02225 – Trenching and Backfilling for Pipelines.

1.3 REFERENCES

A. ANSI/ASTM C136 - Method for Sieve Analysis of Fine and Coarse Aggregates.

B. ASTM D2049 - Test Method for Relative Density of Cohesionless Soils.

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

D. ASTM D2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

E. ANSI/ASTM D1557 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 10 lb Rammer and 18 inch Drop.

F. AASHTO T-99 - Moisture Density relations of soils using a 5.5 lb rammer with a twelve (12) inch drop.

1.4 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Samples: Submit, in airtight containers, 45 lb. (20 kg) sample of each type of aggregate material to testing laboratory. Submit test results to Engineer.

C. Materials Source: Submit name of aggregate materials suppliers. Provide materials from same source throughout the work. Change of source requires Engineer approval.

PART 2 PRODUCTS

2.1 AGGREGATE MATERIALS

A. All fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to the engineer for evaluation.

1. Structural/Engineered Fill - Type M1: Well-graded sandy gravel material

Sieve Size	Percent Passing
4 inch	100
No. 200	5-25

Use for structural fill at all locations below floor slabs and concrete structures.

2. Stabilization Fill - Type M2: Angular, well-graded gravel material

Sieve Size	Percent Passing
4 inch	100
No. 200	15 max

Liquid Limit	35 max
Plasticity Index	15 max

Use on soft subgrades. Geotextile fabric may be used to reduce the amount of granular material required.

3. Pipe Trench Backfill Material – per APWA standards

4. Base Coarse Material – per APWA standards

Use for import base course material under traffic areas and as shown on the Drawings.

5. Riprap Apron Material – per APWA standards

Use for detention/retention basin outlet material and as shown on the Drawings.

2.2 SOURCE QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section 01400.

B. Tests and analysis of aggregate material will be performed in accordance with ASTM C136 and ASTM D2487. A minimum of three (3) tests of each material source must be done.

C. If tests indicate materials do not meet specified requirements, change material and retest at no cost to Owner.

PART 3 EXECUTION

3.1 STOCKPILING

A. Stockpile materials on site.

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

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

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

E. Upon removal, do not mix material with native materials.

3.2 STOCKPILE CLEANUP

A. Remove stockpile, leave area in a clean and neat condition. Grade site surface to prevent freestanding surface water.

END OF SECTION

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SECTION 02211
ROUGH GRADING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Removal of topsoil and subsoil.

B. Cutting, grading, filling and rough contouring the site.

1.2 RELATED SECTIONS

A. Section 01400 - Quality Control: Testing fill compaction.

B. Section 02110 - Site Clearing and Grubbing.

C. Section 02223 - Backfilling and Compacting for Structures: General paved area backfilling.

D. Section 02225 - Trenching and Backfilling for Utilities

1.3 PROJECT RECORD DOCUMENTS

A. Accurately record actual locations of utilities remaining, by horizontal dimensions, elevations or inverts, and slope gradients, referenced from permanent improvements.

PART 2 PRODUCTS

2.1 MATERIALS

A. Structural Fill: Type M1 specified in Section 02207.

B. Stabilization Fill: Type M2 specified in Section 02207.

C. Subsoil: Type S1 specified in Section 02205.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that survey bench mark and intended elevations for the Work are as indicated.

3.2 PREPARATION

A. Identify required lines, levels, contours, and datum.

B. Identify known underground, above ground and aerial utilities. Stake and flag locations.

C. Coordinate work with utility companies to remove and relocate utilities, as necessary.

D. Protect above and below grade utilities that remain.

E. Protect soil from erosion.

F. Protect bench marks, existing structures, fences, and sidewalks from excavating equipment and vehicular traffic. Replace in kind if damaged.

3.3 NATURAL SOILS EXCAVATION

A. Excavate natural soils from areas excavated.

B. Utilize natural soils as site grading fill and as fill in non-load bearing areas or dispose of natural soils at a location selected by the Contractor.

3.4 FILLING

A. Fill areas to contours and elevations with approved materials.

B. Structural fill and stabilization fill: Place and compact materials in continuous layers not exceeding 8 inches loose depth (depending on type of compaction equipment used) to 95% of ASTM D-1557 in foundation, floor slab, and pavement areas or as directed in the drawings and Geotech report. Compact materials to 90% of the maximum dry density (ASTM D-1557) in other non-structural areas of fill and backfill or as directed in the drawings and Geotech report.

C. Make grade and alignment changes gradual. Blend slope into level areas.

D. Remove surplus fill materials from site.

E. Abate dust during construction using water from an approved source.

3.5 FIELD QUALITY CONTROL

A. Field review and testing will be performed under provisions of Section 01400.

B. Compaction testing will be performed in accordance with ANSI/ASTM D1557 and with Section 01400.

END OF SECTION

SECTION 02222
EXCAVATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Excavation

1.2 RELATED SECTIONS

A. Section 01400 - Quality Control.

B. Section 01500 - Construction Facilities.

C. Section 02205 - Soil Materials.

D. Section 02211 - Rough Grading

E. Section 02223 - Backfilling and Compacting for Structures.

F. Section 02225 - Trenching and Backfilling for Pipelines

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 PREPARATION

A. Identify required lines, levels, contours, and datum.

B. Verify location of potentially conflicting utilities, underground, above-ground and overhead.

C. Coordinate with utility owners to allow relocation of utilities if necessary.

D. Identify limits of excavation to protect vegetation where possible.

E. Protect all plant life outside the limits of construction.

F. Identify and protect all bench marks, existing structures, drainage way, etc.

3.2 EXCAVATION

A. Reference Geotechnical Engineering Report

B. Underpin or shore up adjacent structures which may be damaged by excavation work, including utilities.

C. Dewater excavation as necessary.

D. Excavate subsoil to the lines and grades shown on the plans required to accommodate building and structure construction (minimum twelve inches below the bottom of foundation/footing or deeper, as shown on the Drawings).

E. Excavate subsoil to the required line and grade to accommodate paving and roadway construction operations (minimum eight inches below the bottom of asphalt or deeper, as shown on the Drawings).

F. Grade top perimeter of excavation to prevent surface water from draining into excavated area.

G. Hand trim excavation. Remove loose matter.

H. Remove lumped subsoil, frozen subsoil and boulders.

I. Notify Engineer of unexpected subsurface conditions.

J. Correct unauthorized excavation at no extra cost to Owner.

K. Correct areas over-excavated by filling with structural fill material and compacting to ninety five percent (95%) ANSI/ASTM D-1557 Density at no additional cost to Owner.

L. Stockpile excavated material in a designated place. Stock piles must be protected from eroding until final placement is achieved.

M. Repair utilities damaged during excavation at no additional cost to Owner.

N. No excavated material, pipe embedment or foundation material shall be stockpiled on embankment or roadway on embankment

O. Preparation: To minimize differential settlement it is essential that earth surfaces upon which footings/foundations will be placed, be compacted in accordance with the compaction requirements and be protected from rain and runoff. No footing shall be placed on saturated material. Footing/foundation material which becomes saturated during construction due to lack of protection by the Contractor shall be over excavated to suitable material and backfilled with suitable foundation soil at no cost to the owner.

P. Debris encountered during excavation must be disposed of off-site in conformance with all local, state, and federal regulations

3.3 FIELD QUALITY CONTROL

A. Field inspection will be performed under provisions of Section 01400.

B. Provide for visual inspection of bearing surfaces and compaction testing.

3.4 PROTECTION

A. Protect excavated area by methods required to prevent cave-in or loose soil from falling into trench.

B. Protect bottom of excavations and soil adjacent to and beneath foundation, from freezing.

C. Prevent water from ponding on excavated surfaces.

D. Protect excavations in embankment by use of trench box or other approved method to prevent cave-in and to limit trench width.

END OF SECTION

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SECTION 02223
BACKFILLING AND COMPACTING FOR STRUCTURES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Backfilling areas excavated for structures.

B. Consolidation and compaction.

C. Fill for over-excavation.

1.2 RELATED SECTIONS

A. Section 01300 - Submittals.

B. Section 01400 - Quality Control.

C. Section 02140 – Dewatering.

D. Section 02205 - Soil Materials.

E. Section 02207 - Aggregate Materials.

F. Section 02222 - Excavation.

G. Section 02225 - Trenching and Backfilling for Utilities.

H. Section 03300 - Cast-in-Place Concrete.

1.3 REFERENCES

A. ANSI/ASTM C136 - Method for Sieve Analysis of Fine and Coarse Aggregates.

B. ANSI/ASTM D1557 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 10 lb Rammer and 18 inch Drop.

C. ANSI/ASTM D-698 - Test Methods for Moisture – Density Relations of soil and soil aggregate mixtures, using 5.5 lb. Rammer and 12” drop.

D. ASTM D2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

E. ASTM D3017 - Test Methods for Moisture Content of Soil and Soil-Aggregate Mixtures.

1.4 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Samples: Submit 45 lb. sample of each type of aggregate and soil materials to testing laboratory, in air-tight containers.

C. Submit all sample and compaction test results to Engineer.

PART 2 PRODUCTS

2.1 STRUCTURAL FILL MATERIALS

A. Type M1 Aggregate specified in Section 02207 – use for structural fill at all locations below floor slabs and concrete structures.

2.2 STABILIZATION FILL MATERIALS

A. Type M2 Aggregate as specified in Section 02207 – use on soft subgrades.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify fill materials to be used are acceptable.

3.2 PREPARATION

A. Cut out soft areas of subgrade not capable of insitu compaction. Backfill with Type M1 or M2 fill as necessary and compact to density equal to or greater than requirements for subsequent backfill material.

B. Prior to placement of any fill material, compact subgrade to ninety-five percent (95%) of its maximum dry density in accordance with ANSI/ASTM-D1557 or to density requirements for subsequent backfill materials. Scarify, wet and recompact, if necessary, to achieve densities.

3.3 BACKFILLING

A. Backfill areas to contours and elevations with the material(s) specified in Part 2 of this section.

B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces. If wet, frozen, porous, spongy or other unsuitable materials are encountered, backfill with import backfill at no additional cost to Owner.

C. Aggregate Type M1 or M2 Backfill: Place and compact material in continuous layers not exceeding eight (8) inches loose depth, depending on type of compaction equipment.

D. Compact fill materials to ninety-five percent (95%) maximum density as determined by ANSI/ASTM-D1557 in foundation, floor slab, and pavement areas. Compact to 90% of the maximum dry density (ASTM-D1557) in other non-structural areas of fill and backfill.

E. Employ a placement method that does not disturb or damage existing structures or utilities.

F. Remove surplus and unusable backfill materials from site.

G. Make gradual grade and alignment changes. Blend slope into level areas.

3.4 TOLERANCES

A. As specified in drawings.

3.5 FIELD QUALITY CONTROL

A. Field testing will be performed under provisions of Section 01400.

B. Tests and analysis of fill material will be performed in accordance with ANSI/ASTM C136 and ANSI/ASTM-D1557 and with Section 01400.

C. Compaction testing will be performed in accordance with ASTM-D6398 (nuclear method) or ASTM-D1556 (sand cone method) and with Section 01400.

D. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

3.6 PROTECTION OF FINISHED WORK

A. Protect finished Work under provisions of Section 01500.

B. Recompact fills subjected to vehicular traffic before placement of subsequent layers.

END OF SECTION

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SECTION 02225
TRENCHING AND BACKFILLING FOR PIPELINES AND UTILITIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Excavation for pipelines and utilities.

B. Compacted bedding over pipelines and utilities.

C. Backfilling and compaction.

1.2 RELATED SECTIONS

A. Section 01400 - Quality Control

B. Section 01500 - Construction Facilities and Temporary Controls

C. Section 02140 – Dewatering.

D. Section 02211 - Rough Grading:

E. Section 02222 - Excavation.

F. Section 02223 - Backfilling and Compaction for Structures.

G. Section 15060 - Pipe and Pipe Fittings.

1.3 REFERENCES

A. ANSI/ASTM C136 - Method for Sieve Analysis of Fine and Coarse Aggregates.

B. ANSI/ASTM D1556 - Test Method for Density of Soil in Place by the Sand-Cone Method.

C. ANSI/ASTM D1557 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb (4.54 Kg) Rammer and 18 inch (457 mm) Drop.

D. ASTM D2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

1.4 SUBMITTALS

A. Submit under provisions of Section 01300.

1.5 FIELD MEASUREMENTS

A. Verify that survey bench mark and intended elevations for the Work are as shown on drawings.

PART 2 PRODUCTS

2.1 BACKFILL MATERIALS

A. Per APWA Standards

2.2 BEDDING MATERIALS

A. Per APWA Standards

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify fill materials to be reused if acceptable.

3.2 PREPARATION

A. Identify required lines, levels, contours, and datum.

B. Identify, maintain and protect existing utilities remaining, which pass through work area.

C. Protect bench marks, existing structures, sidewalks, paving, and curbs from excavation equipment and vehicular traffic.

D. Protect above and below grade utilities which are to remain.

E. Cut out soft areas of subgrade not capable of in situ compaction. Backfill per APWA standards and compact to density equal to or greater than requirements for subsequent backfill material to a point 4" below the bottom of the pipe.

F. Provide means by which natural drainage ways can be diverted away during trenching. Do not permit runoff water to enter the trench.

3.3 EXCAVATION – PER APWA STANDARDS

A. Dewater as necessary.

B. Underpin adjacent structures which may be damaged by excavation.

C. Have utility pole supported which may become undermined by excavation.

D. Excavate subsoil required for water piping, sewer piping, culverts and other utilities.

E. Cut trenches sufficiently wide to enable safe installation of utilities and allow review, meeting dimensions shown on the plans. Minimize the length of open trenches.

F. Excavation shall not interfere with normal 45 degree bearing splay of foundations.

G. Provide trench bracing in strict accordance to safety standards.

H. Hand trim excavation. Hand trim for bell and spigot pipe joints. Remove loose matter.

I. Remove lumped subsoil, boulders, and rock up to 1/3 cu yd, measured by volume.

J. Correct unauthorized excavation using suitable backfill materials, at no cost to the Owner.

K. Correct areas over excavated by error using suitable backfill materials, at no cost to the Owner.

L. Stockpile excavated material in area designated on site.

M. Provide means for removing ground water from trench. No pipe shall be laid in a trench with standing water in it.

3.4 BEDDING – PER APWA STANDARDS

A. Support pipe and conduit during placement and compaction of bedding.

3.5 BACKFILLING – PER APWA STANDARDS

A. Backfill trenches to contours and elevations with unfrozen materials.

B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces.

C. Employ a placement method that does not disturb or damage pipe in trench.

D. Maintain moisture content within 2% of optimum moisture content for fill materials to attain required compaction density.

E. Leave fill material stockpile areas completely free of excess fill materials.

3.6 FIELD QUALITY CONTROL

A. Field review and testing will be performed under provisions of Section 01400.

B. Tests and analysis of fill material if required by Engineer will be performed in accordance with ANSI/ASTM C136 and with Section 01400.

C. Compaction testing if required by Engineer will be performed in accordance with ANSI/ASTM D1556, ANSI/ASTM D1557, and with Section 01400.

D. If tests indicate Work does not meet specified requirements, remove Work, replace, compact, and retest at no cost to the Owner.

E. Frequency of Compaction Tests: (Trench)

1. Horizontal Location:

   Test at start of trench with subsequent tests at every 100' along the trench length.

2. Vertical Location:

   At every horizontal location, obtain one test at half the depth of the trench, one test at the top of the trench, and subsequent test(s) at locations where materials or construction procedures change.

3.7 PROTECTION OF FINISHED WORK

A. Protect trench excavation to prevent cave in.

B. Maintain and protect finished Work until project is completed.

C. Recompact fills subjected to vehicular traffic.

D. Protect excavations by use of trench box or other approved method to prevent cave-in and to limit trench width.

END OF SECTION

SECTION 02231
AGGREGATE BASE COURSE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Aggregate base course.

1.2 RELATED SECTIONS

A. Section 02211 - Rough Grading: Preparation of site for base course.

B. Section 02223 – Backfilling and Compacting for Structures: Compacted fill under base course.

C. Section 02225 – Trenching and Backfilling for Utilities: Compacted fill under base course.

1.3 REFERENCES

A. AASHTO M147-65 - Materials for Aggregate and Soil-Aggregate.

B. ASTM C136 - Sieve Analysis of Fine and Coarse Aggregates.

C. ANSI/ASTM D1557 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb (4.54 Kg) Rammer and 18 inch (457 mm) Drop.

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

E. ASTM D2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

PART 2 PRODUCTS

2.1 MATERIALS

A. Base Course per APWA Standards.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify subgrade or subbase has been reviewed; gradients and elevations are correct, and dry.

3.2 AGGREGATE PLACEMENT

A. Spread aggregate over prepared substrate to a total compacted thickness not to exceed 6 inches.

B. Level and contour surfaces to elevations and gradients indicated.

C. Add small quantities of aggregate to course base as appropriate to assist compaction.

D. Compact placed aggregate materials to achieve compaction to 95 percent of its maximum dry density in accordance with ANSI/ASTM D1557.

E. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.

F. Maintain finished surface of each lift until next lift is placed. No ballast or base material shall be placed on a surface which has become potholed, rutted or developed other surface irregularities.

G. Use mechanical vibrating tamping in areas inaccessible to compaction equipment.

3.3 TOLERANCES

A. Flatness: Maximum variation of 1/4 inch measured with 10-foot straight edge.

B. Scheduled Compacted Thickness: Within 1/4 inch.

C. Variation from True Elevation: Base within 1/2 inch. Subbase within 1/2 inch not cumulative.

3.4 FIELD QUALITY CONTROL

A. Field review and testing will be performed under provisions of Section 01400.

B. Gradation of Aggregate: In accordance with APWA standards.

C. Compaction testing will be performed in accordance with ANSI/ASTM D1557 and with Section 01400.

D. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to the Owner.

E. Frequency of Tests: A minimum of one test per 250 square yards of surface area per lift or as required to meet performance criteria as specified.

3.5 PROTECTION OF FINISHED WORK

A. Maintain and protect finish work until project is complete.

B. Blade and recompact base course subjected to vehicular traffic prior to placement of next lift or surface.

C. Remove and replace base and ballast material that has become contaminated during construction.

END OF SECTION

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SECTION 02510
ASPHALTIC CONCRETE PAVING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Asphaltic concrete paving.

1.2 RELATED SECTIONS

A. Section 02211 - Rough Grading: Preparation of site for paving and base.

B. Section 02231 - Aggregate Base Course.

1.3 REFERENCES

A. MS-2 - Mix Design Methods for Asphalt Concrete and Other Hot Mix Types - The Asphalt Institute (AI).

B. MS-3 - Asphalt Plant Manual - The Asphalt Institute (AI).

C. MS-8 - Asphalt Paving Manual - The Asphalt Institute (AI).

D. MS-19 - Basic Asphalt Emulsion Manual, The Asphalt Institute (AI).

E. ASTM D946 - Penetration-Graded Asphalt Cement for Use in Pavement Construction.

1.4 QUALITY ASSURANCE

A. Quality control shall be per Section 02741 of the Utah Department of Transportation Standard Specifications.

B. Obtain materials from same source throughout.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Do not place asphalt when base surface or air temperature is less than 40 degrees F, or surface is wet or frozen.

PART 2 PRODUCTS

2.1 MATERIALS

A. Asphalt concrete pavement: In accordance with Granger-Hunter Improvement District, West Valley City, state and local Engineering Standards and Construction Specifications.

B. Aggregate for Plant Mix: In accordance with Granger-Hunter Improvement District, West Valley City, state and local Engineering Standards and Construction Specifications.

2.2 ACCESSORIES

A. Tack Coat: In accordance with Section 02741 of the Utah Department of Transportation Standard Specifications

2.3 ASPHALT PAVING MIX

A. Mix In accordance with Granger-Hunter Improvement District, West Valley City, state and local Engineering Standards and Construction Specifications.

2.4 SOURCE QUALITY CONTROL

A. Provide mix design for asphalt under provisions of Section 01400 and in accordance with Granger-Hunter Improvement District, West Valley City, state and local Engineering Standards and Construction Specifications, except that there shall be between 3% and 5% air voids in the mix. The mix design shall reflect the actual aggregate stockpile(s) and asphalt cement type to be used.

B. Submit proposed mix design for review a minimum of ten (10) days prior to commencement of work.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that compacted granular base is dry and ready to support paving and imposed loads.

B. Verify gradients and elevations of base are correct.

3.2 SUBBASE

A. Section 02231 - Aggregate Base Course forms the base construction for work of this Section.

3.3 PREPARATION - TACK COAT

A. Apply tack coat in accordance with Section 02741 of the Utah Department of Transportation Standard Specifications

B. Apply tack coat to contact surfaces of curbs, gutters and existing asphalt.

3.4 HAULING EQUIPMENT

A. Trucks used for hauling plant mix material shall have a tight clean, smooth metal bed. When necessary each truck shall have a cover of canvas or other suitable material to protect the mixture from weather.

B. All trucks shall be loaded in a manner to minimize segregation in accordance with the asphalt institute.

C. The temperature of the plant mix shall not drop more than 20º F between the hot plant and the paver.

3.5 PLACING ASPHALT PAVEMENT - SINGLE COURSE

A. Install Work in accordance with Granger-Hunter Improvement District, West Valley City, state and local Engineering Standards and Construction Specifications.

B. Place asphalt within 8 hours of applying primer or tack coat.

C. Place asphalt to thickness shown in plans in lifts up to 3 inch compacted thickness.

D. Install gutter drainage grilles and frames and manhole frames in correct position and elevation.

E. Compact pavement by rolling. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.

F. Develop a rolling pattern with consecutive passes to achieve even and smooth finish, without roller marks.

3.6 TOLERANCES

A. Flatness: Maximum variation of 1/4 inch measured with 10 foot straight edge.

B. Scheduled Compacted Thickness: Within 1/4 inch.

C. Variation from True Elevation: Within 1/4 inch.

3.7 FIELD QUALITY CONTROL

A. Field review and testing will be performed under provisions of Section 01400.

3.8 PROTECTION

A. Immediately after placement, protect pavement from mechanical injury for 14 days.

3.9 SCHEDULES

A. All paved areas: Single course plant mix pavement to a compacted depth as shown on plans.

END OF SECTION

SECTION 02607
MANHOLES, FRAMES, AND COVERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Modular precast concrete manhole section with tongue and groove joints, covers, anchorage, and accessories.

1.2 RELATED SECTIONS

A. Section 02225 – Trenching and Backfilling.

B. Section 03300 – Cast-in-Place Concrete.

C. Section 15060 - Pipe and Fittings

1.3 REFERENCES

A. ACI (American Concrete Institute) 318 - Building Code Requirements for Reinforced Concrete.

B. ASTM C39 - Test Method for Compressive Strength of cylindrical Concrete Specimens.

C. ASTM C443 - Joints for Circular Concrete Sewer and Culvert Pipe using Rubber Gaskets.

D. ASTM C478 - Precast Reinforced Concrete Manhole Sections.

E. ASTM C497 - Test Method for Concrete Pipe, Manhole Sections, or Tile.

F. ASTM C913 - Precast Concrete Water and Wastewater Structures.

G. ASTM C923 - Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes.

1.4 DESIGN REQUIREMENTS

A. Equivalent strength: Based on structural design of reinforced concrete as outlined in ACI 318.

B. Design of Lifting Devices for Precast Structures: In accordance with ASTM C 913.

C. Design of Joints for Precast Structures: In accordance with ASTM C 913.

1.5 SUBMITTALS

A. Section 01300 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate manhole locations, elevations, and sizes and elevations of penetrations.

C. Product Data: Submit manhole covers, component construction, features, configuration and dimensions.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with the Granger-Hunter Improvement District Standards and the contract drawing and specifications.

1.7 DELIVERY, STORAGE AND HANDLING

A. Section 01600 - Product Requirements: Product storage and handling requirements.

B. Comply with precast concrete manufacturer's instructions for unloading, storing and moving precast manholes and drainage structures.

C. Store precast concrete manholes and drainage structures to prevent damage to Owner's property or other public or private property. Repair property damaged from materials storage.

D. Mark each precast structure by indentation or waterproof paint showing date of manufacture, manufacturer, and identifying symbols and numbers shown on Drawings to indicate its intended use.

PART 2 PRODUCTS

2.1 MANHOLES, FRAMES, AND COVERS

A. Manhole Sections: Reinforced precast concrete in accordance with ASTM C478 with gaskets in accordance with ASTM C923.

B. Grout: As specified in Section 03300.

C. Manhole Gaskets: Conform to ASTM C-443, or Ram-Nek Sealant or approved equivalent.

D. Manhole Connectors: Conform to ASTM C923.

2.2 COMPONENTS

A. Lid and Frame: ASTM A48, Class 20 ksi cast iron construction, machined flat bearing surface, removable closed lid design; lid molded with "Sanitary Sewer" with minimum 1 inch high letters; highway load rating of HS20, opening size as indicated on drawings.

B. Bedding: Type M1 or M2 as specified.

2.3 CONFIGURATION

A. Shaft Construction: Concentric with cone top section; lipped male/female joints; sleeved to receive pipe.

B. Cone Top Section: As indicated on Drawing.

C. Shape: Cylindrical.

D. Clear Inside Dimensions: 48-inch diameter or as shown on Drawings.

E. Design Depth: As indicated on Drawings.

F. Pipe Entry: Furnish openings as indicated on Drawings.

G. Grade Rings: As indicated on Drawings.

H. Steps: As indicated on Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01300 - Administrative Requirements: Coordination and Project Conditions.

B. Verify items provided by other sections of Work are properly sized and located.

C. Verify built-in items are in proper location, and ready for roughing into Work.

D. Verify excavation for manholes is correct.

3.2 PREPARATION

A. Coordinate placement of inlet and outlet pipe or duct sleeves required by other sections.

B. Do not install structures where site conditions induce loads exceeding structural capacity of structures.

C. Inspect precast concrete structures immediately prior to placement in excavation to verify structures are internally clean and free from damage. Remove and replace damaged units.

3.3 INSTALLATION

A. Excavation and Backfill:

1. Excavate for manholes in accordance with Section 02225 in location and to depth shown. Provide clearance around sidewalls of structure for construction operations.

2. When groundwater is encountered, prevent accumulation of water in excavations. Place manholes or drainage structures in dry trench.

3. Where possibility exists of watertight structure becoming buoyant in flooded excavation, anchor structure to avoid flotation.

B. Place base pad, trowel top surface level.

C. Place manhole sections plumb and level, trim to correct elevations, anchor to base pad.

D. Install manholes supported at proper grade and alignment as shown on Drawings.

E. Backfill excavations for manholes in accordance with Section 02225.

F. Grout base of shaft sections to achieve slope to exit piping. Trowel smooth. Contour to form continuous drainage channel as indicated on Drawings.

G. Set cover frames and covers level without tipping, to correct elevations.

H. Coordinate with other sections of Work to provide correct size, shape, and location.

3.4 PRECAST CONCRETE MANHOLE INSTALLATION

A. Lift precast structures at lifting points designated by manufacturer.

B. When lowering manholes into excavations and joining pipe to units, take precautions to ensure interior of pipeline and structure remains clean.

C. Set precast structures bearing firmly and fully on bedding material as specified in Section 02207 and compacted in accordance with provisions of Section 02225. Extend bedding at least 12 inches outside the limits of the manhole base.

D. Assemble multi-section structures by lowering each section into excavation. Lower, set level, and firmly position base section before placing additional sections.

E. Remove foreign materials from joint surfaces and verify sealing materials are placed properly. Maintain alignment between sections by using guide devices affixed to lower section.

F. Joint sealing materials may be installed on site or at manufacturer’s plant.

G. Verify manholes and drainage structures installed satisfy required alignment and grade.

H. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe. Fill annular space with mortar.

I. Cut pipe to finish flush with interior of structure.

J. Shape inverts through manhole as shown on Drawings.

3.5 FIELD QUALITY CONTROL

A. Section 01400 - Quality Requirements: Testing and inspection services.

B. Test cast-in-place concrete in accordance with Section 03300.

C. Vertical Adjustment of Existing Manhole and Drainage Structures:

1. Where required, adjust top elevation of existing manholes and drainage structures to finished grades shown on Drawings.

2. Reset existing frames, grates and covers, carefully removed, cleaned of mortar fragments, to required elevation in accordance with requirements specified for installation of castings.

3. Remove concrete without damaging existing vertical reinforcing bars when removal of existing concrete wall is required. Clean vertical bars of concrete and bend into new concrete top slab or splice to required vertical reinforcement, as indicated on Drawings.

4. Clean and apply sand-cement bonding compound on existing concrete surfaces to receive cast-in-place concrete in accordance with Section 03300.

END OF SECTION

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SECTION 02675
DISINFECTION OF PROCESS PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Cleaning and disinfection of process water piping and equipment.

B. Testing and reporting results.

1.2 RELATED SECTIONS

A. Section 01014 – Work Sequence.

B. Section 15060 - Pipe and Pipe Fittings.

1.3 REFERENCES

A. Utah Administrative Rule – R309-520: Disinfection

B. ANSI/AWWA B300-92 - Standard for Hypochlorites.

C. ANSI/AWWA B301-92 - Standard for Liquid Chlorine.

D. ANSI/AWWA C651-92 - Standards for Disinfecting Water Mains.

E. ANSI/AWWA C652 - Disinfection of Water Storage Facilities.

1.4 SUBMITTALS

A. Test Reports: Indicate results comparative to specified requirements.

B. Certificate: Certify that cleanliness of water distribution system meets or exceeds specified requirements.

1.5 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 01700.

B. Disinfection report; record:

1. Type and form of disinfectant used.
2. Date and time of disinfectant injection start and time of completion.
3. Test locations.

4. Initial and 24 hour disinfectant residuals (quantity in treated water) in ppm for each outlet tested.
5. Date and time of flushing start and completion.
6. Disinfectant residual after flushing in ppm for each outlet tested.
7. Engineer's signature that test was performed with Engineer present.

C. Bacteriological report; record:

1. Date issued, project name, and testing laboratory name, address, and telephone number.
2. Time and date of water sample collection.
3. Name of person collecting samples.
4. Test locations.
5. Initial and 24 hour disinfectant residuals in ppm for each outlet tested.
6. Coliform bacteria test results for each outlet tested.
7. Certification that water conforms, or fails to conform, to bacterial standards of State of Utah.
8. Bacteriologist's signature and authority.
9. Engineer's signature that test was performed with Engineer present.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance Utah Administrative Rule – R309-210 and AWWA Section C652.

1.7 REGULATORY REQUIREMENTS

A. Conform to Utah Administrative Rule – R309-210.

B. Conform to applicable code or regulation for performing the work of this Section. Discharge of heavily chlorinated water will not be discharged into the sanitary sewer system. Contractor to provide chlorine reducing agents as required to meet discharge performance requirements.

C. Provide certificate of compliance from authority having jurisdiction indicating approval of water system. Coordinate discharge point with affected utilities.

1.8 SEQUENCING AND SCHEDULING

A. Hydrostatic and leakage testing may be performed in conjunction with disinfection.

B. Final connections to the existing distribution system shall not be made until disinfection and flushing of the new facilities is complete.

PART 2 PRODUCTS

2.1 DISINFECTION CHEMICALS

A. Chemicals: ANSI/AWWA B300, Hypochlorite, ANSI/AWWA B301, and Liquid Chlorine.

B. Water for disinfection and testing shall be clean, uncontaminated, and potable. Water may be obtained from OWNER's water mains. Connections between the existing distribution system and pipelines not disinfected and tested that are constructed under this Contract shall remain closed at all times until disinfection and flushing and testing are complete.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that piping system and equipment have been cleaned, reviewed, and pressure tested.

B. Perform scheduling and disinfection activity with start-up, testing, adjusting and balancing, demonstration procedures, including coordination with related systems.

C. Notify engineer 24 hours minimum prior to conducting test.

3.2 EXECUTION – PIPELINES AND EQUIPMENT

A. Provide and attach required equipment to perform the work required of this Section.

B. Introduce treatment into piping system.

C. Maintain disinfectant in system for required period at required concentration in accordance with ANSI/AWWA C651-92.

D. Flush, circulate and clean until required cleanliness is achieved; use potable domestic water.

E. Replace permanent system devices removed for disinfection.

F. Flush and disinfect equipment prior to final acceptance. Coordinate with membrane manufacturer to determine if they have additional disinfection/flushing requirements to protect the membranes.

G. Properly dechlorinate and dispose of heavily chlorinated water, in accordance with Utah Department of Environmental Quality Regulations.

3.3 QUALITY CONTROL

A. Provide testing of treated water under provisions of Section 01400.

B. Test pipeline samples in accordance with ANSI/AWWA C651-92.

END OF SECTION

SECTION 02810
UNDERGROUND IRRIGATION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY
- A. Section includes:
  1. Underground irrigation systems complete with heads, valves, controls, and accessories.
- B. Related sections:
  1. Section 02910 Planting

1.2 REFERENCE STANDARDS
- A. NFPA 70: National Electric Code.
- B. ASTM: American Society for Testing and Materials
- C. IA: The Irrigation Association: Main BMP Document, Landscape Irrigation Scheduling and Water Management Document.
- D. ASIC: American Society of Irrigation Consultants: ASIC Grounding Guideline
- E. City Codes/Ordinances relating to Landscape and Irrigation

1.3 DEFINITIONS
- A. Water Supply: Culinary and/or secondary pumping, piping, and components provided and installed by others to provide irrigation water to this project. Includes but is not limited to: storage ponds, pump stations, saddles, nipples, spools, shut-off valves, corporation stop valves, water meters, pressure regulation valves, and piping or components upstream of (or prior to) the Point-of-Connection.
- B. Point-of-Connection: Location where the Contractor shall tie into the water supply for landscape irrigation needs and use. Tie to existing piping.
- C. Main Line Piping: Pressurized piping downstream of the point-of-connection to provide water to remote control valves and quick coupling valves. Normally piping is under constant pressure.
- D. Lateral Line Piping: Circuit piping downstream of the remote control valves to provide water to sprinkler heads, drip system, or bubblers. Normally piping is under pressure only when control valve is in operation.

1.4 PERFORMANCE REQUIREMENTS
- A. The work to be performed under this Section shall consist of furnishing all labor and materials necessary to construct a complete working and tested underground sprinkler irrigation system per all drawings and specifications, providing one hundred (100) percent head-to-head coverage on all lawn and planting areas on the site without overspray onto hardscape, buildings, or other site features. Included also will be system maintenance and warranties.
- B. The efficiency of the completed irrigation system shall meet the following minimum standards:
  1. Circuits using spray sprinklers shall perform at a minimum 60% efficiency.
  2. Circuits using rotor sprinklers shall perform at a minimum 70% efficiency.
  3. At the discretion of the Landscape Architect, efficiency shall be determined by an independent water audit performed by a certified irrigation auditor selected by the

Owner. The Contractor shall include in his bid price the cost of this audit. The audit shall be conducted after substantial completion and before final acceptance of the irrigation system.

C. The Contractor shall perform, but not be limited to, all of the following functions: paying all connection fees, deposits, and all other charges related to the connection to the water source; obtain all permits; complete all excavation and backfill; provide backflow device, tapping saddle, yoke, stop and waste, corp. cock, concrete vaults and miscellaneous pipe fittings; make necessary road repairs; provide safety barrier; make connection to water source; install all electric valves, valve control devices, isolation gate valves, quick coupling valves, drain valves, meter base, conduit, junction boxes, controller, backflow prevention devices and enclosures, filters and enclosures, and all necessary wiring. All work shall be in compliance to applicable codes and requirements of the utility companies involved.

D. If any or all of the above mentioned fees or charges are not listed on the bidding schedule or on plan, they shall be included in the bid lump sum price of the irrigation sprinkling system item.

E. Contractor shall verify with the appropriate water district the location of the water service main line and water pressure, and complete all requirements necessary to bring water service to the site. Total cost to be included in the irrigation sprinkling system bid item.

F. The above specification statement supersedes the graphic representation location of the contract limit line. This pertains to the water line location on either side of the street adjacent to the project site.

G. All work shall be done in accordance with the drawings and specifications, as well as all applicable water and electrical codes.

H. The Contractor shall operate, maintain until acceptance, and guarantee the new system as specified herein until all lawn and plants installed on this project have become established and have been accepted by the Owner.

1.5 SUBMITTALS

A. Product Data: Complete set of manufacturer's technical data and installation instructions for all equipment to be installed on the project. Submittal shall be made prior to commencement of any irrigation work.

B. Main line and lateral line pressure test results: Submitted at the time of occurrence.

C. Operation and Maintenance (O&M) Manual:
   1. O&M manual shall contain the following information:
      a. Manufacturer cut sheets and current printed specifications for each element or component of the irrigation system.
      b. Parts list for each operating element of the system.
      c. Manufacturer's printed literature on operation and maintenance of operating elements of the system.
      d. Section listing instructions for overall system operation and maintenance. Include directions for spring start-up and winterization.
   2. Manual shall be submitted at least thirty (30) days prior to final inspection and acceptance of the project.

D. Complete As-Built Drawings:
   1. Drawings shall conform to the following criteria:
      a. One (1) 22" x 34" and one (1) 11" x 17" drawing shall be submitted.
      b. All submitted drawings shall be made on Mylar or Tyvek original.
      c. Show detail and dimension changes made during installation.

d. Include field dimension locations of sleeving, points of connection, main line piping, wiring runs not contained in main line pipe trenches, valves and valve boxes, quick coupling valves.
e. Dimensions shall be taken from permanent constructed surfaces, features, or finished edges located at or above finished grade.

2. A complete set of as-built drawings shall also be submitted in electronic digital format (.pdf).
3. As-Built drawings shall be submitted prior to final inspection and acceptance.

E. Controller Map: Each controller shall be equipped with a color-coded copy of the area that the controller services. Include valve zone number, type of plant material irrigated, and zone location on the project. Laminate map with heat shrink clear plastic and mount inside controller.

1.6 QUALITY ASSURANCE

A. Acceptance: Do not install work of this section prior to acceptance of the area by the Owner as being properly prepared to receive said work (i.e. at proper grade, properly compacted, permanent fixtures in place, etc.).
B. Adequate Water Supply: Contractor shall verify that proper connection is available to supply lines, and is of adequate size and volume. Perform static water pressure test prior to commencement of work. Notify Owner of problems encountered prior to proceeding.
C. Workmanship: It is the intent of this specification that all materials herein specified with the best standards of practice relating to the trade.
D. The Contractor shall provide to the Owner a document or resume which includes the following information:
1. The Contractor has been installing sprinkler systems on commercial projects for at least ten (10) previous consecutive years.
2. The Contractor is currently licensed to perform landscape construction in the State of Utah.
3. The Contractor is bondable and insurable for the work to be performed.
4. References of at least five (5) projects of similar size and scope completed within the last five (5) years. Three (3) of the projects listed must be located in the general region of the project site.
5. List of suppliers from whom materials will be obtained for use on this project.

1.7 PROJECT CONDITIONS

A. Any discrepancies between existing site conditions and those indicated on the plans shall be called to the attention of the Landscape Architect or Owner's Representative prior to continuance of the project.
B. The Contractor shall use only the equipment and products specified in the construction drawings. No substitution of materials will be allowed on the irrigation system without prior authorization from the Landscape Architect and the Owner's Representative.
C. During delivery, installation, and storage of materials for the project, all materials shall be protected from contamination, damage, vandalism, and prolonged exposure to sunlight. All material stored at the project site shall be neatly organized in a compact arrangement and storage shall not disrupt the project Owner or other trades on the project site. All material to be installed shall be handled by the Contractor with care to avoid breakage or damage. Materials damaged by the Contractor shall not be used, but shall be replaced with new materials at the Contractor's expense.

D. The Contractor shall familiarize himself and his workmen with all hazards and existing utilities prior to commencing work. This shall require local Blue Staking to be completed before any construction activity can begin.

PART 2 PRODUCTS

2.1 GENERAL

A. The Contractor shall provide all materials to be used on this project. The Contractor shall not remove any material purchased for this project from the project site, nor mix these project materials with other contractor-owned materials. The Owner retains the right to purchase and provide project materials.

B. Handling and unloading of all equipment, pipe, and fittings shall be in such a manner as to insure delivery to the job site in a sound, undamaged condition. Any installed equipment or pipe found to be damaged or defective in workmanship or materials shall be rejected and removed and replaced at Contractor's expense.

2.2 PIPE

A. All PVC pipe used on this project for the irrigation system shall conform to the requirements of ASTM -1685. It shall be free of cracks, holes, foreign material, blisters, inside bubbles, wrinkles, and dents.

B. All main line pipe, three (3) inches inside diameter and smaller shall be Schedule 40 PVC solvent weld bell end unless otherwise specified.

C. All main line pipe, four (4) inches inside diameter and larger, shall be PVC Class 200 gasketed bell end (except as required for conversion to metal fittings).

D. All lateral line pipe shall be Schedule 40 PVC solvent weld.

E. Maximum flows allowed through main line and lateral line pipe shall be determined by water speed in the pipe. The maximum water speed allowed in both main lines and lateral lines is five (5) feet per second. The resulting maximum gallons per minute (gpm) allowed to flow through PVC pipes are as follows:

PIPE SIZE	GPM
3/4"	8
1"	12
1 1/4"	22
1 ½"	30
2"	50
2 ½"	75
3"	110
4"	190
6"	425

For sizes larger than 6", consult manufacturer's recommendations.

F. No bends in pipe shall be permitted. The Contractor shall use elbow fittings of ninety (90), forty five (45), twenty two and one half (22-1/2), and eleven and one quarter (11-1/4) degrees as individual situations demand.

G. All pipe used from the main line to the control valves shall be solvent weld Sch. 80 PVC pipe unless otherwise noted or shown on the construction drawings.

2.3 FITTINGS

A. All PVC fittings used on this project for the irrigation system shall conform to the requirements of ASTM D-2466.

B. Main Line Fittings:

1. All main line fittings four (4) inches inside diameter and larger shall be either M.J. or deep bell push-on, gasketed, ductile iron.
2. All main line fittings three (3) inches and smaller inside diameter shall be solvent weld Schedule 80 PVC.
3. All main line fittings four (4) inches and larger, whether ductile iron or solvent weld, shall be thrust blocked per details.
4. All main lines three (3) inches and larger having a horizontal change of direction shall have proper concrete thrust blocks installed. Vertical changes in direction shall require the use of M.J or ductile iron fittings with thrust restraining devices (Mega Lug, Harco Knuckle Joint Restraints, or approved equal) in addition to appropriate concrete thrust blocking. The size and type of thrust block depends on pressure, pipe size, type of soil, and type of fitting. As a general rule, one (1) cubic foot minimum of class AA (AE) Type II concrete is required for each thrust block. Follow thrust blocking details for calculating thrust block size.
5. M.J. tees, Schedule 80 tees with SxT Schedule 80 bushings, or Harco ductile iron service tees are approved on PVC main lines for automatic control valve installation. M.J. fittings shall be greased and wrapped.

C. Lateral Line Fittings:

1. All lateral line fittings shall be solvent weld Schedule 40 PVC.
2. All risers and exposed fittings shall be solvent weld Schedule 80 PVC, including conversions to metal pipe and fixtures, unless otherwise noted on the plans.

D. PVC Cement: Solvent weld or glued joints shall use the following materials:

1. Primer: IPS Weld-On P-70 Primer (purple), ASTM F-656.
2. Cement: IPS Weld-On 711 Heavy Bodied PVC Cement (gray), ASTM D-2564.

2.4 VALVES

A. Master Valve: All master valves shall be as specified in the Irrigation Equipment Schedule. Master valve assembly shall be installed according to detail in drawings.

B. Isolation Gate Valve:

1. Isolation gate valves shall only be used on the main line.
2. Isolation gate valves shall be as specified in the Irrigation Equipment Schedule. Valves shall be hydrostatically pressure tested for 400 P.S.I. and shall be designated for a working pressure of 200 P.S.I. Each valve shall contain a resilient wedge urethane rubber seat. Unless otherwise shown or specified, valves three (3) inches and larger shall have flanged end connections.
3. Buried valves shall have two (2) inch square operating nuts. No handles or wheels will be permitted. Valves inside structures (vaults or valve boxes) may have wheel handles if the valve is two (2) inches or less in size.
4. Action unions shall be installed on each side of all valves except flanged valves.
5. The Contractor shall provide adequate material for the connection of valves to the system, i.e., adapters, flanges, nuts, bolts, gaskets, etc.
6. All buried main line isolation valves with a (2) inch square operating nut shall be fitted with a four (4) inch minimum diameter pipe sleeve place over the top of the valve

vertically and extended to grade. Cover with a ten (10) inch round plastic valve box with bolt down lid and set at finished grade.

C. Remote Control Valve Assembly:
   1. Remote control valves shall be as specified in the Irrigation Equipment Schedule.
   2. Remote control valves shall be globe configuration, electrically activated, normally closed, forward flow design.
   3. All pipe on the control valve assembly shall be Schedule 80 PVC pipe. See detailed drawings.
   4. Action unions shall be installed on each side of the control valve assembly, allowing valve to be removed from the box for maintenance without cutting pipe.
   5. Each control valve shall have a brass gate or ball valve installed immediately upstream of the valve and located within the same valve box.
   6. Flows through each remote control valve shall not exceed the following limits:

VALVE SIZE	GPM RANGE
1"	1 - 30
1 ½"	31 - 75
2"	76 - 150

   7. Each drip remote control valve assembly shall contain the following components:
      a. PVC ball valve.
      b. Inline disc or screen filter with 100 micron/150 mesh filter element.
      c. Remote control valve capable of operating at very low flow levels.
      d. Inline pressure regulator.

      All components shall be installed according to manufacturer's recommendations, and located within a single valve box, one valve per box (no multi-valve assemblies permitted).

D. Quick Coupling Valve Assembly:
   1. Quick coupling valves shall be as specified in the Irrigation Equipment Schedule.
   2. Quick coupling valves shall be heavy duty brass, two-piece, single lug locking cap.
   3. The Contractor shall provide to the Owner at least 1 cap lock key and 1 quick coupling key with a swivel hose bib attached. These keys shall be delivered prior to final acceptance of the project.

E. Manual Drain Valve Assembly:
   1. All manual drains shall be three quarter (3/4) inch heavy duty brass ball valve.
   2. Manual drain valves shall be required at all low points in the main lines. See plans, notes, and details.
   3. The location of each manual drain shall be shown on the "as built" drawing with dimensions from the nearest permanent fixture, such as a building corner, etc.
   4. Each manual drain valve will be accessed by a vertical two (2) inch PVC Schedule 40 pipe sleeve, capped by a locking valve cap with a key, enclosed within a ten (10) inch round green valve box with bolt down lid. The top of the drain sleeve shall be three to six (3 - 6) inches below the lid of the valve box.
   5. Each manual drain shall empty into a gravel sump, a minimum of twenty four (24) inches by twenty four (24) inches by eighteen (18) inches deep, (or six (6) cubic feet total capacity). The gravel shall be washed three quarter (3/4) inch rock.

F. Automatic Drain Valves: Automatic drain valves shall not be used.

2.5 VALVE BOXES

A. All valve boxes shall be green HDPE plastic with locking lid, or approved equal.

B. Valve box size shall be listed in the installation details for each irrigation system component.

2.6 BACKFLOW PREVENTION ASSEMBLY – Not Applicable

A. Backflow prevention devices shall be a reduced pressure principle backflow preventer consisting of a pressure differential relief valve located between two independently operated spring-loaded "Y" type center guided check valves. Assembly shall also have two full port resilient seated ball valves for shut-off and four resilient seated ball valve test cocks and bronze body construction. Larger sizes (2 ½" and up) may have two non-rising stem resilient wedge gate valves in lieu of ball valves.

B. Backflow preventer shall be as specified in the Irrigation Equipment Schedule.

2.7 AUTOMATIC CONTROL SYSTEM

A. Furnish a low voltage automatic control system manufactured expressly for the operation of automatic control valves used in an underground irrigation system.

B. Automatic controller devices shall be as specified in the Irrigation Equipment Schedule. No substitutions shall be allowed. Unless specified otherwise, install as follows:
   1. Install in stainless steel enclosure, model as specified in the Irrigation Equipment Schedule.
   2. Whenever a single site has 2 or more controllers, the 2nd and subsequent controllers shall also be mounted in a separate stainless steel enclosure as specified in the Irrigation Equipment Schedule.
   3. Metered enclosures, if required, shall be mounted on a 4" thick concrete pad. Regular enclosures may use a pre-manufactured mounting system as specified in the Irrigation Equipment Schedule.

C. Provide adequate capacity to accommodate each valve on the system separately. Do not double valves to circuits.

D. The Contractor shall provide 120 volt electrical service to the controller. Where required, install meter inside meter socket of the enclosure. Coordinate this work with the Owner and other trades involved in the project.

E. Every controller shall be installed to control a single point of connection (P.O.C.). That point of connection shall be exclusively associated with that controller. Each P.O.C. assembly shall consist of the main line tap, reverse pressure backflow prevention device (if potable water source), filter (if required), master control valve (if specified), flow sensing device (if specified), manual drain valve, and quick coupling valve. No controller shall be wired to control valves which are connected to another P.O.C.

2.8 CONTROL VALVE WIRE

A. All irrigation control wire shall bear approval as U.L. listed type of underground feeder (direct burial) and each conductor shall be of electrical conductivity grade solid copper in accordance with ASTM 30.

B. No aluminum wire shall be used on this project.

C. Wire size shall be #14 gauge minimum.

D. Two spare wires shall be run from each controller to the farthest valve under its control in all directions and any valve which is on a dead-end line.

E. All wire crossing water, attached to bridges, going under paving, or where conditions require protection, shall be housed in conduit or sleeves. All out-of-ground conduits shall be rigid metal. All buried conduit may be PVC.

F. All splices shall be water-tight. All connections made inside the box to connect wires to the valve shall be made using a 3M DBR/Y dry-splice connector or pre-approved equal. Each connector shall be completely sealed and water-proofed.
G. All other splices in control wire shall be housed in a separate valve box.
H. The pigment or color of the wires shall be integrated into the covering, rather than painted on. All common or ground wires shall be white in color. Where more than one controller is required, a different colored hot wire shall be used for each controller. A separate color shall be used for all spare wires.

2.9 SPRINKLER HEADS

A. General:
1. All heads used on this project shall be as specified in the Irrigation Equipment Schedule shown on the plans.
2. All sprinkler heads and nozzles shall be as specified in the Irrigation Equipment Schedule.

B. Spray/Rotary Sprinklers:
1. Spray/Rotary sprinklers shall have either four (4), six (6), or twelve (12) inch pop-up height and built-in check valve. In areas where water pressures are high or fluctuating, pressure regulating series sprinklers shall be used.
2. Spray/Rotary sprinkler nozzles shall be plastic matching precipitation rate nozzles. Variable arc nozzles may be used to meet irregular-shaped areas.
3. Attachment options shall be as specified in the installation details.

C. Rotor Sprinklers:
1. Rotor sprinklers shall be equipped with stainless steel rotor sleeve and check valve.
2. Rotor sprinkler nozzles shall be as manufactured for each individual model.
3. Small rotor sprinklers (½" bottom inlet) may be installed using swing pipe per installation details. Medium (3/4" bottom inlet) and large (1" or greater bottom inlet) rotor sprinklers shall be installed using swing joints as shown in the installation details. Swing joint size shall match sprinkler inlet size.

D. Bubblers, Tree Well, and Root Watering Systems: Installed per manufacturer's recommendations. Use only where and when specified.

2.10 DRIP IRRIGATION

A. Drip irrigation materials shall be as specified in the Irrigation Equipment Schedule.
B. Emitters shall be of the individual, self-cleaning, pressure-compensating type.
C. Dripline tubing shall be constructed of high quality linear, low density, UV-resistant, polyethylene resin materials with internal, integral emitters at specified intervals.
D. All insert barbed fittings shall be constructed of molded, UV-resistant plastic. Each fitting shall have a minimum of two (2) ridges or barbs per outlet. All fittings shall be from the same manufacturer and shall be available in one of the following end configurations:
1. Barbed insert fittings.
2. Male pipe threads (MPT) with barbed insert fittings
3. Female pipe threads (FPT) with barbed insert fittings.

E. Each drip remote control valve assembly shall contain the following components (in required sequence):
1. PVC ball valve.
2. Inline disc or screen filter with 100 micron/150 mesh filter element.
3. Remote control valve.

4. Inline pressure regulator.

F. Provide the following equipment to each drip valve circuit, located and installed per manufacturer's recommendations:
   1. Line flushing valve(s) - minimum of one (1) on each exhaust header, and one (1) on each supply header.
   2. Air/Vacuum relief valve(s) at all high points in the system if required by the manufacturer.

2.11 FLOW SENSING EQUIPMENT

A. Where specified, each controller shall be installed with its own corresponding flow sensor on a single point of connection to the water source.
B. The flow sensor shall be compatible with the specified controller.
C. Size the flow sensor so that it is able to read the high and low flows of the valves used on that particular controller. Install per manufacturer's specifications.

PART 3 EXECUTION

3.1 GENERAL

A. The irrigation plan is diagrammatic in nature, and some drafting liberties have been taken to maintain the graphic clarity of the drawings. All irrigation equipment shall be located in planting areas only, unless noted otherwise. The Contractor shall install piping to minimize changes in direction, avoid placement under trees or large shrubs, and avoid placement under hardscape features. Refer to the irrigation legend, details, and specifications for equipment and proper installation.
B. Site Visit: The Contractor shall visit and inspect the project site. He shall take into consideration known and reasonably inferable conditions affecting the proposed work. Failure to visit the site shall not relieve the Contractor of furnishing materials and performing the work required. Any discrepancies between existing site conditions and those indicated on the plans shall be called to the attention of the Owner, by the Contractor, prior to continuance of the project.
C. The Contractor shall keep the premises clean and free of excess equipment, materials, and rubbish incidental to work of this project. Work areas shall be swept clean and trash and debris picked up daily. Open trenches or hazards shall be protected with yellow caution tape. The Contractor is responsible for removal and legal disposal (off site) of trash and debris generated by his work on this project.
D. Existing Landscapes:
   1. Where existing landscape areas are a part of the project, the Contractor shall repair or replace work damaged by his irrigation system installation at his own expense. If the damaged work is new, the Contractor or the original installer of that work shall perform repairs at the Contractor's expense. The existing irrigation system and landscape shall remain in place, protected, undisturbed, and functional.
   2. The Contractor shall protect in place and work around all existing plant materials designated to remain.
   3. Coordination of trench and valve locations shall be laid out prior to any excavation work. Plant material deemed by the Landscape Architect or Owner's Representative to be damaged by the Contractor shall be replaced with new plant material at the Contractor's expense. The Contractor shall not cut existing tree roots larger than two (2) inches in diameter. Route pipe, wire, and irrigation components around tree

canopy drip lines where possible to minimize damage to tree roots.

4. The Contractor shall leave no part of the existing landscape without water for more than forty eight (48) hours at a time.

E. Pre-Construction Meeting: A pre-construction meeting shall be held prior to beginning any work on a project. The Owner and/or Owner's Representative, the project designer, and the Contractor and his Sub Contractors shall all be in attendance.

1. The purpose of this meeting is to review project goals and expectations, the project schedule, and all procedures relative to inspections, permits, and changes that may arise.
2. In the pre-construction meeting, it shall be made clear that the construction documents (plans, details, specifications, and contract) shall be binding upon the Contractor and upon all of his work. Any work not in accordance with the plans and specifications shall be rejected, and the Contractor shall bring the project into compliance at his own expense.

3.2 CONSTRUCTION STAKING

A. The Contractor shall provide the necessary staking to obtain the layout shown on the plans. The points of reference shall be as indicated in the drawings and shall include such features as the walks, buildings, curbs, etc. Any changes in the system which appear necessary due to field conditions must be called to the attention of the Owner/Owner's Representative and Landscape Architect and approved by the Owner at the time they are discovered and prior to making any changes.

3.3 EXCAVATION AND BACKFILLING

A. Excavation:

1. Excavation work shall only be as deep and as wide as will be required to safely perform the work, such as making mainline connections or forming vaults.
2. Trenches shall be deep and wide enough to provide working space for placing two (2) inches of bedding underneath all new mainline pipe and fittings where the soil is rocky or gravelly. Place twenty (20) to thirty (30) inches of cover over the top of all pipe and fittings on main lines. All trench bottoms shall be sloped so the pipes will gravity-drain back to the main connection point or the nearest manual drain. If the existing main line is deeper than thirty (30) inches, the Contractor shall install a riser to a depth of eighteen (18) to thirty (30) inches and then install the new line at the required depth. At no time will the mainline be installed with less than eighteen (18) inches or greater than thirty (30) inches of cover unless prior approval is given by the Landscape Architect or Owner's Representative.
3. Trenches shall be deep enough to maintain twelve (12) to fourteen (14) inches of cover over the top of all lateral line pipe and fittings. They shall be deep enough to guarantee that all swing joints drain back to the lateral lines. Trenches shall be a minimum of twelve (12) inches away from any walks and/or curbs, buildings, or other hardscape improvements. They shall be of sufficient width to accommodate tees and other fittings that come out sideways (horizontally) from the lateral lines. Lateral lines may be pulled by a mechanical puller provided all other applicable specifications are met.
4. Any rocks or other debris over one (1) inch in diameter uncovered during excavation or trenching shall be removed from the area.
5. If more than one (1) pipe line is required in a single trench, that trench shall be deep

and wide enough to allow for at least six (6) inches of horizontal separation (if both are lateral lines), or six (6) inches of both horizontal and vertical separation (if one line is a main line) between pipes.

6. Any existing utility lines damaged during excavating or trenching shall be reported immediately to the Landscape Architect, the utility Owner, and the project Owner. After proper notification to the Landscape Architect, the utility Owner, and project Owner, repairs to the damaged utility shall be made immediately. Repair materials and methods shall meet industry standards and the utility Owner's satisfaction. Should utility lines be encountered which are not indicated on the plans, the Owner shall be notified. The repair of any damage shall be done as soon as possible by the Contractor or the utility Owner, and proper compensation to the Contractor shall be negotiated with the Owner. Such utility locations shall subsequently be noted on the "As-Built" drawings required before final payment of the irrigation system contract.
7. Where trenching is done in established lawn, care shall be taken to keep the trenches only as wide as is necessary to accomplish the work. The trenches shall be backfilled as specified and then four (4) inches of approved topsoil placed to bring the trench up to existing grade so that sod can be laid. Only new sod shall be used as trench cover. It shall be established new sod, of standard width, and shall be laid along the trenches so as to match the existing sod. No small pieces of sod shall be used and only standard lengths shall be accepted. No sod from the construction site shall be used unless otherwise specified. In the event of any backfill settlement prior to the end of the guarantee period, the Contractor shall perform the required repairs at his own expense.

B. Backfilling:

1. No backfilling of trenches shall be done until the system has been inspected and approved by the Landscape Architect or Owner's Representative for proper trench depths, installation of equipment, control wire, and location of heads.
2. Before trenches are backfilled, the Contractor must show the Landscape Architect or Owner's Representative the redlined "As-Built" drawing he has been keeping on the site, indicating that changes and corresponding dimensions have been recorded where such changes have been made.
3. Prior to backfilling, the system shall be tested under pressure for leaks and general operation of the equipment. The main line shall be tested for a period of four (4) hours at a pressure of 120 PSI. Any failures detected during the testing period shall be repaired by the Contractor and the testing shall be repeated. The Landscape Architect shall certify the testing to insure that it has been completed and that the system has met all testing requirements. All defects discovered by the pressurization and operation test shall be corrected by the Contractor at his own expense before proceeding with further work.
4. Trench bedding and backfill material shall be existing site soil free of rocks larger than one (1) inch in diameter and any other debris. Wasted pipe and other excess project materials or rubbish (tape, wire, trash, wrappers, boxes, bottles, etc.) shall not be backfilled into the trenches. All trenches shall be backfilled, and then watered sufficiently to insure no settling of the surface. In the event of any backfill settlement prior to the end of the guarantee period, the Contractor shall perform all required repairs at his own expense.
5. Backfill under and around the lines to the center line of the pipe shall be placed in maximum layers of six (6) inches and thoroughly compacted. Compaction shall be

ninety five (95) percent relative density (modified proctor) under walks and roads, and eighty five (85) percent in planting areas.

6. Special care shall be taken to assure complete compaction under the haunches of the pipe. Backfill compaction under the haunches of the pipe shall be compacted to the original density. Compaction requirements above the pipe shall be the same as for surrounding areas.

3.4 POINT-OF-CONNECTION

A. The Contractor shall verify the location of the irrigation point-of-connection (P.O.C.) and the static water pressure at that location prior to beginning any irrigation work. Verify water pressure during the time of day that the irrigation system is intended to operate.

B. If the P.O.C. location or water pressure is different than that expressed by the irrigation designer, or if the pressure appears to be unusually high or low, the Contractor shall notify the Landscape Architect or Owner's Representative immediately prior to beginning any irrigation work.

3.5 ELECTRICAL POWER SUPPLY AND AUTOMATIC CONTROLLER

A. If 120 volt ac electrical service is not already in place, the Contractor shall be required to make all necessary arrangements with the appropriate power company and provide all necessary materials and labor to provide said power, including but not limited to: paying fees, making power connections, providing poles, weatherhead and meter, etc., as specified on the plans or as required by the power company and the Owner. The automatic controller shall be of the type and manufacturer specified, and located as shown on the drawings.

3.6 PIPE AND FITTINGS

A. Install pipe to allow for expansion and contraction as recommended by pipe manufacturer. Where the main line sits uncovered for any length of time in the trench prior to testing, the main line shall be shaded with a thin covering of backfill soil to minimize weather-related expansion or contraction of the pipe. Do not cover up valves or other installed equipment prior to inspection and acceptance.

B. The ends of all pipe shall be cut squarely, and remain free of all inside scale or burrs. Spigot ends of pipes three (3) inches and larger shall be beveled. Threads shall be cut clean and sharp, and to a length equal to one and one eighth (1-1/8) times the length of the female thread receiving the pipe. The threaded pipe shall be screwed into a full length of the female thread.

C. All threaded pipe joints shall be properly sealed using Teflon tape that is properly applied to the areas to be joined.

D. Solvent weld joints shall not be glued unless ambient temperatures are at least forty (40) degrees F. Pipe shall not be glued in rainy conditions unless properly tented. Use only the brand and type of primer and glue specified. Glued main line pipe shall cure a minimum of four (4) hours prior to being energized. Lateral lines shall cure a minimum of two (2) hours prior to being energized and shall not remain under constant pressure unless cured for twenty four (24) hours.

E. Every care shall be taken during installation to prevent dirt and debris (especially rocks and pipe shavings) from getting into the pipes.

F. All tees coming out of main lines for valves and other fixtures shall be vertical and constructed with Sch. 80 PVC pipe.

G. All tees coming out of the lateral lines for heads and other fixtures shall be horizontal so that no direct weight or pressure may be exerted through the head to the top or bottom of the lateral line pipe. Tees on lateral lines shall also be SxSxT to the head swing joints.

3.7 THRUST BLOCKS

A. Thrust blocks are needed wherever the main pipe line:
   1. Changes any direction at tees, angles, and crosses vertical and horizontal.
   2. Changes size at reducers.
   3. Stops at a dead-end.
   4. Valves at which thrust develops when closed.

   The size and type of thrust block depends on pressure, pipe size, type of soil, and type of fitting. As a general rule, one cubic foot (minimum) of class AA (AE) Type II concrete (2,000 psi minimum) is required for each thrust block. Follow thrust blocking details for calculating thrust block size.

B. Thrust blocks shall rest against undisturbed original earth in the direction of thrust.

C. Where a fitting is used to make a vertical bend, use a three eighths (3/8) inch bar to anchor the fitting to a thrust block braced against undisturbed soil. The thrust block should have enough resistance to withstand upward and outward thrusts at the fitting.

D. Where concrete thrust blocking shall come in contact with PVC pipe, wrap the PVC pipe with a layer of plastic to protect the pipe from any caustic effects that may be caused by the concrete mix.

E. Thrust restraining devices may be used in lieu of thrust blocking, but they must be installed strictly according to manufacturer's recommendations. Use of these devices in lieu of thrust blocking shall be approved by the Owner or Owner's Authorized Representative prior to use.

3.8 PIPE SLEEVES

A. Pipe sleeves shall be required for all piping under all new concrete or other new paving. The size of the sleeve shall be at least twice the size of the pipe or wires to be sleeved. Wires shall be sleeved separately within their own sleeve. All pipe sleeves four (4) inches and smaller in diameter shall be PVC Schedule 40 pipe; sleeves greater than four (4) inches in diameter shall be Class 200 PVC, unless otherwise specified on the drawings.

3.9 VALVES

A. General:
   1. Isolation valves, remote control valves, and quick coupling valves shall be installed according to manufacturer's recommendations and these drawings and specifications.
   2. Valve boxes shall be set over valves so that all parts of the respective valve assembly can be reached for service. Valve box and lid shall be set to be flush with the proposed finished grade.
   3. No valve box shall rest directly upon the valve or any fixture associated with it, including main line and lateral lines. Each valve box shall be centered on the valve assembly it covers. Each valve box shall have four (4) inches of three quarter (3/4) inch gravel placed in the bottom underneath the valve and lines to reduce the potential of mud and standing water therein.

B. Remote Control Valve:
   1. Each control valve shall have its own gate or ball valve (as specified), and only one (1) control valve and gate/ball valve per valve box. No valve manifolds shall be allowed.

2. The bottom of the remote control valve shall be a minimum of four (4) inches above the gravel.
3. All control valves shall be located within shrub areas where possible and installed per the details on the plans. No large grouping of valves (greater than 3) in any one spot shall be allowed, unless approved by the Landscape Architect or Owner's Representative.
4. Control valve assemblies shall be installed no closer to one another then two (2) feet.
5. No control valve shall be installed more than twelve (12) inches below finished grade.
6. Tag each control valve with a permanent and non-smearing label indicating its proper controller and valve number as shown on the irrigation plans.

C. Quick Coupling Valve:
1. Quick coupling valves shall be installed within a ten (10) inch round green plastic valve box, with the top of the valve box at finished grade.

3.10 VALVE BOX

A. Where indicated in the installation details, valve boxes shall rest on concrete pavers only, thus eliminating any weight or pressure from being exerted on the main line or valve inside the valve box. There shall be a minimum of three (3) inches of clear space between the bottom of the valve box lid and the topmost part of the valve (including solenoid).
B. Valve box extensions shall be used where necessary to prevent soil around the valve from collapsing into the space inside the valve box.

3.11 BACKFLOW PREVENTION ASSEMBLY

A. The Contractor shall install backflow prevention equipment behind (downstream from) the point-of-connection to the supplying main and lateral lines. Installation shall comply with local, state, and national codes and regulations, and per manufacturer's recommendations (whichever is most restrictive). See plans and details for more information. Install a quick coupling valve just down stream of the backflow prevention assembly for system blowout purposes.
B. The Contractor shall have the backflow prevention assemblies operation tested within ten (10) days of the time of installation by a certified backflow preventer assembly tester. Testing shall be conducted per state requirements to insure proper and safe operation. Subsequent annual testing at spring start-up shall be the responsibility of the Owner.

3.12 WIRE & CABLES

A. Multiple wires in the same trenches shall be banded together at ten (10) foot intervals for protection. Where wires pass under paved areas, they shall be installed in Schedule 40 PVC sleeves, separate from lateral or main lines. These sleeves shall be installed prior to installation of the paving, if possible, and prior to installation of the wires. Sleeves for fourteen (14) gauge wires shall be sized as follows:

NUMBER OF WIRES	SLEEVE SIZE
1 - 10	1"
11 - 18	1 1/4"
19 - 25	1 1/2"
26 - 40	2"
41 - 56	2 ½"
57 - 88	3"
89 - 150	4"

B. All control wires shall be bundled and taped together every ten (10) feet and installed in the pipe trench directly adjacent to the pipe. Control wires not placed in the trenches adjacent to the pipes shall be placed in PVC electrical conduit and buried eighteen (18) inches or deeper and marked on the "as built" drawings.

C. Two (2) spare wires shall be run from each controller to the farthest valve under its control in all directions and to any valve which is on a dead-end line. The spare wires shall be a different color from the regular wires and shall be labeled at both ends. Each spare wire shall be brought up to the surface in each valve box it passes through and coiled with twenty four (24) inches for use in future connections. Each spare wire shall be tested for continuity prior to final acceptance of the project and guaranteed by the Contractor to be functional. Should the maintenance personnel discover a defect within one (1) year afterwards, the Contractor shall locate the problem and cause it to be repaired at his own cost. Install extra wires as needed for moisture sensors (if used).

D. Run a single 14 gauge wire along the top of the main line to be used for tracking the location of the main line. The color of the tracing wire shall be different than any other wire color used.

E. All wires shall be installed with twenty four (24) inches of excess wire (coiled) at the end of each wire run, wire splice, and at each controller.

F. Isolation valves, quick coupling valves, manual drain valves, and wire splices not specifically associated with the control valve shall be located in separate valve boxes.

3.13 SPRINKLERS

A. General:

1. All sprinkler heads shall be installed above grade so as to minimize washing of the topsoil and seed during the landscaping establishment period, except those which border paving or flat work of any kind. These heads shall be installed at the finished grade of the adjacent paving or flat work. Prior to final acceptance of the project, all heads shall be raised or lowered to final lawn or planting grade.
2. All sprinkler heads shall be installed using the bottom inlet. No side outlets shall be used. Tape or plug all open ends while installing to prevent debris contamination.
3. Rotor heads located on hillsides shall be adjusted to the downhill side to avoid cutting into the hill by the stream of water and causing erosion.
4. Heads installed in existing sod shall be set at the grade of the soil.
5. All rotor pop-up heads shall be installed at final grade using Lasco unitized swing joint or Spears swing joint riser assemblies. All swing joints must drain by gravity back to the supply lines.
6. All pop-up, shrub spray/rotary, turf spray/rotary, bubbler and strip spray/rotary heads shall be installed as shown in the details.
7. All pipes, lines, and risers shall be flushed thoroughly with water before installation of any heads. All debris and rocks found at that time shall be removed from the area as soon as possible.
8. All spray sprinklers shall be flushed thoroughly with clean water a second time before installation of nozzles.
9. The Contractor shall adjust all heads to provide a uniform coverage and to keep spray off buildings, walkways, walls, parking areas, and drives.
10. Check valves shall be used where indicated and where necessary to prevent water flow from lower elevation heads when system is turned off. Install per manufacturer's recommendations.

B. Drip Irrigation
   1. Point Source Drip System
      a. Place two (2) drip emitters on opposing sides of each shrub, perennial, and ornamental grass. Place three (3) drip emitters equally spaced around trees. Emitters shall be staked near the edge of the newly planted root ball and inside the watering well.
   2. Inline Drip System
      a. Inline drip tubing shall be spaced approximately equal to the inline emitter spacing. Inline drip tubing spacing may be adjusted to be slightly less than the emitter spacing in order to achieve uniform spacing. For slope applications, place drip tubing laterals parallel to the slope contour. When slopes exceed thirty (30) percent, increase the recommended lateral spacing by twenty five (25) percent on the lower one third (1/3) of the slope.
   3. Inline dripper tubing shall be installed at finished grade with soil staples and covered with three (3) inches of specified mulch. Supply and exhaust headers shall be installed at normal lateral line depths.
   4. All drip tubing shall be held in place by soil staples and shall conform to the following:
      a. Sandy Soil - One staple per every three (3) feet and two (2) staples on each change of direction (tee, elbow, or cross)
      b. Loam Soil - One staple every four (4) feet and two (2) staples on each change of direction (tee, elbow, or cross)
      c. Clay Soil - One staple every five (5) feet and two (2) staples on each change of direction (tee, elbow, or cross)
   5. Installation of inline drip circuits shall generally conform to the following steps:
      a. Assemble and install ball valve, filter, remote control valve and pressure regulating valve assembly in accordance with installation details.
      b. Assemble and install supply header(s) in accordance with installation details. Tape or plug all open connections to prevent debris contamination.
      c. Install lateral drip lines in accordance with details and relevant specifications and manufacturer's recommendations. Tape or plug all open ends while installing to prevent debris contamination.
      d. Assemble and install exhaust header(s) in accordance with installation details. Tape or plug all open connections to prevent debris contamination.
      e. Install air/vacuum relief valve(s) at the zone's highest point(s) in accordance with installation details.
      f. Thoroughly flush supply header(s) and connect drip lateral lines while flushing.
      g. Thoroughly flush drip lateral lines and connect to exhaust header(s) and any interconnecting lateral lines while flushing.
      h. Thoroughly flush exhaust header(s) and install line flushing valves in accordance with details.

3.14 AS-BUILT DOCUMENTS

A. The Contractor shall keep a current and accurate record of exact dimensioned locations, grades, elevations, and size of all exterior and interior underground piping, valves, and drains. Dimensions shall indicate distances from columns, buildings, curbs, and similar permanent features on the site. This information shall be recorded on a print as the work progresses, but shall be permanently recorded on a reproducible two (2) mil Mylar or Tyvek original which shall be given to the Owner before the project is accepted. The

Mylar or Tyvek shall be a copy of the original plans for the project produced by a local printer at the Contractor's expense.

B. Final payment for the contract will not be processed until "As-Built" drawings or plans are received by the Owner.

3.15 OPERATIONAL TEST AND MAJOR INSPECTIONS

A. Substantial Completion:
   1. At substantial completion of the irrigation system, the Contractor shall call for an operational and coverage test. Substantial completion shall be defined as the complete installation of all irrigation equipment and completion of all backfilling and grading operations in their entirety. Substantial completion shall not be given for designated portions of the project.
   2. Notice by the Contractor shall be given, in writing, at least three (3) days in advance to the Owner so that proper scheduling can be made for those who are to attend.
   3. At the appointed time, an inspection of all irrigation equipment, including control valve assemblies, controllers, isolation valves, quick coupling valves, drain valves, and sprinklers shall be made. The entire system will be tested for operation, coverage, and head adjustment. Please note that the pressure testing of the main lines shall already have been completed prior to this time.
   4. A list of uncompleted items or repairs (punch list) shall be generated by the Owner and distributed to the Contractor and other involved parties within three (3) days of the operational testing. Each item on the punch list shall be corrected before the system will be approved and accepted by the Owner. The Contractor will be back charged for time spent by the Owner and any consultants who have been brought to the site for a final inspection when the project is not ready for said inspection.

B. Maintenance/Establishment Period:
   1. The duration of the irrigation maintenance period shall be equal to the plant maintenance/establishment period. It shall begin one (1) day after the substantial completion inspection. The Contractor shall complete all punch list items during the maintenance period, as well as maintain and operate the entire irrigation system.
   2. The irrigation Contractor (if different than the landscaping Contractor) shall coordinate with the landscaping Contractor during the entire plant and lawn establishment period on the use, scheduling, and maintenance of the sprinkler system.
   3. The maintenance period shall not end until Final Acceptance of the project.

C. Final Acceptance:
   1. A second inspection shall be held at the end of the maintenance period to insure that all punch list items have been completed and the entire system is ready for acceptance by the Owner.
   2. Upon satisfaction that the Contractor has completed all punch list items, the irrigation system is fully and completely functional, and the required As-Built drawings (Mylar or Tyvek) and maintenance manuals have been submitted, the Owner shall accept the project.
   3. An official letter of final acceptance shall be prepared and issued by the Owner to the Contractor and Landscape Architect. Upon acceptance of the system by the Owner, the Owner shall assume full responsibility for the system, and the guarantee period shall begin.

3.16 GUARANTEE AND MAINTENANCE

A. Guarantee:

1. Upon final acceptance of the irrigation system as being operational and properly installed, the Contractor shall guarantee the workmanship, materials, fixtures, and equipment to be free from defects for a period of one (1) year after that date.
2. The Contractor shall insure and guarantee complete drainage of the system. In working with or connecting to an existing system, the Contractor shall guarantee compatibility in operation and drainage between the two systems.

B. Maintenance Required During Guarantee Period:

1. In the fall of the year during the installation and guarantee period, the CONTRACTOR shall meet with the Owner's maintenance personnel on the site. The Contractor shall winterize the system by draining all of the water and doing everything necessary to insure protection of the system until spring. Blowing out the lines by compressor shall be permitted during the one (1) year guarantee. Maximum compressor pressure shall be 30 psi on spray circuits, 50 psi on rotor circuits, and 20 psi on all drip circuits. The individuals involved from both parties shall exchange all information necessary for the eventual take-over of the system by the Owner.
2. The Contractor, with the Owner's maintenance personnel and Owner in attendance, shall energize the sprinkler irrigation system again the following spring and shall repair all defects found as a result of winter damage, improper installation, improper maintenance, defective materials or inadequate sprinkler drainage.
3. At the end of the guarantee period, when the lawn and landscaping have been accepted, the Contractor shall call for a final inspection of the sprinkler irrigation system. There shall be at least five (5) days prior notice given in writing to the Owner so the appropriate people have opportunity to attend.
4. Prior to that time, the Owner shall adjust all heads to their proper pattern, radii, and height. The system shall have been flushed out, checked for operation, and any defects covered by the guarantee shall be repaired. The entire system shall be inspected and checked to determine if everything is in working order. A final list of warranty items found in need of correction (if any) shall be made and the Contractor shall correct them. The Contractor shall notify the Owner when he has verified that every item is corrected.
5. After all warranty items have been corrected, the Owner shall, in writing, officially release the Contractor from all warranty claims pertaining to the irrigation system and assume full and complete responsibility for said system.

END OF SECTION

SECTION 02910
PLANTING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:
   1. Trees, shrubs, perennials, vines, and groundcover requirements.
   2. Bedding, topsoil, and temporary support.

B. The work to be performed under this section shall consist of furnishing all materials, labor, and plants necessary for the proper planting for all trees, shrubs, perennials, vines, and groundcovers of the kind and sizes specified at the prescribed locations and otherwise in accordance with the drawings and specifications or as directed by the Landscape Architect or Owner's Representative.

C. Related sections:
   1. Section 02810 Underground Irrigation Systems.

1.2 REFERENCES

A. ANN: American Associations of Nurserymen, Inc.

B. ANSI Z60.1: American Standard for Nursery Stock.

C. FS O-F-241: Fertilizers, Mixed Commercial.

D. ICN: International Code of Nomenclature for algae, fungi, and plants.

E. City Standards/Ordinances relating to irrigation and planting.

1.3 QUALITY ASSURANCE

A. Perform work in conformity with applicable requirements of AAN.

B. Upon receiving Notice to Proceed, the Contractor shall provide written proof that the specified plant material is available and has been secured or reserved specifically for this project. Obtain nursery stock and other plant materials from reliable and stable sources prior to order and delivery.

C. Provide plants that are declared free of disease and insect pests.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Exercise care in digging, transporting, handling, and packing of all plants.

B. Handle plants so roots are protected at all times. If delivery is in open vehicles, cover entire load without causing overheating.

C. Deliver plant material immediately prior to placement. Keep plant material moist.

D. Protect root balls from sun and wind by covering with soil or other suitable material if not planted immediately on delivery.

E. Store fertilizer in a weatherproof location such that its effectiveness will not be impaired.

1.5 ACCEPTANCE

A. Plants shall not be accepted if the ball of the earth surrounding roots (rootball) has been cracked or broken.

B. Plants shall be accepted if burlap, staves, and ropes required in connection with transplanting are installed and still intact upon delivery.

C. Heeled in stock from cold storage shall not be accepted.

1.6 SAMPLES

A. Samples of the topsoil, mulch, fertilizer, and tree ties listed below shall be submitted to the Landscape Architect or Owner's Representative for inspection and approval prior to the beginning of work under this contract.

B. Delivery of materials may begin only after samples have been approved. All materials furnished for the work shall conform in every respect to the approved samples. Any non-conforming materials will be rejected.

PART 2 PRODUCTS

2.1 GENERAL

A. The planting plan is diagrammatic, and all plant locations are approximate. Plant symbols take precedence over plant quantities shown on the plans and in the plant material schedule. The contractor shall verify all plant quantities and notify the Landscape Architect or Owner's Representative of any discrepancies between the quantities and the symbols shown.

B. Provide plants of normal growth and uniform height, according to species, with straight canes and well-developed leaders, roots, and tops.

C. Provide plants of sizes indicated. The size stated in each case shall be interpreted to mean dimension of plant as it stands in its mature position in the nursery without straightening of any branches or leaders.

D. Provide legible labels attached to all plants, specimens, bundles, boxes, bales, or other containers indicating botanical genus, species, and size of each.

E. Plants cut back from larger sizes to meet specifications shall be rejected.

F. Balled and burlapped deciduous shrubs may be acceptable in lieu of container growth deciduous shrubs only if there is a demonstrated significant shortage of container grown stock.

2.2 PLANTS

A. All plants shall comply with federal and state laws requiring inspection for plant disease and infestations.

B. Any inspection certificates required by law shall accompany each delivery of plants and such certificate shall be given to the Landscape Architect or Owner's Representative. All plants shall be subject to inspection and approval at the place of growth or upon delivery to the site for their quality, size, species, and variety. Such approval shall not impair the right of inspection and rejection at the site or during progress of work for size and condition of the plants, latent defects, or injuries. Any and all rejected plants shall be removed immediately from the premises by the Contractor. The Contractor shall make all replacements at his expense should he fail to comply in full with any of the specifications. Necessary replacements will be made as soon as weather conditions permit, and all such plants replaced shall conform to all specifications herein.

C. Names and Grades:

1. Plant names shall conform to the nomenclature of "Standardized Plant Names," "International Code of Nomenclature for algae, fungi, and plants (ICN)," or "International Code of Nomenclature for Cultivated Plants (ICNCP), 9th edition." When a name is not found in any of these references, consult the accepted name used in the

nursery trade. All plants shall be tagged by the nursery with the proper identification labels to insure the correct varieties of plants.

2. Size and grading standards shall conform to those of the American Association of Nurserymen, Inc., as published in "American Standard for Nursery Stock", 2014 Edition, with all current revisions unless otherwise specified.
3. The caliper of trees shall be measured six (6) inches above the surface of the ground.
4. Measurements on all trees and shrubs shall be taken with the branches in a normal position. Height and spread dimensions specified refer to the main body of the plant and not from branch or root tip to tip. No trees which have had their leaders cut, or are so damaged that cutting is necessary, will be accepted.

D. No substitution of size, grade, variety, or any species shall be permitted except by written permission of the Landscape Architect or Owner's Representative.

E. Plant Size:
1. All plants shall conform to the size, age, and condition as specified in the plant list shown on the drawings. Undersized plant material shall not be approved.
2. No additional compensation shall be due the Contractor if larger than specified plant material is provided.
3. Only balled and burlapped or container stock shall be accepted. No bare root stock shall be accepted.
4. Plants cut back from larger sizes to meet specifications shall be rejected.

F. Plant List:
1. Plant Lists indicate minimum size requirements only. Plant materials shall be equal to or greater in size than those specified.
2. Any discrepancies between plant lists and plans shall be immediately brought to the attention of the Landscape Architect or Owner's Representative.
3. In all cases the Contractor shall be held responsible for all plant materials indicated on the plans unless otherwise directed in writing by the Landscape Architect or Owner's Representative.
4. Each bidder shall investigate sources of supply and satisfy himself that he can supply all of the plants mentioned in the planting lists in size, variety, and quantity noted and specified before submitting his bid. Failure to take this precaution will not relieve the successful bidder from his responsibility as Contractor to furnish and install all plant material in strict accordance with the contract requirements without additional expense to the owner.
5. If a shortage of the specified plant material truly exists and can be verified by the Contractor, the Contractor shall notify the Landscape Architect immediately and discuss what varieties and sizes are available as a suitable substitution. Last minute substitutions are not acceptable.

G. All plants shall be fresh and vigorous, of normal habit and growth, and free of disease, insects and insect eggs and insect larvae, weeds and weed seed. No heeled-in plants from cold storage shall be accepted except on approval by the Landscape Architect or owner's Representative prior to installation.

2.3 SEED

A. All seed shall be accurately labeled and tested for purity and germination, using the procedure sanctioned by the Association of Official Seed Analysts.

B. The seed tag shall indicate the date of testing, along with the testing results showing

purity (percentage of the labeled species by weight), the percentages of other crop, weed, inert material, dormant or hard seed, and also the percentage of seed that will germinate.

C. Seed labels or tags shall list the following:
   1. Manufacturer's name and address.
   2. Date and location of packaging.
   3. Name of the species of seed or seeds being sold.
   4. Variety of seed or seeds being sold.
   5. Percent purity of the seed. (Purity is defined as the percent weight of the entire sample of each seed species or variety that is present in excess of 5% of the total.)
   6. Percent other seed crop. (Other seed crop is defined as the percent weight of the entire sample of seed found in the sample that are less than 5% of the total seed weight and are generally recognized by the Association of Official Seed Analysts as seeds or plants grown as crops. If more than one crop species or cultivar is found in the sample, their weights are combined and reported.)
   7. Percent weed seed. (Weed seeds are all other seed species that the Association of Official Seed Analysts does not classify as crop seeds.)
   8. Percent inert matter. (Inert matter is defined as the percent weight of the sample that is not viable seed. It can include plant parts, broken seeds, or other materials that are not viable seeds.)
   9. Percent germination.
   10. Percent hard and/or dormant seed. (Hard seed is the percent of the number of seeds that remain hard at the end of the testing period because they have not absorbed water because of an impermeable seed coat. Dormant seed is defined as the percent of the number of seeds, other than hard seed, that fail to germinate, but are determined to be viable by subjecting them to other seed testing techniques. Both of these seed types are generally considered to be seed that will germinate at a later date than seed reported in the percent germination calculation.)
   11. Percent Total Viability.
   12. Noxious weed seeds of the continental USA found in the seed mix.
   13. Last date the seed was tested for germination.
   14. Bulk pound quantity of seed contained in the bag.
   15. Pure Live Seed (PLS) pound quantity contained in the bag.

2.4 SOD

A. Sod shall be obtained only from approved sources. The sod shall have been mowed regularly and carefully maintained from planting to harvest.

B. The sod shall be free of grassy and broad-leaf weeds, contain no bare or burned spots, and be clean and strongly rooted. It shall be of the varieties noted on the plans and notes.

C. The sod shall be cut using approved methods and equipment. It shall be cut in pieces not exceeding one (1) square yard, with a minimum of three quarter (3/4) inch and a maximum one and one half (1 ½) inch thickness. All sod for a particular contiguous area must have the same thickness.

D. For very large turf areas and all athletic fields, large roles of sod shall be used. All sod roles shall be uniform and consistent thickness within the range described above.

2.5 TREE STAKES & TIES

A. Tree Stakes shall be two by two (2x2) inch square or two (2) inch diameter round wood

stakes ten (10) feet in length as indicated on the plans. Steel stakes may not be used.

B. Tree stake ties shall be manufactured of virgin flexible vinyl meeting ASTM-D-412 standards for tensile and elongation strength. The material shall be black in color for ultraviolet resistance. Hose and wire shall not be used.

2.6 TOPSOIL

A. All planting areas shall receive either a minimum of four (4) inches of stockpiled or imported topsoil.

B. All topsoil used on this project (stockpiled or import) shall meet the following criteria:

1. pH: .....5.5 - 8.0
2. EC (electrical conductivity): .....<2.0 mmhos per centimeter
3. SAR (sodium absorption ratio):.....<3.0
4. % OM (percent organic matter):.....≥2%
5. Nitrogen (NO_3N).....48 ppm min.
6. Phosphorus (P).....11ppm min.
7. Potash (K).....130 ppm min.
8. Iron (Fe) .....5.0 ppm min.
9. Texture (particle size per USDA classification):
   a. Sand: .....<70%
   b. Clay:.....<30%
   c. Silt: .....<70%
10. Stone Fragments (gravels or any soil particle greater than two (2) mm in size): .....<5% (by volume)
11. Rock > 1.5” .....none

C. In addition, the topsoil shall be fertile, friable, natural loam and shall be capable of sustaining vigorous plant growth. It shall be free of stones, lumps, clods of hard earth, plants or their roots, sticks, and other extraneous matter. The topsoil shall contain neither noxious weeds nor their seeds. It shall not be used for planting operations while in a frozen or muddy condition.

2.7 WEED BARRIER FABRIC

A. If specified, a weed barrier fabric shall be placed in all planting beds to prevent the growth and spread of unwanted vegetation. The fabric shall be Typar #3301B or approved equal.

2.8 MULCH

A. Mulch shall be used as top dressing for all planting beds unless specified otherwise. See plant material schedule for mulch types to be used.

B. Where used, mulch shall be placed to a depth of three (3) inches on top of the topsoil.

C. Other mulches may be used only as specified on the drawings or in the planting notes and details.

2.9 FERTILIZER

A. Commercial fertilizer shall be a homogenous pellet composition, dry, and free flowing. Deliver fertilizer mixed as specified in bulk or bag, showing weight analysis, formula, and manufacturer’s name.

B. A 16-16-16 balanced fertilizer shall be used. Any exceptions to this formula shall be based on horticultural recommendations resulting from a site-specific soils test, and must be

approved prior to application by the Owner's Representative.

2.10 ALUMINUM EDGING

A. Where two different types of rock mulch are adjacent to one another, an aluminum edge barrier shall be used between them. No other edging materials may be used unless specifically noted on the plans and approved by the Landscape Architect or Owner's Representative.
B. The edging shall be Permaloc CleanLineXL 3/16" x 8" Mill Finish or approved equal.

2.11 MOWSTRIP

A. Where turf/grass areas are separated from mulch areas (along fence lines), a concrete mowstrip shall be used. No other edging materials may be used unless specifically noted on the plans and approved by the Landscape Architect or Owner's Representative.
B. The mowstrip shall be constructed using concrete having a compressive strength rating of two thousand five hundred pounds per square inch (2,500 psi) or greater, and a maximum slump of four (4) inches.
C. A three eighth (3/8) inch diameter rebar (#3) shall be placed continuously as shown in the mowstrip detail to provide support and help prevent differential settling of the mowstrip after cracking. Overlap joints a minimum of twelve (12) inches.
D. Include a concrete mowstrip at the base of all fences. Fence posts shall be located in the center of the mowstrip.

2.12 BOULDERS

A. Boulders shall be angular in shape and of the size specified on the plans.
B. Color of boulders shall be selected and approved by Owner.

PART 3 EXECUTION

3.1 GENERAL

A. Site Visit: The Contractor shall visit and inspect the site. He shall take into consideration known and reasonably inferable conditions affecting work. Failure to visit the site will not relieve the Contractor of furnishing materials and performing the work required.
B. Prior to any planting operations, the irrigation system shall be fully operational and all planting areas shall be thoroughly moistened.
C. Where weeds or other undesirable vegetation are present in planting areas, the Contractor shall apply a contact herbicide a minimum of ten (10) days prior to commencement of any planting or irrigation work. Apply herbicide per manufacturer's recommendations. The poisoned vegetation shall be allowed to completely die back, including the roots, before proceeding with the work. Dead vegetation shall then be removed from the site and disposed of in a legal manner.
D. The Contractor shall conform to the following requirements with regard to existing vegetation:
    1. The Contractor shall be fully responsible for any damage to existing trees or shrubs. He shall use all reasonable means to protect and preserve plants on the project not designated for demolition.
    2. No pruning, thinning, or cutting of existing vegetation shall be allowed unless written permission is given by the Owner's Representative.

3. The Contractor shall replace any trees or existing shrubs damaged by him or his sub-contractors with like kind and size.
4. All denuded or disturbed areas not specifically noted for specific surface repair are to be seeded with appropriate mix from PART 2.

3.2 PLANTING SEASONS

A. All new plant installation shall be completed between April 15 and October 15. If planting must be done after October 15 or before April 15, the Contractor shall obtain specific approval to do so from the Landscape Architect or Owner's Representative prior to beginning any planting operations.
B. No planting shall be done in frozen soil or during unfavorable weather conditions, subject to the approval of the Landscape Architect or Owner's Representative.

3.3 FINAL GRADE PREPARATION

A. The subgrade material shall be rough graded to plus or minus one tenth (+0.1) foot of the final rough grade, which will allow the Contractor to achieve final finished grade through the placement of the topsoil.
B. Protect existing trees, shrubs, lawns, existing structures, fences, roads, sidewalks, paving, curb and gutter and other features.
C. Protect above or below grade utilities. Contact utility companies to repair damage to utilities. Contractor shall pay all cost of repairs which he causes.
D. Maintain all benchmarks, control monuments and stakes, whether newly established by surveyor or previously existing. Protect from damage and dislocation.
E. Grading Intent: Spot elevations and contours indicated are based on the best available data. The intent is to maintain constant slopes between spot elevations.
F. Conduct work in an orderly manner. Do not create a nuisance. Do not permit soil accumulation on streets or sidewalks. Do not allow soil to be washed into sewers and storm drains.
G. Grade slopes to provide adequate drainage after compaction. Do not create water pockets or ridges. Use all means necessary to prevent erosion of freshly graded areas during construction until surfaces have been constructed and landscaping areas have taken hold.
H. Grades shall be smooth, even, and maintain a consistent uniform slope. Grades with undulating surfaces will be rejected and require regarding.
I. The Contractor shall maintain a minimum of two (2) percent drainage away from all buildings, structures, and walls. Finished grades shall be smoothed to eliminate puddling or standing water.
J. All finished grades shall be approved by the Owner's Representative prior to installation of any plant materials.
K. Owner shall extend an irrigation system as necessary for the new vegetated area shown on the Plans. Provide Owner 30 days to complete irrigation system prior to placing top soil and subsequent seeding activities.

3.3 TOPSOIL

A. The Contractor shall obtain a soil analysis from any authorized soil testing agency of any existing stockpiled or imported topsoil to be used on the project to verify that it conforms to the topsoil specifications. Test results shall include horticultural recommendations. The soil samples shall be obtained per the testing agency directions. Allow ten (10) working

days to obtain test results. The costs for such testing shall be the responsibility of the Contractor.

B. Prior to delivery of the imported topsoil to the site, the Contractor shall provide to the Landscape Architect or Owner's Representative the name and location of the topsoil source, along with the certified soil analysis of the topsoil to be used. The analysis shall verify that the proposed topsoil meets the topsoil specifications and is capable of supporting healthy plant growth.

C. After imported topsoil has been delivered to the site, a second soil test may be required to verify that it is indeed the same soil as previously tested and designated for use in this project. No substitution of topsoil shall be allowed without prior written authorization from the Landscape Architect.

D. The following procedure shall be followed in placing all topsoil:

1. All areas to receive topsoil which have a slope of less than ten (10) percent shall be cross-ripped to a depth of four (4) to six (6) inches.
2. The surface of the subgrade shall be scarified to a depth of two (2) inches to provide a transition zone between the subgrade and the topsoil. Place the topsoil on the subgrade and fine grade to the final finished grade and topsoil depths as indicated on the drawings and in these specifications.
3. Any required soil amendments (i.e. mulch, organic matter, etc.) shall be placed directly on the topsoil at the required rates and spread evenly over the planting area. The amendments shall then be thoroughly blended into the topsoil to a depth of four (4) inches. Where only a dry, granular fertilizer is to be added, it may be applied to the surface and raked in during the fine grading process.

3.4 PLANT CONDITION

A. All precautions customary in commercial landscape installation practice shall be taken in preparing plants for planting. Workmanship that fails to meet these minimum standards shall be rejected. All balled and burlapped plants shall have firm and natural balls of earth around their roots. No plants shall be planted if the rootball is cracked or broken, either before or during the process of planting. Loose, broken, or manufactured rootballs shall be rejected.

B. All plant materials in five (5) gallon containers or larger shall have been established in that container for a period of not less than six (6) months and not more than two (2) years. Plant material shall not be root bound. They shall exhibit sound, healthy, and vigorous growth and be free from diseases and pests.

C. The Contractor shall have the Landscape Architect or Owner's Representative approve plant material size and quality prior to installation. Any plants which are not true to form, appear stressed or unhealthy, are infested with pests, infected with disease, or are undersized for their containers shall be rejected.

D. All plant material shall be planted as soon upon arrival on the premises as possible. If planting cannot be done immediately, the roots shall be protected from the sun and kept in a moist condition until the time of planting. Such protection may be provided by laying the plants on the north side of the building and covering the roots with wet straw.

E. If it is anticipated that planting will not be done for more than twenty-four (24) hours after the arrival of plants upon the premises, the balled and burlapped stock shall be heeled-in on the north side of a building and all roots completely covered with dirt which

shall be wetted down frequently. Care will be taken in the handling of all ball and burlap materials so that the earth around the roots is disturbed as little as possible.

3.5 PLACEMENT OF PLANTS

A. Plants shall be generally located as indicated by the drawing. The Contractor shall stake out the location of all plants and planting areas with identified plant stakes, and no excavation shall commence until such locations have been approved by the Landscape Architect or Owner's Representative.

B. In the event that underground construction work or obstructions are encountered during excavation of the plant holes, alternate locations will be assigned and approved by the Landscape Architect or Owner's Representative.

C. Except for turf and groundcovers, plants shall not be placed within twenty-four (24) inches of sprinkler heads.

D. The Contractor must locate and stake any sprinkling head or valve box within the dripline of a proposed or existing tree location and must establish the direction of the lateral or main irrigation line that serves the staked sprinkler head or valve box. This procedure will help eliminate damage to existing or future tree roots.

3.6 PLANT INSTALLATION

A. All concrete work, sprinkling systems, and finished grading shall be completed and approved by the Landscape Architect or Owner's Representative before any planting of the specified plant materials is begun.

B. No tree planting shall be initiated until sprinkling system is complete and tested. However, tree planting shall precede lawn planting.

C. Each plant will be placed in an individual plant pit. The sharing of pits shall not be allowed.

D. All trees and shrubs shall be planted in pits as detailed in the planting details contained herein or as noted on the drawings. Tree and shrub pits shall be circular in outline, with a diameter at least two (2) times the diameter of the rootball of each plant to be installed. They shall be one to two and one half (1 – 2 ½) inches shallower than the rootball depth. When the plant is properly placed in the plant pit, the root collar shall be approximately one (1) inch above finished grade of the topsoil. For perennial plants (which have no root collar), the top of the rootball shall be even with the finished grade or the topsoil. The sides of the plant pit shall be roughened, and not smooth or sculpted.

E. Plant backfill mix shall be one hundred (100) percent native site soil.

F. For container grown plants, remove the container and place the plant vertically in the plant pit, directly on undisturbed soil. The root crown or collar shall be at or just above the finished grade. Perennial and ornamental grass plants shall be planted with the root collar at finished grade.

G. For balled and burlapped plants, place the plant vertically in the center of the pit, with the rootball resting on undisturbed soil. Cut and remove the wire basket and burlap or other wrapping material from the rootball. This may be done with the rootball in the pit. Any burlap or wire pieces underneath the rootball may be left in place if they cannot be removed. Do not fold the burlap over but cut away as much as possible without disturbing the rootball. No burlap shall be pulled from under the rootball. Backfill the bottom one third (1/3) of the pit as the wire and burlap are removed. In all cases, maintain the integrity of the rootball.

H. Specified backfill material shall be carefully and firmly worked and tamped under and around the rootball to fill all vids. When backfilled and compacted to two thirds (2/3) the depth of the pit, thoroughly water with a hose to completely soak the roots and remove any air pockets.

I. The plant pit shall then be completely backfilled with the specified backfill mix and tamped well. A shallow watering basin or rain cup shall be formed around each plant. This basin will be equal in diameter to that of the original planting pit.

J. Monitor all plants to ensure that no settling occurs. Pits which settle shall be immediately filled with additional soil mixture at no additional expense to the Owner.

K. After planting, the following operations shall be performed:
   1. Stake and mulch all trees per installation details.
   2. Remove all nursery stakes ties, and tags from all plants. Prune and remove any dead, damaged, or broken branches. Maintain side growth on all trees.

3.7 STAKING

A. All trees, including evergreen trees, shall be staked.

B. Staking shall be performed as follows:
   1. Two (2) 2"x 2" square or 2” diameter round wood stakes, ten (10) feet in length, shall be used to support each tree planted under this contract unless otherwise indicated.
   2. Tree ties shall conform to the staking detail shown on the planting detail sheet.
   3. Each stake will be located adjacent to the rootball, on opposing sides, to provide maximum support to the trunk. Do not penetrate the rootball with the stake.
   4. The stakes will be driven into the pit bottom after the tree has been placed in the pit, but before backfilling begins so as to avoid damage to the roots.

C. Stakes and ties shall be removed after one (1) full growing season from the time the tree was installed.

3.8 WATERING

A. All plants shall be thoroughly watered immediately after planting. This shall mean full and thorough saturation of all backfill in the pits and beds during the same day of planting. Water shall be applied only by open end hose at very low pressure to avoid creating air pockets, causing injury to the plant, or washing away of backfill. When installed, watered, and fully settled, the plants shall be vertical with the root collar at the appropriate level.

B. Subsequent watering shall be provided by the site’s irrigation system. The Contractor shall insure that all plants, especially trees, receive sufficient water to maintain healthy growth and vigor. Overwatering shall be avoided, and prolonged saturation of the soil around the trees shall be eliminated by appropriately controlling the irrigation circuit which provides water to that area.

3.9 WEED BARRIER FABRIC

A. Prepare final grade prior to placing fabric. Placement of fabric shall comply with the following:
   1. Place pre-emergent herbicide prior to installing fabric.
   2. Install fabric directly on topsoil. With drip tubing, install tubing on top of fabric.
   3. Overlap and secure per manufacturer’s recommendations.
   4. Cut an “X” where plant will be located. Peel back corners to allow plant installation. Fold corners back in to place after plant is installed.

3.10 MULCHING

A. Shredded bark mulch shall be placed to a depth of three (3) inches on top of the topsoil in all planting beds and over tree planting pits.
B. The finished grade of the bark mulch shall be as follows:
    1. Two (2) inches below the surface or finished grade of any paving, mowstrips, or walks adjacent to the planting area.
    2. At adjacent finished grade of the turf surrounding tree planting pits.
C. In tree pits, the bark shall be kept six (6) inches away from the base of the tree.
D. Just prior to placement of the mulch, the Contractor shall treat the mulched areas with a pre-emergent herbicide according to the manufacturer's recommendations.

3.11 SOD INSTALLATION

A. The Contractor shall notify the Landscape Architect or Owner's Representative of the source of the sod prior to placement.
B. The sod shall be free of grassy and broad-leaf weeds, contain no bare or burned spots, and be clean and strongly rooted. It shall be of the varieties noted on the plans and plant materials schedule.
C. The sod shall be cut using approved methods and equipment. It shall be cut in pieces not exceeding one (1) square yard, with a uniform thickness on all pieces. Sod thickness may vary between a minimum of one (1) inch and maximum one and one half (1 ½) inches but must be consistent throughout this project. For very large turf areas and all athletic fields, large rolls of sod shall be used. Sod shall be placed using equipment specifically designed to lay large sod rolls.
D. The Contractor shall notify the Landscape Architect of the source of the sod prior to placement. The sod shall be stripped and delivered to the site not more than twenty-four (24) hours prior to laying. The sod shall be maintained in a moist and healthy condition to encourage immediate growth.
E. The following procedure shall be followed when installing the sod:
    1. Lay the sod on smooth, moist topsoil, working off planks if required.
    2. Rake the topsoil to loosen and level prior to placing each course of sod.
    3. Lay strips perpendicular to the direction of the slope. Strips shall be parallel to each other, with their end seams staggered. The sod shall be neither stretched nor overlapped, and all joints shall be butted tightly together.
    4. Roll the sod immediately after placing and thoroughly water with a fine spray to a depth sufficient that the underside of the new sod and the soil immediately below the sod are thoroughly wet.
    5. On slopes two (2) horizontal to one (1) vertical or steeper, lay the sod perpendicular to the slope and secure every row with wooden pegs at two (2) feet maximum on center. Drive the pegs flush with the soil portion of the sod.
    6. Sod pieces shall be laid tightly together. Sod areas with gaps caused by pieces not being laid tightly enough together or with ridges from overlapping pieces shall not be accepted and the Contractor will be required to re-lay the sod.

3.12 HYDROSEEDING

A. General:
    1. Wood fiber mulch shall be virgin wood fiber, free of growth- or germination- inhibiting

substances. The mulch shall be air dried with not more than fifteen (15) percent moisture by weight. The total organic weight shall be a minimum of ninety eight (98) percent. Inorganic ash content shall be 0.7±0.2 percent. Water holding capacity shall be 1000G/100G (oven dried weight). The pH range shall be 4.0 - 6.0. The fiber length shall meet the following:

a. Fifty (50) percent shall be at least 0.15 inches in length or longer.
b. Fifty (50) percent shall be retained on the twenty eight (28) mesh screen.
c. It shall be Echofiber or Conwed or approved equal.

2. The seed mix shall be designed to match existing vegetation. Provide written certification that the seed conforms to Utah seed law and is in compliance with Utah State Department of Agriculture regulations.
3. The tackifier shall be M-Binder or Plantego or equal.
4. Application rates shall be as follows:
   a. Wood fiber mulch.....50 pounds (min.)/1,000 SF
   b. Seed mix .....See plans (7 pounds/1,000 SF typ.)
   c. Tackifier .....100 pounds/Acre
   d. Fertilizer .....7 - 8 pounds/1,000 SF
   e. Water .....92 gallons/1,000 SF

B. One-step preparation and application of hydroseed mulch shall be as follows:

1. The wood fiber mulch, seed, tackifier, fertilizer, and water shall be mixed together in a hydroseeding machine having a capacity of at least two thousand (2,000) gallons to allow for a homogeneous slurry which is thoroughly mixed and can be applied easily without clogging. The machine shall be mounted on a traveling unit which is either self-propelled or drawn by a separate unit. Equipment used in the hydroseeding process shall be thoroughly cleaned of all seed and other materials used in any previous hydroseeding process, prior to hydroseeding on this project.
2. The equipment shall have a built-in agitation system and operating capacity sufficient to agitate, suspend, and homogeneously mix a slurry containing not less than fifty (50) pounds of organic mulching amendment plus chemical additives and solids for each one hundred (100) gallons of water.
3. The slurry shall be prepared at the site and its components shall be mixed to supply the rates of application as specified. The slurry preparation shall begin by adding water to the tank when the engine is at one half (½) throttle. The engine throttle shall be open to full speed when the tank is one half (½) filled with water. All organic amendments, fiber, and chemicals shall then be added by the time the tank is two thirds (2/3) to three fourths (3/4) full. At this time and not before, the seed mix shall also be added. Spraying shall commence immediately when the tank is full and the slurry is mixed.
4. Apply the hydroseed to form even appearing cover over the required areas. The slurry shall be applied in a downward drilling motion via a fan stream nozzle. It is important to ensure that all of the components enter and mix with the soil. Use only qualified and trained personnel to insure uniformity of the hydroseed applications.
5. The hydroseeding slurry components shall not be left in the hydroseed machine for more than two (2) hours in order to avoid seed deterioration.

C. A two-step hydroseeding procedure may be used in lieu of the one-step method. The two-step procedure shall consist of first sowing the seed mix by broadcasting, and second, applying the hydromulch. Specifically, this procedure shall conform to the following:

1. The seed shall be broadcast over the planting bed at the rates noted in the plant schedule. The seed shall be sown in two (2) perpendicular directions with a cyclone seeder or other similar mechanical seeder. Lightly rake the seed into the soil.
2. Apply a fine spray watering immediately after each area has been sown.
3. Prepare and apply hydromulch slurry (minus the seed mix) according to the procedure outlined in 3.5.B, steps 1 through 5 above.

3.13 ALUMINUM EDGING

A. Install aluminum edging per manufacturer's specifications.

3.14 CONCRETE MOWSTRIP

A. Install per installation detail on plans.

3.15 BOULDERS

A. Place boulders directly on weed barrier fabric after it has been properly placed and staked down.
B. Install specified rock mulch around boulders and on top of weed barrier fabric to the specified depth.

3.16 CLEAN UP

A. Throughout the course of planting, excess and waste materials as well as excavated subsoil shall be continuously and promptly removed. All areas shall be kept clear and all reasonable precautions taken to avoid damage to existing structures, plants, and grass.
B. When planting has been completed in an area, it shall be thoroughly cleaned of all debris, rubbish, subsoil, and waste materials. These shall be removed from the property and disposed of legally. All planting tools shall also be put away.
C. The ground surface shall be left in a condition satisfactory to the Landscape Architect or Owner's Representative.

3.17 AS-BUILT DOCUMENTS

A. The Contractor shall keep a record of all departures from the working drawings that occur during construction. These changes shall be shown on a clean set of prints, and the prints kept on the job site at all times for review.
B. As a part of his observation work, the Landscape Architect or Owner's Representative shall review the as-built drawings regularly to verify that changes are being recorded. At the conclusion of the work, the Contractor shall present to the Owner fresh, clean drawings of all the changes made and recorded previously and they shall become part of the permanent record of the project.

3.18 MAINTENANCE

A. Substantial Completion:
    1. At Substantial Completion of all planting work outlined in these plans, the Contractor shall contact the Owner to arrange for a walk through to verify that all aspects of the work have been completed. Work must be fully completed (except for final clean-up) according to all plans, notes, and specifications and exhibit professional workmanship. Substantial completion shall be defined as the complete installation of all plant

materials, staking, mulching, and other work on the project in its entirety. Substantial completion shall not be given on designated portions of the project.

2. Notice by the Contractor shall be given, in writing, at least three (3) days in advance to the Landscape Architect or Owner's Representative so that proper scheduling can be made for those who are to attend.
3. At the appointed time, an inspection of all plant materials, including staking and mulching, shall be made.
4. A list of uncompleted items (punch list) shall be generated by the Landscape Architect or Owner's Representative and distributed to the Contractor and other involved parties within three (3) days of the substantial completion inspection. Each item on the punch list shall be corrected before the project will be approved and accepted by the Landscape Architect or Owner's Representative. The Contractor will be back charged for time spent by the Owner and any consultants who have been brought to the site for a final inspection when the project is not ready for said inspection.

B. Maintenance/Establishment Period:

1. The maintenance/establishment period shall begin one (1) day after the substantial completion inspection. The Contractor shall complete all punch list items during this period, as well as maintain and operate the entire irrigation system.
2. In cases where the maintenance/establishment period runs beyond October 15 of any given year, the balance of the maintenance/establishment period days shall be extended into the spring of the following year. Counting of the balance of days shall begin no sooner than April 15, unless mutually agreed upon by both the Contractor and the Owner prior to that date. Early counting shall be based on weather conditions at the time.
3. The Contractor shall maintain all plantings until the turf is fully established. The turf shall be considered fully established when grass stands come in uniform and thick, with no bare or thin spots, and roots have begun to spread and knit together. No weeds shall be allowed in the grass. If the grass is hydroseeded, the Contractor must complete the hydroseeding by September 1. This shall be a minimum period of sixty (60) days.
4. The maintenance work required shall include but not be limited to the following:
    a. Appropriate watering of all plant materials.
    b. Weeding and removal of all weeds from groundcover and planting areas.
    c. Replacement of any dead, dying, or damaged trees, shrubs, perennials, or groundcover.
    d. Filling and replanting of any low areas which may cause standing water.
    e. Adjusting of sprinkler head heights and watering patterns.
    f. Filling and re-compaction of eroded areas, along with any required reseeding and/or replanting.
    g. The grass shall be mowed when the blades reach three (3) inches tall and maintained to a minimum height of two (2) inches. No more than one third (1/3) of the blade shall be removed per cutting. The cutting frequency shall be once every five (5) to seven (7) days depending upon grass height and growth rate.
    h. Weekly removal of all trash, litter, clippings, and all foreign debris.
    i. At thirty (30) days after planting, a balanced fertilizer (16-16-16) shall be applied to the grass areas at a rate of one half (½) pound of nitrogen per one thousand (1,000) square feet.

j. At intervals of thirty (30) days after the first application of fertilizer to the grass, apply a balanced fertilizer (16-16-16) at a rate of one half (½) pound of nitrogen per one thousand (1,000) square feet until the grass is established.

5. The maintenance period shall not end until Final Acceptance of the project.

C. Final Acceptance:
   1. A final inspection shall be held prior to the end of the maintenance period to ensure that all punch list items have been completed and the entire project is ready for acceptance by the Owner.
   2. Upon satisfaction that the Contractor has completed all punch list items, the irrigation system is fully and completely functional, and the required As-Built drawings, mylars, and maintenance manuals have been submitted, the Owner shall accept the project.
   3. An official letter of final acceptance shall be prepared and issued by the Owner to the Contractor, designer, and the Landscape Architect. Upon final acceptance of the project by the Landscape Architect or Owner's Representative, the Owner shall assume full responsibility for the project, and the guarantee period shall begin.

3.19 GUARANTEE

A. Upon final acceptance of the project as being properly installed, the Contractor shall guarantee the plant materials as follows:
   1. All shrubs and groundcovers shall be guaranteed by the Contractor as to growth and health for a period of sixty (60) days after completion of the maintenance period and final acceptance.
   2. All trees shall be guaranteed by the contractor to thrive and grow in an acceptable upright position for a period of one (1) year after completion of the maintenance period and final acceptance.

B. The Contractor shall, within fifteen (15) days after receiving written notification by the Landscape Architect or Owner's Representative, remove and replace all guaranteed plant materials which die or become unhealthy or appear to be in a badly impaired condition at any time during the guarantee period. Any plants that settle below or rise above the desired finished grade shall also be reset to the proper grade.

C. All replacements shall be plants of the same kind, size, and quality as originally specified in the "plant list" and they shall be furnished, planted, staked, and maintained as specified herein at no additional cost.

D. The Contractor will not be responsible for plants destroyed or lost due to occupancy of the project, vandalism on the part of others, or improper maintenance or lack thereof.

E. At the conclusion of the guarantee period and prior to final inspection of the plant materials by the Landscape Architect or Owner's Representative, the Contractor shall remove all tree stakes. This period of time shall be approximately 1 year after initial planting.
   1. Stakes shall be removed by first cutting the ties securing the tree to stakes and secondly pulling stakes or guys out of the ground.
   2. Stakes shall not be broken off above, at, or below ground levels but removed completely.

F. At the conclusion of the guarantee period a final inspection of all planting included in this contract shall be made by the Landscape Architect or Owner's Representative. At that time any plant found to be unhealthy, broken, damaged, or otherwise in an impaired condition shall be noted. Plants so noted shall be removed immediately from the site by

the Contractor and replaced by him, as specified under this section, with plants of like kind and size in the manner previously specified for the original planting without extra compensation.

END OF SECTION

SECTION 02951
TELEVISION INSPECTION OF PIPELINES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Requirements for cleaning and television inspection of sewers and storm drain lines.

1.2 RELATED SECTIONS

A. Section 01200 – Price and Payment Procedures

B. Section 01300 – Submittal Procedures

C. Section 15060 – Pipe and Fittings

1.3 SUBMITTALS

A. Submit Manufacturer Specifications for Television Equipment and Appurtenances.

B. Submit completed DVD, identified by disk number, project name and manhole number.

C. Submit in accordance with Section 01300.

1.4 QUALIFICATIONS

A. A company that specializes in cleaning and television inspection of sewers that has a minimum of two (2) years experience.

PART 2 PRODUCTS

2.1 CAMERA AND APPURTENANCES

A. Television camera and appurtenances specifically designed and constructed for inspections of sewers that meet the following requirements:

1. Operative in one hundred (100) percent humidity conditions and under water.
2. Lighting quality that sufficiently lights the sewer so a clear, in-focus picture of a minimum of six (6) linear feet of the inside periphery of the sewer is obtained.
3. A minimum of six hundred (600) lines of resolution in color.
4. Variable intensity control on the lights to meet all lighting conditions of the pipeline so a clear, in-focus picture is obtained.
5. A camera monitor capable of continuous six hundred (600) line resolution in color for instant viewing television inspection in progress, located within a temperature controlled studio that allows adequate seating for two persons.
6. A pan-and-tilt camera capable of viewing perpendicular to the sewer bore. The camera shall be capable of 360 degree rotation. Adequate lighting shall be provided under pan-and-tilt conditions so a clear, in-focus picture is obtained.

7. A video recorder that records the closed-circuit television (CCTV) inspection complete with audio so that technician can record the required information as it appears on the monitor, on a high quality DVD format.
8. Control equipment that allows the operating technician to have complete control of the camera at all times and that allows a uniform travel speed of a maximum of thirty (30) feet per minute.
9. The entire system shall operate with its own power source.
10. A system that measures and displays on the video the footage with an accuracy of ± six (6) inches in five hundred (500) feet.

B. Television camera and appurtenances specifically designed and constructed for inspections of storm drains that meet the following requirements:

1. Operative in one hundred (100) percent humidity conditions and under water.
2. Lighting quality that sufficiently lights the storm drain so a clear, in-focus picture of a minimum of six (6) linear feet of the inside periphery of the sewer is obtained.
3. A minimum of six hundred (600) lines of resolution in color.
4. Variable intensity control on the lights to meet all lighting conditions of the pipeline so a clear, in-focus picture is obtained.
5. A camera monitor capable of continuous six hundred (600) line resolution in color for instant viewing television inspection in progress, located within a temperature controlled studio that allows adequate seating for two persons.
6. A pan-and-tilt camera capable of viewing perpendicular to the sewer bore. The camera shall be capable of 360 degree rotation. Adequate lighting shall be provided under pan-and-tilt conditions so a clear, in-focus picture is obtained.
7. A video recorder that records the closed-circuit television (CCTV) inspection complete with audio so that technician can record the required information as it appears on the monitor, on a high quality DVD format.
8. Control equipment that allows the operating technician to have complete control of the camera at all times and that allows a uniform travel speed of a maximum of thirty (30) feet per minute.
9. The entire system shall operate with its own power source.
10. A system that measures and displays on the video the footage with an accuracy of ± six (6) inches in five hundred (500) feet.

PART 3 EXECUTION

3.1 RECORDS

A. Keep records of all television inspection work on a printed form that includes the following information. Submit original copies to Engineer or Representative at the completion of each television inspection run.

1. Project.
2. Date and Time of Inspection.
3. Contractor.
4. Engineer.
5. Name of Operating Technician.
6. Size of Pipe.
7. Entry (Beginning) and Exit (Ending) Manholes.

8. Distance to all Service Connections from Entry Manhole.
9. Points-of-Interest which may Affect Work (Protruding Taps, Offset Joints, Blockages, Roots, etc.).
10. Distance to all Points of Interest from Entry Manhole.
11. Total Length of Line
12. Unusual Conditions.

B. Complete the above form for each television inspection run required.

C. Complete the form legibly and in ink.

D. A video record of the television inspection will be recorded at the time of inspection on a DVD. A copy of the video record will be made and maintained by the Contractor. The original copy of the video will be submitted to the Engineer or Representative at the completion of each television inspection run.

3.2 CLEANING

A. The Contractor shall provide all equipment and personnel necessary to clean the lines of interest for this project.

B. Clean all construction debris from pipe.

C. All debris generated during the cleaning process shall be collected and properly disposed of.

D. If CCTV inspection shows incomplete removal of debris, re-clean and re-inspect.

3.3 TELEVISION INSPECTION

A. The television inspection and video record of the sewer shall provide a clear, in-focus color picture of a minimum of six (6) linear feet of the inside periphery of the sewer. Do not exceed thirty (30) feet per minute travel speed.

B. Stop at all service connections in the sewer so they are displayed on the screen, and record the distance from the entry manhole on the form and on audio. Provide a 360 degree view of the service connection with the pan-and-tilt camera.

C. Stop at all points-of-interest in the sewer so they are displayed on the screen, and describe the type of point-of-interest and distance from the entry manhole on the form and on audio. Provide a 360 degree view of the point-of-interest with the pan-and-tilt camera.

D. Stop at all unusual conditions in the sewer so they are displayed on the screen, and describe the unusual condition and distance from the entry manhole on the form and on audio. Provide a 360 degree view of the unusual condition with the pan-and-tilt camera.

E. If a clear video recording is not obtained, repeat the closed-circuit television inspection until a clear, in-focus video is obtained. Repeating the television inspection process to obtain a clear video recording will be at no additional cost to the Owner.

3.4 SCHEDULE

A. Clean construction debris and CCTV inspect all gravity sewer mains (SAN, SS Lines) replaced or installed new as part of this project. Perform work only after backfill is complete, but prior to final surface repair.

END OF SECTION

SECTION 03100
CONCRETE FORMS AND ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Formwork for cast-in place concrete.
2. Shoring, bracing, and anchorage.
3. Form accessories.
4. Form stripping.

B. Related Sections:

1. Section 03200 - Concrete Reinforcement.
2. Section 03300 - Cast-in-Place Concrete.
3. Section 05500 - Metal Fabrications: Product requirements for metal fabrications for placement by this Section.

1.2 REFERENCES

A. American Concrete Institute:

1. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials.
2. ACI 301 - Specifications for Structural Concrete.
3. ACI 318 - Building Code Requirements for Structural Concrete.
4. ACI 347 - Guide to Formwork for Concrete.
5. ACI 350 - Code Requirements for Environmental Engineering Concrete Structures.

B. American Forest and Paper Association:

1. AF&PA - National Design Specifications for Wood Construction.

C. The Engineered Wood Association:

1. APA/EWA PS 1 - Voluntary Product Standard for Construction and Industrial Plywood.

D. ASTM International:

1. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).

2. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.

E. West Coast Lumber Inspection Bureau:

1. WCLIB - Standard Grading Rules for West Coast Lumber.

1.3 DESIGN REQUIREMENTS

A. Design and construct formwork, shoring and bracing in accordance with ACI 318/350 to conform to design and applicable code requirements to achieve concrete shape, line and dimension as indicated on Drawings.

1.4 SUBMITTALS

A. Section 01300 - Submittal Procedures: Requirements for submittals.

1.5 QUALITY ASSURANCE

A. Codes and Standards

1. The Contractor shall design, construct, erect, maintain, and remove forms and related structures for cast-in-place concrete work in compliance with the American Concrete Institute Standard ACI 347, "Recommended Practice for Concrete Formwork."

B. Allowable Tolerances

1. Tolerances for finished concrete surfaces shall meet the following requirements, class of surface is per Table 3.1:
   a. Footings: Class C
   b. Foundation Walls: Class B
   c. Above grade concrete not visible to sight: Class B
   d. Above grade concrete visible to sight: Class A

2. The Contractor shall construct formwork to provide complete cast-in-place concrete work as follows:

   a. Variation from plumb lines and surfaces: 1/4 inch per 10 feet, but not more than 1 inch. For exposed corners, control joints grooves and other conspicuous lines: 1/4 inch in 20 feet maximum; ½ inch maximum in 40 feet or more. Depressions In Wall Surface: Maximum ¼ inch when 10-foot straightedge is placed on high points in any direction or at any location. Wall Thicknesses: Maximum ¼ inch minus or ½ inch plus from dimension shown.

   b. Variation from level or grade in slabs, and in arises: 1/4 inch in 10 feet, 3/8 inch in 40 feet or more. For exposed horizontal grooves and other

conspicuous lines: 1/4 inch in 20 feet maximum and ½ inch in 40 feet or more. Slab Finish Tolerances and Slope Tolerances: Floor surface shall not have crowns so high as to prevent 10-foot straightedge from resting on ¼-inch end blocks, nor low spots that allow a block of twice the tolerance in thickness to pass under the supported 10-foot straightedge. Finish Slab Elevation: Within ½ inch of elevation specified except slabs which are designed and detailed to drain to floor drain or gutter shall adequately drain regardless of tolerances. Repair floor slopes in an approved manner if necessary to provide complete drainage. Thickness: Maximum ¼ inch minus or ½ inch plus from thickness shown.

c. For beams and columns physical dimensions: Maximum ¼ inch minus or ½ inch plus from dimension shown. Elevations: Within ½ inch plus or minus except where tops of beams become part of finished slab. In this case refer to slab tolerances. Columns shall be plumb within ¼ inch in any 10 feet with maximum ½ inch out-of-plumb at top with respect to bottom.

d. Forms for sidewalks and driveways shall be standard steel forms or wood forms constructed and fastened to prevent movement. Set forms to true lines and grades, and securely stake in position.

3. Before concrete placement, the Contractor must check the lines and levels of erected formwork. The Contractor shall make corrections and adjustments to ensure proper size and locations of concrete members and stability of forming systems.

4. During concrete placement, the Contractor must check formwork and related supports to ensure that forms are not displaced and that completed work will be within the specified tolerances.

C. For wood products furnished for work of this Section, comply with AF&PA.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01600 - Product Requirements: Products storage and handling requirements.

B. Store off ground in ventilated and protected manner to prevent deterioration from moisture.

1.7 COORDINATION

A. Section 01300 - Administrative Requirements: Coordination and project conditions.

B. Coordinate this Section with other sections of work, requiring attachment of components to formwork.

PART 2 PRODUCTS

2.1 WOOD FORM MATERIALS

A. Softwood Plywood: APA/EWA PS 1, C Plugged Grade, Group 3.

B. Lumber Forms:

1. Application: Use for edge forms and unexposed finish concrete.

2. Boards: 6 inches or 8 inches in width, shiplapped or tongue and groove, “Standard” Grade Douglas Fir, conforming to WCLIB Standard Grading Rules for West Coast Lumber. Surface boards on four sides.

C. Plywood Forms:

1. Application: Use for exposed finish concrete.

2. Forms: Conform to PS 1; full size 4 x 8 feet panels; each panel labeled with grade trademark of APA/EWA.

3. Plywood for Surfaces to Receive Membrane Waterproofing: Minimum of 5/8 inch thick; APA/EWA “B-B Plyform Structural I Exterior” grade.

4. Plywood where “Smooth Finish” is required, as indicated on Drawings: APA/EWA “HD Overlay Plyform Structural I Exterior” grade, minimum of 3/4 inch thick.

2.2 PREFABRICATED FORMS

A. Preformed Steel Forms: Minimum 16 gage matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.

B. Glass Fiber Fabric Reinforced Plastic Forms: Matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished concrete surfaces.

C. Tubular Column Type: Round, spirally wound laminated fiber material, surface treated with release agent, non-reusable, sizes.

D. Steel Forms: Sheet steel, suitably reinforced, and designed for particular use indicated on Drawings.

E. Form Liners: Smooth, durable, grainless and non-staining hardboard, unless otherwise indicated on Drawings.

F. Framing, Studding and Bracing: Stud or No. 3 structural light framing grade.

2.3 FORMS FOR CURVED WALLS

A. All curved walls as indicated on the project drawings shall be formed with curved, prefabricated forms constructed to match the radial lines, interior and exterior, of the walls as indicated on the plans.

2.4 FORMWORK ACCESSORIES

A. Form Ties: Snap-off type, carbon steel, fixed or adjustable length, cone type, with waterproofing washer, 1 inch back break dimension, free of defects capable of leaving holes larger than 1 inch in concrete surface.

B. Spreaders: Standard, non-corrosive metal form clamp assembly, of type acting as spreaders and leaving no metal within 1 inch of concrete face. Wire ties, wood spreaders or through bolts are not permitted.

C. Form Anchors and Hangers:

1. Do not use anchors and hangers exposed concrete leaving exposed metal at concrete surface.
2. Symmetrically arrange hangers supporting forms from structural steel members to minimize twisting or rotation of member.
3. Penetration of structural steel members is not permitted.

D. Form Release Agent: Colorless mineral oil that will not stain concrete, or absorb moisture, or impair natural bonding or color characteristics of coating intended for use on concrete.

E. Corners: Fillet or Chamfer with rigid plastic or wood strip, dimensions as indicated on the drawings; maximum possible lengths.

F. Bituminous Joint Filler: ASTM D1751.

G. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Size, strength and character to maintain formwork in place while placing concrete.

2.5 COATINGS

A. Coatings for Aluminum: Polyamide epoxy finish coat with paint manufacturer's recommended primer for aluminum substrate. Apply one coat primer and one coat finish.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01300 - Administrative Requirements: Coordination and project conditions.

B. Verify lines, levels, and centers before proceeding with formwork. Verify dimensions agree with Drawings.

C. When formwork is placed after reinforcement resulting in insufficient concrete cover over reinforcement before proceeding, request instructions from Engineer.

3.2 INSTALLATION

A. Earth Forms:

1. Earth forms are not permitted, except for concrete encasement of pipes and conduits and as specifically indicated on the drawings.

B. Formwork - General:

1. Provide top form for sloped surfaces steeper than 1.5 horizontal to 1 vertical to hold shape of concrete during placement, unless it can be demonstrated that top forms can be omitted.
2. Construct forms to correct shape and dimensions, mortar-tight, braced, and of sufficient strength to maintain shape and position under imposed loads from construction operations.
3. Camber forms where necessary to produce level finished soffits unless otherwise shown on Drawings.
4. Carefully verify horizontal and vertical positions of forms. Correct misaligned or misplaced forms before placing concrete.
5. Complete wedging and bracing before placing concrete.

C. Forms for Smooth Finish Concrete:

1. Use steel, plywood or lined board forms.
2. Use clean and smooth plywood and form liners, uniform in size, and free from surface and edge damage capable of affecting resulting concrete finish.

3. Install form lining with close-fitting square joints between separate sheets without springing into place.

4. Use full size sheets of form lines and plywood wherever possible.

5. Tape joints to prevent protrusions in concrete.

6. Use care in forming and stripping wood forms to protect corners and edges.

7. Level and continue horizontal joints.

8. Keep wood forms wet until stripped.

D. Forms for Surfaces to Receive Membrane Waterproofing: Use plywood or steel forms. After erection of forms, tape form joints to prevent protrusions in concrete.

E. Framing, Studding and Bracing:

1. Space studs at 16 inches center maximum for boards and 12 inches on center maximum for plywood.

2. Size framing, bracing, centering, and supporting members with sufficient strength to maintain shape and position under imposed loads from construction operations.

3. Construct beam soffits of material minimum of 2 inches thick.

4. Distribute bracing loads over base area on which bracing is erected.

5. When placed on ground, protect against undermining, settlement or accidental impact.

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

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

H. Obtain Engineer’s approval before framing openings in structural members not indicated on Drawings.

I. Install fillet and chamfer strips on external corners of beams, joists, columns and other members as indicated on the drawings.

J. Install void forms in accordance with manufacturer's recommendations.

3.3 APPLICATION - FORM RELEASE AGENT

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

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

C. Do not apply form release agent where concrete surfaces are indicated to receive special finishes or applied coverings that are affected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces coated prior to placement of concrete.

D. Reuse and Coating of Forms: Thoroughly clean forms and reapply form coating before each reuse. For exposed work, do not reuse forms with damaged faces or edges. Apply form coating to forms in accordance with manufacturer's specifications. Do not coat forms for concrete indicated to receive "scored finish". Apply form coatings before placing reinforcing steel.

3.4 INSTALLATION - INSERTS, EMBEDDED PARTS, AND OPENINGS

A. Install formed openings for items to be embedded in or passing through concrete work.

B. Locate and set in place items required to be cast directly into concrete.

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

D. Install accessories straight, level, and plumb. Ensure items are not disturbed during concrete placement.

E. Install water stops continuous without displacing reinforcement. Heat seal joints watertight.

F. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.

G. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.

H. Form Ties:

1. Use sufficient strength and sufficient quantity to prevent spreading of forms.
2. Place ties at least 1 inch away from finished surface of concrete.
3. Leave inner rods in concrete when forms are stripped.
4. Space form ties equidistant, symmetrical and aligned vertically and horizontally unless otherwise shown on Drawings. See attached drawings for additional information.

I. Arrangement: Arrange formwork to allow proper erection sequence and to permit form removal without damage to concrete.

J. Construction Joints:

1. Install surfaced pouring strip where construction joints intersect exposed surfaces to provide straight line at joints.
2. Just prior to subsequent concrete placement, remove strip and tighten forms to conceal shrinkage.
3. Show no overlapping of construction joints. Construct joints to present same appearance as butted plywood joints.
4. Arrange joints in continuous line straight, true and sharp.

K. Embedded Items:

1. Make provisions for pipes, sleeves, anchors, inserts, reglets, anchor slots, nailers, water stops, and other features.
2. Do not embed wood or uncoated aluminum in concrete.
3. Obtain installation and setting information for embedded items furnished under other Specification sections.
4. Securely anchor embedded items in correct location and alignment prior to placing concrete.
5. Verify conduits and pipes, including those made of coated aluminum, meet requirements of ACI 318/350 for size and location limitations.

L. Openings for Items Passing Through Concrete:

1. Frame openings in concrete where indicated on Drawings. Establish exact locations, sizes, and other conditions required for openings and attachment of work specified under other sections.
2. Coordinate work to avoid cutting and patching of concrete after placement.
3. Perform cutting and repairing of concrete required as result of failure to provide required openings.

M. Screeds:

1. Set screeds and establish levels for tops of concrete slabs and levels for finish on slabs.
2. Slope slabs to drain where required or as shown on Drawings.
3. Before depositing concrete, remove debris from space to be occupied by concrete and thoroughly wet forms. Remove freestanding water.

N. Screed Supports:

1. For concrete over waterproof membranes and vapor retarder membranes, use cradle, pad or base type screed supports which will not puncture membrane.

2. Staking through membrane is not permitted.

O. Cleanouts and Access Panels:

1. Provide removable cleanout sections or access panels at bottoms of forms to permit inspection and effective cleaning of loose dirt, debris and waste material.

2. Clean forms and surfaces against which concrete is to be placed. Remove chips, saw dust and other debris. Thoroughly blow out forms with compressed air just before concrete is placed.

3.5 FORM CLEANING

A. Clean forms as erection proceeds, to remove foreign matter within forms.

B. Clean formed cavities of debris prior to placing concrete.

C. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.

D. During cold weather, remove ice and snow from within forms. Do not use de-icing salts. Do not use water to clean out forms, unless formwork and concrete construction proceed within heated enclosure. Use compressed air or other means to remove foreign matter.

3.6 FORM REMOVAL

A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads and removal has been approved by Engineer.

B. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.

C. Store removed forms in manner that surfaces to be in contact with fresh concrete will not be damaged. Discard damaged forms.

D. Leave forms in place for minimum number of days as specified in ACI 347, or as indicated on the drawings.

3.7 ERECTION TOLERANCES

A. Construct formwork to maintain tolerances required by ACI 301.

3.8 FIELD QUALITY CONTROL

A. Section 01400 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect erected formwork, shoring, and bracing to ensure that work is in accordance with formwork design, and that supports, fastenings, wedges, ties, and items are secure.

C. Notify Engineer after placement of reinforcing steel in forms, but prior to placing concrete.

D. Schedule concrete placement to permit formwork inspection before placing concrete.

3.2 BACKFILL AGAINST WALLS

A. Do not backfill against walls until concrete has obtained compressive strength equal to specified 28-day compressive strength.

B. Place backfill simultaneously on both sides of wall where required to prevent differential pressures.

3.3 FIELD TESTS

A. Wall Finish Tolerances: Test for compliance with tolerances as specified.

B. Slab Finish Tolerances and Slope Tolerances:

1. Floor flatness measurements will be made the day after floor is finished and before shoring is removed, to eliminate effect of shrinkage, curling, and deflection.

2. Support 10-foot long straightedge at each end with steel gauge blocks of thicknesses equal to specified tolerance.

3. Compliance with designated limits in four of five consecutive measurements is satisfactory unless obvious faults are observed.

4. A check for adequate slope and drainage will also be made to confirm compliance with these Specifications.

C. Finish Tolerance Failures: Repair or replace concrete as specified in Section 03300, CONCRETE.

END OF SECTION

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SECTION 03200
CONCRETE REINFORCEMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Reinforcing steel bars, wire fabric and accessories for cast-in-place concrete and reinforced unit masonry.

1.2 RELATED SECTIONS

A. Section 01400 - Quality Control

B. Section 03100 - Concrete Formwork

C. Section 03300 - Cast-in-Place Concrete

D. Section 03346 – Concrete Floor Finishing

1.3 REFERENCES

A. ACI 301 - Structural Concrete for Buildings

B. ACI 315 – Manual of Standard Practices for Detailing Concrete Structures

C. ACI 318 - Building Code Requirements for Reinforced Concrete

D. ACI 350 - Environmental Engineering Concrete Structures

E. ACI SP-66 - American Concrete Institute - Detailing Manual

F. ANSI/ASTM A82 - Cold Drawn Steel Wire for Concrete Reinforcement

G. ANSI/ASTM A184 - Fabricated Deformed Steel Bar Mats for Concrete Reinforcement

H. ANSI/ASTM A185 - Welded Steel Wire Fabric for Concrete Reinforcement

I. ANSI/ASTM A496 - Deformed Steel Wire Fabric for Concrete Reinforcement

J. ANSI/ASTM A497 - Welded Deformed Steel Wire Fabric for Concrete Reinforcement

K. ANSI/AWS D1.4 - Structural Welding Code for Reinforcing Steel

L. ASTM A615 - Deformed and Plain Billet Steel Bars for Concrete Reinforcement

M. ASTM A706 - Low-Alloy Steel Deformed Bars for Concrete Reinforcement

N. AWS D12.1 - Welding Reinforcement Steel, Metal Inserts and Connections in Reinforced Concrete Construction

O. CRSI - Concrete Reinforcing Steel Institute - Manual of Practice

P. CRSI 63 - Recommended Practice For Placing Reinforcing Bars

Q. CRSI 65 - Recommended Practice For Placing Bar Supports, Specifications and Nomenclature

1.4 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Shop Drawings:

1. Indicate bar sizes, spacings, locations, and quantities of reinforcing steel and wire fabric bending and cutting schedules, and supporting and spacing devices, if dissimilar from Drawings.

2. Indicate dimensions, materials, bracings, and arrangement of joints and ties.

C. Submit plan for placement of all concrete walls four weeks prior to placement.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Indicate locations of all construction joints prior to concrete placement.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 301, ACI 315, ACI 318, and ACI 350.

B. Maintain one copy of each document on site.

C. Submit certified copies of mill test report of reinforcement materials analysis.

1.6 COORDINATION

A. Coordinate work under provisions of Section 01039.

B. Coordinate with placement of formwork, formed openings and other Work.

1.5 DELIVERY, HANDLING, AND STORAGE

A. All steel reinforcement delivered to the project site shall be bundled, tagged, and marked. Metal tags shall be used indicating the bar size, lengths, and other information corresponding to markings shown on placement diagrams in accordance with ACI 315.

B. The Contractor shall store concrete reinforcement materials at the site in a manner that will prevent damage and accumulation of dirt or excessive rust. Store to prevent contact with the ground. Protect all reinforcement from any contact with oil, grease, or petroleum based products of any kind.

PART 2 PRODUCTS

2.1 REINFORCEMENT

A. Reinforcing Steel: ASTM A615, 60 ksi yield grade; deformed billet steel bars (#3 bars may be grade 40 ksi), unfinished, free of dirt, oil, grease, loose scale or other substances that might reduce development of the bond strength.

B. Welded Steel Wire Fabric: ASTM A185 Plain Type, or ASTM A496 Welded Deformed Type; in coiled rolls.

C. Mechanical Rebar Splicing Devices: Where indicated on the drawings, provide mechanical threaded dowel rebar splicing devices of the size type, spacing and placement indicated. The system shall be a standard two-piece threaded coupler system, with the first piece consisting of a dowel with integral female-threaded head which will accept the 2nd (future or second phase placement) male threaded dowel section. The first piece shall have an integral flat surfaced, flush mounted flange allowing for attachment to the pour stop forming in such a manner as to securely hold the device in place.

1. Mechanical splices shall meet the Acceptance Criteria of ICC Evaluation Services report AC133.

2. Mechanical Splice shall conform to Type 1 requirements and develop 100% of the specified ultimate strength of the bar being spliced.

2.2 ACCESSORY MATERIALS

A. Tie Wire: Minimum 16 gage annealed type.

B. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for strength and support of reinforcement during concrete placement conditions.

C. Special Chairs, Bolsters, Bar Supports, Spacers Adjacent to Weather Exposed or Moisture Exposed Concrete Surfaces:

1. Plastic coated steel type; size and shape as required.

2. Stainless steel type; size and shape as required.

D. Slabs on grade where the base material will not support chairs, shall use supports with sand plates, horizontal runners or dobies to properly locate steel reinforcing in the slab.

E. Wire-bar type supports shall comply with CRSI recommendations. Wood, brick, or other materials will not be accepted.

2.3 FABRICATION

A. Fabricate reinforcing bars to conform to required shapes and dimensions, with fabrication tolerances complying with CRSI "Manual of Standard Practice" and ACI 301. In case of fabricating errors, the heating, re-bending or straightening of reinforcement will not be permitted. Fabricate concrete reinforcing in accordance with ACI 318 and ACI 350.

B. Locate reinforcing splices not indicated on drawings, at point of minimum stress.

2.4 EMBEDMENT ANCHORS

A. Simpson SET high-strength epoxy system or Hilti, HVA epoxy embedment anchors.

PART 3 EXECUTION

3.1 GENERAL

A. Meet requirements in the manual titled, "Placing Reinforcing Bars", published by Concrete Reinforcing Steel Institute (CRSI).

B. Steel reinforcement shall be protected at all times from injury. When placed in the work, it shall be free from dirt, detrimental scale, paint, oil and other foreign substance. When steel reinforcement has detrimental rust, loose scale and dust which is easily removable, it shall be cleaned by a satisfactory method, if approved.

C. All bars shall be bent cold, unless otherwise permitted. No bars partially embedded in concrete shall be field bent except as shown on the Drawings or otherwise permitted.

D. Details of concrete reinforcement and accessories not covered herein or on the Drawings shall be in accordance with ACI 315.

E. Notify Engineer when reinforcing is ready for inspection and allow sufficient time for this inspection prior to close-up of the forming system or placing concrete.

3.2 PLACEMENT

A. The Contractor shall clean reinforcement to remove all loose rust and mill scale, earth, ice, oil or grease, and other materials which reduce or destroy the bond between the concrete and reinforcing steel.

B. The Contractor shall position, support, and secure all reinforcement to prevent displacement by formwork, construction loadings, or concrete placement operations. Steel reinforcing shall be located and supported by metal chairs, runners, bolsters, spacers and hangers, as required. The reinforcement shall be placed to obtain the coverage for concrete protection noted on the Drawings. Where the coverage is not shown, the reinforcement shall be placed to obtain at least the minimum coverage specified hereinafter. The Contractor shall arrange, space, and securely tie bars and bar supports together with 16-gauge wire to hold reinforcement accurately and solidly in position during concrete placement operations. Wire ties shall be set so that the twisted ends are directed away from the exposed concrete surfaces. All reinforcement will be tied and secured in the correct position in the forms before placing concrete. Do not stab reinforcing into fresh placed concrete.

C. The Contractor shall provide a sufficient number of supports of adequate strength to carry the reinforcement. Reinforcing bars shall not be placed more than 2 inches beyond the last leg of any continuous bar support. Supports shall not be used as bases for runways for concrete conveying equipment and similar construction loads.

D. Supports or spacers of pebbles, pieces of broken stone, concrete rubble, broken brick or building blocks, metal pipe or wooden blocks will not be permitted.

E. Do not displace or damage vapor barrier/retarder.

F. Accommodate placement of formed openings.

G. Conform to ACI 350 for concrete cover over reinforcement.

H. Metal clips or supports holding the reinforcement shall not be placed in contact with the forms or the subgrade.

I. Secure and support reinforcement and dowels in position with wire or other approved methods. Shoving reinforcement or dowels into freshly poured concrete is prohibited.

J. Splices:

1. Standard reinforcement splices shall be done by lapping the ends, placing the bars in contact, and tightly wiring the splice together. The requirements of ACI 318/350 for minimum lap of spliced bars shall be provided. Use lap splices unless otherwise shown on the Drawings or permitted in writing by the Engineer. Stagger splices minimum of 48 bar diameters in adjacent bars unless otherwise shown on the Drawings or permitted in writing by the Engineer.

2. No field welding or tacking of reinforcement will be permitted.

3. Vertical bars in columns shall be offset at least one bar diameter at lapped splices. To ensure proper placement, templates shall be furnished for all column dowels.

F. Unless otherwise shown on the Drawings, the Contractor shall provide cover as follows:

1. Not less than 3 inches where the concrete is placed against the ground and without use of forms.

2. Not less than 1 1/2-inches for bars smaller than No. 6 and not less than 2-inches for No. 6 bars and larger where concrete is exposed to the weather, water, or in contact with earth, but placed in forms.

3. Not less than 1 1/2-inches for interior slabs, walls, beams, and columns.

G. The Contractor shall provide a minimum of two No. 4 bars in the top and bottom of a slab or wall face at 45 degrees on all four corners at all openings in structural slabs and walls, unless otherwise shown on the Drawings. Bars shall extend on each side sufficiently to develop bond in each bar.

H. The Contractor shall notify the Engineer when reinforcing is in place so that an inspection of reinforcement placement can be made prior to the close-up of formwork or the placement of concrete.

I. Conform to ACI 301 for all placing tolerances.

J. Bars may be moved to avoid interference with other reinforcing steel, conduits, or embedded items. If moved more than one bar diameter or the stipulated tolerance, the Contractor shall consult with the Engineer to determine final placement.

K. At construction joints and before constructing concrete form work for next stage of construction, the Contractor shall clean all dowels, reinforcing bars and concrete surfaces. All loose material and foreign objects shall be cleaned out of forming before placement of concrete.

L. Placing Welded Wire Fabric:

1. Extend fabric to within 2-inches of edges of slab, and slab control joints and lap splices at least 1½ courses of fabric or minimum 8-inches.

2. Tie laps and splices securely at ends and at least every 24-inches with 16-gauge black annealed steel wire.

3. Place welded wire fabric on #4 continuous bars at 4'-0" at proper distance above bottom of slab. All slab reinforcing is to be discontinuous at slab control joints.

4. Meet current ACI 318 and current Manual of Standard Practice, Welded Wire Fabric, by the Wire Reinforcement Institute regarding placement, bends, laps, and other requirements.

5. All welded wire fabric shall be provided in flat sheets. Rolled fabric will not be permitted.

M. Field Bending:

1. Straightening and Re-bending: Do not straighten or re-bend metal reinforcement. Field bending of reinforcing steel bars is not permitted.

2. Unless permitted by Engineer, do not cut reinforcing bars in the field.

3.4 MECHANICAL SPLICES AND CONNECTIONS

A. Install as required by manufacturer with threads tightened as required by referenced ICC Report.

B. Carefully inspect each splice and verify that each component meets manufacturer's and ICC requirements.

C. Maintain minimum edge distance and concrete cover. Place, support and secure reinforcement against displacement. Do not deviate from required position.

3.3 FIELD QUALITY CONTROL

C. Field inspection will be performed under provisions of Section 01400.

END OF SECTION

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SECTION 03251
EXPANSION AND CONSTRUCTION JOINTS

PART 1 GENERAL

1.1 WORK INCLUDED

A. Concrete expansion, construction and control joints.

B. Concrete joint fillers.

1.2 RELATED WORK SPECIFIED UNDER OTHER SECTIONS

A. Submittals: Section 01300.

B. Reinforcing Steel: Section 03200.

C. Concrete and Grout: Section 03300.

D. Saw-cut Control Joints: Section 03300.

1.3 SUBMITTALS

A. Product Data: Furnish for the following:

1. Joint fillers for horizontal and sloped joints.

2. Preformed control joints.

3. Water stop.

4. Adhered strip seal.

1. Sealants.

B. Shop Drawings: Furnish information listed below:

1. Construction Joints: The contractor is to provide layout and location indicating type of construction joint to be used to engineer for review and approval.

C. Quality Control submittals: Furnish the following documents:

1. Joint Filler and Primer: Manufacturer's written instructions for product shipment, storage, handling, application, and repair.

2. Adhered strip seal manufacturer’s written instructions for product shipment, storage, handling, application, and repair.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: Prepare and protect materials for shipment in accordance with manufacturer's recommendations.

B. Acceptance at Site: Verify that water stops delivered meet the cross-section dimensions shown and manufacturer's reviewed product data prior to unloading and storage at the site.

PART 2 PRODUCTS

2.1 BOND BREAKER TAPE FOR EXPANSION JOINT

A. Adhesive-backed glazed butyl or polyethylene tape which will adhere to the premolded joint material or concrete surface.

B. Width: Same as the joint.

C. Location: As shown.

2.2 BOND BREAKER

A. Provide either bond breaker tape as hereinbefore specified or a bond prevention material, nonstaining type, as specified in Section 03300, CONCRETE, except where a tape is specifically called for.

2.3 PREMOLDED JOINT FILLER (PJF)

A. Bituminous Type: ASTM D994 or D1751.

B. Sponge Rubber: Neoprene, closed-cell, expanded; ASTM D1056, Type RE-45-E1, with a compression deflection, 25 percent deflection (limits), 119 to 168 kPa (17 to 24 psi) minimum.

C. Closed-Cell Neoprene: ASTM D1752, Type I; as manufactured by W.R. Meadows, Inc., Elgin, IL; or equal.

2.4 PREFORMED CONTROL JOINT

A. One-piece, flexible, polyvinyl chloride joint former; Kold-Seal Zip-Per Strip KSF-150-50-50, manufactured by Vinylex Corp., Knoxville, TN; or equal.

B. One-piece steel strip with preformed groove; Keyed Kold Retained Kap, manufactured by Burke Concrete Accessories, Inc., San Mateo, CA; or equal.

C. Provide in full-length unspliced pieces.

D. Provide only where specifically permitted by Drawings.

2.5 POURABLE JOINT FILLERS

A. Pourable joint filler shall be approved for use in potable water supply systems. The specific gravity of the in-place filler after curing shall be greater than 1.5. The manufacturers of the following fillers shall provide written certification that the products are approved by the EPA and the State Department of Health for use in potable water supply systems, and will not be a hazard to health.

B. Manufacturers and Products:

1. Sikaflex 2C, Colonial White color only, as manufactured by Sika Chemical Company, Lyndhurst, NJ; or equal.

2. On sloping joints, use Gun Grade material of the above products of Sikaflex 1A similar nonsag material; submit product information for review and acceptance.

3. Or equal.

2.6 STEEL EXPANSION JOINT DOWELS

A. Dowels: Round smooth steel bars; ASTM A36.

B. Bar Coating: Two-coating system No. 29A, FUSION BONDED, STEEL DOWEL COATING, as specified under Section 09900, PAINTING.

2.7 ACCESSORIES

A. Joint Sealant: Joint sealant shall be two-part polysulfide or urethane conforming to FS TT-S-00227. The type used shall be specifically intended for exterior, submerged control joint applications. A non-sag joint sealant shall be used for vertical joints and self-leveling for horizontal joints.

B. Nonshrink Grout:

1. As specified in Section 03300, CONCRETE.
2. Compatible with joint sealant.

C. Roofing Felt: 30-pound asphalt-saturated; ASTM D226, Type II; or a tar-saturated roofing felt of equal quality.

D. Reinforcing Steel: As specified in Section 03200, CONCRETE REINFORCEMENT.

E. Nails: Provide for securing bituminous type premolded joint filler.

PART 3 EXECUTION

3.1 GENERAL

A. Locate joints as shown, or noted on the Drawings.

B. Verify conformance of water stops with dimensions shown and with reviewed product data prior to embedding water stops in concrete.

C. Construct straight joints; make vertical or horizontal, except where walls intersect sloping floors.

D. Commence concrete placement after the joint preparation is complete.

E. Time Between Concrete Pours:

1. At least 2 hours must elapse after depositing concrete in long or high columns and/or heavy walls before depositing concrete in beams, girders, or slabs supported thereon.

2. For short columns and low height walls, 10 feet or less, wait at least 45 minutes prior to depositing concrete in beams, girders, brackets, column capitals, or slabs supported thereon.

3. Consider beams, girders, brackets, column capitals, and haunches as part of the floor or roof system and place monolithically with the floor or roof system.

4. Should concrete placement sequence result in cold joint located below finished water surface, install water stop in joint prior to additional concrete placement. Notify Engineer prior to installing waterstop. Engineer shall approve preparations prior to concrete placement.

3.2 SURFACE PREPARATION

A. Construction Joints: Prior to placement of abutting concrete, clean contact surface:

1. Remove laitance and spillage from reinforcing steel and dowels.

2. Roughen surface to a minimum of ¼-inch amplitude:

a. Sandblast after the concrete has fully cured.

b. Water blast after the concrete has partially cured.

c. Green cut fresh concrete with high pressure water and hand tools.

3. Perform cleaning so as not to damage water stop, if one is present.

B. Expansion Joint with Pourable Filler:

1. Use motorized wire brush or other motorized device to mechanically roughen and thoroughly clean concrete surfaces on each side of joint from plastic water stop to the top of the joint.

2. Use clean and dry high pressure air to remove dust and foreign material, and dry joint.

3. Prime surfaces before placing joint filler.

4. Avoid damage to water stop.

C. Control Joint:

1. Coat concrete surfaces above and below plastic water stop with bond breaker. Do not get bond breaker on water stop.

2. Avoid damage to water stop.

3. Verify that proper type and size of reinforcing and dowels are provided.

3.3 EXPANSION JOINT INSTALLATION

A. General:

1. Place bond breaker above and below water stop when premolded joint filler and pourable joint filler is not used.

2. Premolded Joint Filler:

a. Sufficient in width to completely fill the joint space where shown.

b. If a water stop is in the joint, cut premolded joint filler to butt tightly against the water stop and the side forms.

3. Precut premolded joint filler to the required depth, as detailed, at locations were joint filler or sealant is to be applied.

4. Form cavities for joint filler with either precut, premolded joint filler, or smooth removable accurately-shaped material.

5. Vibrate concrete thoroughly along the joint form to produce a dense, smooth surface.

B. Bituminous Type Premolded Joint Filler:

1. Drive nails approximately 1 foot 6 inches on center through the filler to provide anchorage embedment into concrete prior to concrete placement.

2. Secure premolded joint filler in forms before concrete is placed.

3. Install in walks, at changes in direction at intersections, and at each side of driveway entrances.

C. Pourable Joint Filler:

1. General: Install in accordance with the manufacturer's written instructions, except as specified below:

a. Apply primer prior to pouring joint filler.

b. Fill entire joint above the water stop with joint filler as shown.

c. Use masking tape on top of slabs at sides of joints; clean all spillage.

2. Place cold-applied, two-component fillers in accordance with manufacturer's written instructions.

D. Steel Expansion Joint Dowels:

1. Install coated bars parallel to wall or slab surface and in true horizontal position perpendicular to the joint in both plan and section views so as to permit joint to expand or contract without bending the dowels.

2. Secure dowels tightly in forms with rigid ties.

3. Install reinforcing steel in the concrete as shown to protect the concrete on each side of the dowels and to resist any forces created by joint movement.

3.4 CONTROL JOINT INSTALLATION

A. Locate reinforcing and/or dowels as shown.

B. Concrete surface to be dense and smooth.

3.5 PREFORMED CONTROL JOINTS

A. Use only where specifically shown.

B. Locate flush, or slightly below the top of slab.

C. Install in accordance with manufacturer's written instructions in straight, full-length unspliced pieces.

D. Steel Strip Type with Preformed Groove: Brace to with-stand pressure of concrete during and after placement.

END OF SECTION

SECTION 03300
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Cast-in-place concrete slabs-on-grade, structural floors, beams, joists, decks, foundations, walls, and columns.

B. Control and contraction joint devices including joint sealant.

C. Equipment pads and thrust blocks.

D. Concrete grout and bonding adhesives.

1.2 RELATED SECTIONS

A. Section 01300 - Submittals.

B. Section 01400 - Quality Control.

C. Section 03100 - Concrete Formwork.

D. Section 03200 – Concrete Reinforcement.

E. Section 03346 - Concrete Floor Finishing.

F. Section 03390 – Concrete Curing.

G. Section 03410 – Testing Concrete Structures for Water-tightness.

1.3 REFERENCES

A. ACI 211.1 – Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.

B. ACI 301 - Structural Concrete for Buildings.

C. ACI 302 - Guide for Concrete Floor and Slab Construction.

D. ACI 304 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.

E. ACI 305R - Hot Weather Concreting.

F. ACI 306R - Cold Weather Concreting.

G. ACI 308 - Standard Practice for Curing Concrete.

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

I. ACI 350 – Environmental Engineering Concrete Structures.

J. ANSI/ASTM D994 - Preformed Expansion Joint Filler for Concrete (Bituminous Type).

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

L. ANSI/ASTM D1751 - Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).

M. ANSI/ASTM D1752 - Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

O. ASTM C31 - Making and curing concrete test specimens in the field.

P. ASTM C33 - Concrete Aggregates.

Q. ASTM C39 - Compressive strength of cylindrical concrete specimens.

R. ASTM C94 - Ready-Mixed Concrete.

S. ASTM C150 - Portland Cement.

T. ASTM C260 - Air Entraining Admixtures for Concrete.

U. ASTM C494 - Chemicals Admixtures for Concrete.

V. ASTM C618 - Fly Ash and Raw or Calcinated Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.

1.4 SUBMITTAL

A. Submit under provisions of Section 01300.

B. Product Data: Provide data on joint devices, attachment accessories, admixtures and aggregate and cement.

C. Samples: Submit two inch long samples of contraction joint and control joint.

D. Manufacturer's Installation Instructions: Indicate installation procedures and interface required with adjacent Work.

E. Submit mix design and certification of compliance for all admixtures and curing compounds.

F. A concrete placement schedule shall be prepared by the Contractor and submitted to the

Engineer for review prior to the start of concrete placement operations. This schedule shall take into account placement time of concrete in the forms, delivery time of the trucks to site and weather conditions expected during the placement of concrete.

1.5 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 01700.

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

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 301.

B. Maintain one copy of each document on site.

C. Acquire cement and aggregate from same source for all work.

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

E. Conform to ACI 306R when concreting during cold weather.

1.7 FIELD SAMPLES

A. Provide under provisions of Section 01400.

1.8 COORDINATION

A. Coordinate work under provisions of Section 01039.

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

PART 2 PRODUCTS

2.1 PROPORTIONING AND DESIGN OF MIXES

A. Proportion and design concrete mixes shall meet the following requirements:

1. M2500-SEC: Secondary concrete mix for fill and backfill around buried pipes underneath structural footings and foundation slabs:

Strength @ 7 days	1500 psi
Strength @ 28 days	2500 psi
Maximum water/cement + fly ash ratio	0.55 by weight
Slump @ point of placement	8 inches
Entrained Air	6% ± 1.5%

	Maximum Aggregate Size 3/4 inch, as defined below, unless otherwise shown on the Drawings.

2. M4000-INT: Structural concrete mix for Interior Slabs on Grade:

Strength @ 7 days	2400 psi
Strength @ 28 days	4000 psi
Maximum water/cement + fly ash ratio	0.50 by weight
Slump @ point of placement	4 inches
Entrained Air	1% ± 1.0% (non-air entrained mix) Maximum Aggregate Size 3/4 inch, as defined below, unless otherwise shown on the Drawings.

3. M4000-STD: Standard structural concrete mix for non-water retaining structural concrete including foundation walls, above grade structural walls, columns, piers, slabs, beams and all other structural concrete:

Strength @ 7 days	2400 psi
Strength @ 28 days	4000 psi
Admixture:	Mid-range water reducer conforming to ASTM C494.
Maximum water/cement + fly ash ratio	0.45 by weight
Slump @ point of placement	4 inches
Entrained Air	6% ± 1.5% Maximum Aggregate Size 3/4 inch, as defined below, unless otherwise shown on the Drawings.

4. M-CDF: Mix for Controlled Density Fill (CDF) or Controlled Low Strength Material (CLSM). CDF shall be a mixture of cement, fine and course aggregate, fly ash and admixtures formulated to be flowable and self-consolidating with a net 28 day compressive strength of 200 to 300 psi.

B. Design shall be by an approved independent testing laboratory and a trial mix batch shall be made and tested by that laboratory. Average strength of cylinders in trial batch must exceed specified strength by 15%.

C. A previously used mix design may be used provided aggregate source is the same, the mixing equipment is the same, and provided at least 10 tests were made by an independent laboratory with results meeting these specifications.

D. If any of the first three 7-day cylinder tests fail to meet the specified 7-day strength, the mix shall be modified for higher strength. Submit modified mix for review before use.

E. Adjustment to Concrete Mixes: Mix design adjustments may be requested by the Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, at no additional cost to the Owner. Test data for revised

mix designs and strength results must be submitted and accepted before using the mix adjustments.

F. Entrained Air: Air-entraining admixture shall be used unless otherwise shown or specified. Air-entraining admixture shall be added at the manufacturer's prescribed rate to result in concrete at the point of placement with an air content as specified herein (volume basis).

G. Concrete shall be mixed in conformance with ASTM C94.

2.2 CONCRETE MATERIALS

A. Cement:

1. ASTM C150, Type II standard mixes.

2.3 AGGREGATES

A. Fine: Clean, sharp, natural sand, ASTM C 33. Fineness modulus shall not be less than 2.5 nor more than 3.0. Materials passing 200 sieve shall be 4 percent maximum.

B. Coarse: Crushed stone or gravel, ASTM C 33. Maximum size of coarse aggregate shall be 3/4-inches, unless otherwise indicated on the Drawings. Materials passing 200 sieve shall be 0.5 percent maximum.

C. Aggregates shall be natural, free from deleterious coatings, meeting ASTM C 33, nonreactive. Thoroughly and uniformly wash before use. In accordance with ASTM C 33, Appendix XI, paragraph X1.1, evidence of reactive problems on existing structures will be used to prove sources of aggregates are reactive and are unsuitable for use in the work. Import nonreactive aggregates if local aggregates are reactive. Import aggregates if local aggregates and concrete produces shrinkage volume changes in excess of specified amount.

2.4 WATER

A. All water for concrete mixtures shall be clean, potable, and free from injurious substances and conforming to ASTM C 94. Water containing 2 percent or more common salt shall not be used and chloride levels shall be less than 500 parts per million.

2.5 ADMIXTURES

A. Air Entrainment:

1. Air entraining admixtures shall be used in all concrete exposed to the weather and as specified for quality of concrete used, ASTM C 260, except that admixture shall be non-toxic after 30 days and contain no chlorides or other chemicals causing corrosion; manufactured by Grace Daravair `M' or SIKA Chemical `AER'.

2. Must be compatible with water-reducing admixture. Concrete with air-entrainment admixture added shall maintain air percentage as batched, within 2 percent for minimum 1 ½ hours after addition to concrete mix and through concrete pumping.

B. Water-Reducing Admixtures:

1. Water-reducing admixtures shall conform to ASTM C494, Type A or Type D.

2. Complex, multi-component, nonchloride, noncorrosive admixture providing unique performance qualities unobtainable from conventional water-reducing admixtures.

3. Manufacturer and Product:

i. Master Builders, Inc., Cleveland, OH, Pozzolith or Pozzolith Polyheed.

ii. W.R. Grace & Co., Cambridge, MA, WRDA-79.

4. Must be compatible with air entraining admixture.

C. Superplasticizers

1. Meet ASTM C494 and use only Type F or G, of second or third generation type.

2. Hold slump of 5 inches or greater for the time required for placement into structure, or 2 hours minimum.

3. Type F Superplasticizer: Batch plant added to extend plasticity time, control temperature of fresh concrete, reduce water 20 to 30 percent, and give higher strengths at all ages.

4. Type G Superplasticizer: Batch plant added to extend plasticity time, maintain setting characteristics similar to normal concrete throughout its recommended dosage range and at varying concrete temperatures, reduce water 30 to 40 percent, and give high-early and ultimate strengths.

5. Superplasticizers for Hot Weather Placements:

i. A synthesized sulfonated complex polymer type superplasticizer containing no chlorides or alkalines.

ii. Add to mix at manufacturer's recommended dosage to allow placement with concrete temperatures up to 90 degrees F.

6. Manufacturer and Product:

i. Master Builders, Inc., Cleveland, Ohio, Rheobuild or Pozzolith Polyheed at a dosage greater than 10 ounces per 100 pounds of cement.

ii. W.R. Grace & Co., Cambridge, Maine, Daracem 100.

iii. Euclid Chemical Co., Cleveland, Ohio, Eucon Super F or 537G.

2.6 FLY ASH

A. Fly ash may only be permitted if specifically approved by Engineer. Submit complete manufacturer's literature. If approved, conform to ASTM C618, Type F modified to allow SiO_2+Al_2O_3+FeO_3 minimum 66 percent and SiO_2 minimum 40 percent and to require a maximum loss on ignition of 2 percent. Do not use to replace more than 25% of cement by weight.

2.7 CALCIUM CHLORIDE

A. Calcium chloride and products containing more than 0.1% chloride ions are not permitted. Provide admixture manufacturer's written certification that chloride ion content complies with specified requirements.

2.8 FREEZE PROTECTION ADMIXTURE

A. ASTM C494 Type E admixture, specially formulated to provide protection from freezing down to 20 degrees F. (-7 degrees C.) until initial set has been reached.

B. Manufacturer and Product:

1. Master Builders Co., Pozzutec 20.

2. Or equal.

2.9 CONCRETE CURING MATERIALS

A. Curing materials, preparation and application shall be per Section 03390 – Curing Materials.

B. Do not use curing compound where additional finishes such as hardeners, paintings, and other special coatings are required. Use water curing as specified instead.

2.10 ACCESSORIES

A. Bonding Agent: Two component modified epoxy resin.

B. Non-Shrink Grout Category I:

1. Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents for use in filling tie holes in concrete, blockouts for gate guides, joints of precast components or members, and grouting baseplates of columns that do not exceed one story in height; capable of developing minimum compressive strength of 2,400 psi in 48 hours and 7,000 psi in 28 days.

2. All grout shall be a fluid consistency in use except that for formwork tie holes the grout shall be dry pack consistency and shall fill the conical section with dense grout hammered in with steel tool and steel hammer.

3. Use Category II type grout for filling through-bolt openings as hereinafter specified.

4. Use Category II grouts for patching defects in walls and slabs after form removal.

C. Nonshrink Grout Category II:

1. Nonshrink grout with natural aggregate for use in high strength, precision support of machine bases of 25 hp or less; bases for precast wall sections,

columns, and precast members more than one story in height; filling of through-bolt openings in concrete walls; and patching defects in walls and slabs after form removal shall conform to the Corps of Engineers' Specification for Non-Shrink Grout, CRD-C261-81 and to these specifications. Fluid grout as determined by the flow cone, CRD-C611-81, shall have a minimum strength of 4,800 psi at 7 days and 6,800 psi at 28 days as determined by CRD-C227.

2. No material other than water shall be added to the premixed grout at the jobsite. Follow manufacturer's instructions relative to mixing, placing, and curing.

D. Nonshrink Grout Category III:

1. Nonshrink grout for use in high strength, precision support of machine bases for machinery of 30 hp or greater and soleplates where very large loads and stresses from vibration and other dynamic loads are involved and when the equipment will be subject to thermal movements.

2. The location for use, other than that specified above, shall be as shown on the Drawings and/or as specified hereinafter.

3. The grout shall be free of gas-producing or gas-releasing agents, free of oxidizing catalysts, free of inorganic accelerators, and free of chlorides. Provide performance characteristics when mixed to fluid consistency, 22 to 25 seconds (flow cone method, CRD-C 611-80) as follows:

   i. When mixed and maintained at 45 degrees F (7 degrees C) or higher, no visible bleeding and/or settlement up to 2 hours on ½ gallon grout poured into gallon can, covered with glass plate to prevent evaporation.

   ii. Grout shall be cured in accordance with grout manufacturer's instructions.

   iii. Provide (2" x 2" cube) strengths as specified. Prepare specimens and test in accordance with ASTM C 109-80 except as follows: Mix grout in accordance with manufacturer's instructions. Fill molds in two layers, puddling each layer gently with gloved finger five times; strike off excess grout; wipe edges of mold clean with rag and cover with steel plate clamped to mold until time to test. Seal cover 24 hours after placement.

4. The grout shall obtain a minimum compressive cube strength of 5,000 psi at 7 days and 9,000 psi at 28 days (2-inch cubes).

E. Epoxy/Grout Adhesive:

1. Three Component Epoxy Resin System:

   i. Two liquid epoxy components.

   ii. One inert aggregate filtered component.

iii. Each component furnished in separate package for mixing at job site.

2. Apply only to clean, dry, sound surface.
3. Mix and place in accordance with manufacturer's instructions.
4. Completely fill all cavities and spaces around dowels and anchors without voids.

F. Vapor Retarder/Barrier: Provide Vapor retarder or barriers underneath concrete slabs as noted on the drawings. Vapor retarder/barrier shall be minimum 10-mil thick polyethylene sheeting conforming to ASTM E1745 Class A, B and C.

1. Overlap edges of adjacent sheets a minimum of 6-inches.
2. Seal overlaps, side and end edges with special vapor-barrier tape.
3. Do not puncture or teat vapor barrier/retarder after it has been placed.

2.11 JOINT DEVICES AND FILLER MATERIALS

A. Joint Filler Type A: ASTM D1751; Asphalt impregnated fiberboard or felt, 1/2 inch thick; tongue and groove profile.

B. Joint Filler Type B: ASTM D1752; Closed cell polyvinyl chloride foam, resiliency recovery of 95 percent if not compressed more than 50 percent of original thickness.

C. Construction Joint Devices: Integral extruded plastic; 3/8 inch thick, formed to tongue and groove profile, with removable top strip exposing sealant trough, knockout holes spaced at 6 inches, ribbed steel spikes with tongue to fit top screed edge.

D. Contraction Joint Devices: ASTM B221 resilient elastomeric or neoprene filler strip with a Shore A hardness of 35 to permit plus or minus 25 percent joint movement with full recovery; of longest manufactured length at each location, flush mounted.

E. Sealant: Elastomeric sealant conforming to ASTM C920 and Federal Specification TT-S-00277E. In all joints for liquid-retaining structures provide sealants specially formulated to conform to Use Requirement I, for submerged conditions.

2.12 CONCRETE BONDING ADHESIVE

A. Concresive liquid bonding adhesive (LPL) two-component, liquid epoxy bonding agent.

B. No substitutes.

PART 3 EXECUTION

3.1 CONCRETE MIXING

A. The materials for concrete shall be mixed at an acceptable concrete batch plant. Meet ACI 304 current edition and other requirements as specified for mix design, testing, and quality control.

B. Ready-mix concrete shall comply with the requirements of ASTM C94 and as herein specified:

1. The addition of water to the mix at project site must be approved by the Engineer and the maximum water-cement ratio shall not be exceeded. The delivery ticket shall be noted with amount of additional water added and submitted to the Engineer.

2. Concrete shall be discharged at the job within 1-1/2 hours after water has been added to the cement and aggregates or cement batched with the aggregates, unless a longer time is specifically authorized by the Engineer.

3. During hot weather or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C94 may be required:

a. When the air temperature is between 85 degrees Fahrenheit and 90 degrees Fahrenheit, the mixing and delivery time shall be reduced from a maximum of 1-1/2 hours to 75 minutes and when the air temperature is above 90 degrees Fahrenheit, the mixing and delivery time shall be reduced to no more than 60 minutes.

C. Truck Mixers:

1. Equip with electrically actuated counters to readily verify the number of revolutions of the drum or blades.

2. Counter:

a. Resettable, recording type, mounted in driver's cab.

b. Actuated at time of starting mixers at mixing speeds.

3. Performance Requirements:

a. Truck mixer operation shall provide a concrete batch as discharged within acceptable limits of uniformity with respect to consistency, mix and grading.

b. If slump tests taken at approximately the 1/4 and 3/4 points of the load during discharge give slumps differing by more than 1 inch when specified slump is 3 inches or less, or differing by more than 2 inches when specified slump is more than 3 inches, discontinue use of truck mixer unless causing condition is corrected and satisfactory performance is verified by additional slump tests.

c. Check mechanical details of mixer, such as water measuring, and discharge apparatus, condition of blades, speed of rotation, general mechanical condition of unit, and clearance of drum before attempting to reuse unit.

4. Do not use nonagitating or combination truck and trailer equipment for transporting ready-mixed concrete.

D. Mixing Process:

1. Concrete Volume in Truck:
   a. Limit to 63 percent of total volume capacity per ASTM C94 when truck mixed.

   b. Limit to 80 percent of total volume capacity when central mixed.

2. Mix each batch of concrete in truck mixer for minimum 70 revolutions of drum or blades at rate of rotation designated by equipment manufacturer as mixing speed.

3. Perform additional mixing, if required, at speed designated by equipment manufacturer as agitating speed.

4. Place materials, including mixing water, in mixer drum before actuating the revolution counter for determining the number of mixing revolutions.

3.2 EXAMINATION

A. Verify site conditions under provisions of Section 01010.

B. Verify formwork installation, placement of reinforcing steel, concrete cover over reinforcement, and items to be embedded or cast-in.

C. Verify that sleeves, anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not cause hardship in placing concrete. Reinforcing shall not be stabbed into freshly placed concrete.

3.2 PREPARATION

A. Prepare previously placed concrete by cleaning with steel brush and applying bonding agent in accordance with manufacturer's instructions.

B. In locations where new concrete is dowelled to existing work, drill holes in existing concrete, insert steel dowels and pack solid with non-shrink grout.

C. Wood forms shall be wetted immediately before placing the concrete when form coatings are not used. Dampen subgrade before placing concrete for slabs on grade unless a vapor barrier is used.

D. Prior to placement verify that mix design on delivery tickets correspond to required specification for component.

3.3 PLACING CONCRETE

A. Notify Engineer minimum 24 hours prior to commencement of operations.

B. Concrete shall be placed in compliance with the practices and recommendations of ACI Standards 304, 318, 350, and 614, and as herein specified:

1. Concrete shall be placed continuously or in layers of such thickness 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, the Contractor shall provide construction joints as specified in Section 03251, EXPANSION AND CONSTRUCTION JOINTS. The placement of concrete shall be done at such a rate that concrete is still workable. Concrete shall be placed as near as practicable to its final location to prevent segregation due to rehandling or flowing. Do not subject concrete to any procedure which will cause segregation.

2. In no case shall concrete be allowed to freely drop more than five feet.

3. Screed concrete which is to receive other construction to the proper level to avoid excessive skimming or grouting.

4. Concrete which has become non-plastic and unworkable, or does not meet the required quality control limits, or which has been contaminated by foreign material shall not be used. Do not use retempered concrete. Remove rejected concrete from the project site and dispose of it at an approved location.

C. Placing Concrete Into Forms:

1. Concrete shall be placed in forms in horizontal layers not deeper than 48 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while the preceding layer is still workable to avoid cold joints.

2. Temporary spreaders in forms shall be removed when concrete placement has reached the elevation of such spreaders.

3. Concrete placed in forms shall be consolidated by mechanical vibrating equipment supplemented by hand-spading, rodding, and tamping. Use equipment and procedures for consolidation of concrete in accordance with the recommended practices of ACI 309, to suit the type of concrete and project conditions. Vibration of forms and reinforcing will not be permitted.

4. Vibrators shall not be used to transport concrete inside of the 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 inches 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 the vibration to the time necessary to consolidate the concrete and complete embedment of reinforcement and other embedded items without causing segregation of the mix. Generally, this will be from 5 to 15 seconds in accordance with ACI 301.

5. Do not use aluminum pipe or other aluminum conveying devices.

6. Provide sufficient illumination for interior of forms so concrete at places of deposit is visible to permit confirmation of consolidation quality.

C. Conveyor Belts and Chutes:

1. Design and arrange ends of chutes, hopper gates, and other points of concrete discharge throughout conveying, hoisting, and placing system such that concrete passing from them will not become segregated.

2. Do not use chutes longer than 50 feet.

3. Minimum Slopes of Chutes: Angled to allow concrete of specified consistency to readily flow without segregation.

4. Conveyor Belts:

a. Approved by Engineer.

b. Wipe clean with a device which does not allow mortar adhering to the belt to be wasted.

c. Cover conveyor belts and chutes.

D. Retempering: For concrete or mortar in which cement has partially hydrated, retempering is not permitted.

E. Pumping of Concrete:

1. General:

a. Pumping is the preferred method of placing concrete.

b. If pumped concrete does not produce satisfactory end results, discontinue pumping operation until the problem is corrected.

c. At Contractor's option, other approved methods of placement may be used.

2. Equipment:

a. Provide standby pump, conveyor system, crane and concrete bucket, or other system acceptable to Engineer, on site during pumping, for adequate redundancy to assure completion of concrete placement without cold joints in case of a primary placing equipment breakdown.

b. Minimum Pump Hose (Conduit) Diameter: 4 inches.

c. Replace pumping equipment and hoses (conduits) that are not functioning properly.

d. Do not use aluminum conduits for conveying concrete.

3. Field Control (For Pumped Concrete): Take concrete samples for slump (ASTM C143) and test cylinders (ASTM C31 and C39) and shrinkage specimens (ASTM C157) at placement (discharge) end of line.

F. Removal of Water: Remove all water from space to be occupied by concrete.

G. Consolidation and Visual Observation:

1. Consolidate concrete with internal vibrators with minimum frequency of 8,000 vpm and amplitude required to consolidate concrete in section being placed.

2. Provide at least one standby vibrator in operable condition at placement site prior to placing concrete.

3. Consolidation equipment and methods shall meet ACI 309.

4. Provide sufficient windows in the forms or limit form height to allow visual observation of concrete.

5. Vibrator operator shall be required to see concrete being consolidated to ensure good quality workmanship, or an individual shall actually

observe the vibration of concrete at all times and advise vibrator operator of any changes needed to ensure complete consolidation.

6. Consolidation and placement locations shall be planned and accomplished so that vibrators shall be inserted in the concrete as it is placed and in locations not to exceed a distance of 5 feet from point of placement.

H. Placing Concrete Slabs:

1. Prior to concrete placing, any area of subgrade on which concrete is to be placed shall be properly wetted. Concrete slabs shall be placed in a continuous operation, within the limits of construction joints, until the placement of a panel or section is completed. When in-place concrete has sufficiently set up (at least 24 hours), an alternate section may be placed. All joints between sections shall be properly keyed. The edges of all sections shall be tooled with a minimum radius or chamfer edging tool.

2. Concrete shall be consolidated during placement operations using vibrating equipment, so that the concrete is thoroughly worked around reinforcement and other embedded items and into the corners.

3. Slab surfaces shall be brought up to the correct level with a straightedge and struck off. Bull floats or darbies may be used to smooth the surface, leaving it free from humps or hollows. Do not sprinkle water on the plastic surface. Do not disturb the slab surfaces prior to beginning finishing operations.

4. Control Joints for Slabs on Grade:

   a. Locate as shown on the Drawings.

   b. Construct with a manufactured, embedded control joint form or stop pour at each control joint and place concrete in checkerboard pattern with no two adjacent panels placed on the same day. Install form with no offsets and in straight lines as specified elsewhere.

   c. Sawn control joints will be permitted where shown. Saw joint 1½-inches deep, or 1/4 slab thickness, whichever is greater. Start sawing within 12-hours of placement but delay as necessary to prevent raveling.

5. Reinforcing steel shall be continuously maintained in the proper position during concrete placement operations.

6. All exterior concrete slabs shall be sloped in a manner to prevent the collection of water.

J. Bonding:

1. Surfaces of set concrete at all joints shall be roughened, except where bonding is obtained by use of an approved concrete bonding agent, and the surfaces shall be cleaned of laitance coating, loose particles, and foreign matter. Surfaces shall be roughened in a manner to expose bonded aggregate uniformly and laitance, loose particles of aggregates, or damaged concrete at the surface shall be removed.

2. Bonding of fresh concrete to new concrete that has set, but is less than 60 days old or is not fully cured shall be done as follows:

   a. At joints between a footing and walls or columns, and between walls or columns and beams or slabs that they support, and elsewhere unless otherwise specified herein, dampen, but do not saturate, the roughened and cleaned surface of set concrete immediately before placing the fresh concrete.

   b. At vertical joints in exposed work, and at joints designed to contain liquids, dampen, but do not saturate, the roughened and cleaned surface of set concrete.

   c. Neat cement grout as specified hereinbefore shall be applied to a minimum thickness of 2 inches. Fresh concrete shall be placed before the cement grout has attained its initial set. Limit concrete lift placed immediately on top of grout to 12 inches.

   d. An approved commercial bonding agent may be used in lieu of neat cement grout for non- water stop applications. The agent shall be applied to cleaned concrete surfaces in accordance with the printed instruction of the bonding agent manufacturer.

3. Epoxy bonding adhesive shall be applied in accordance with the manufacturer's recommendations for bonding to old concrete (more than 60 days old). Coat contact surfaces with bonding agent after mechanically roughening surface to a clean, rough surface.

J. Cold Weather Placing:

1. All concrete work shall be protected from physical damage or reduced strength which could be caused by freezing or low temperatures, in compliance with the requirements of ACI 306 and ACI 318 and as herein specified.

2. When the temperature of the surrounding air is expected to be below 40 degrees Fahrenheit during concrete placement or within 3 days (72 hours) thereafter, the temperature of the placed concrete shall be maintained at temperatures no lower than 60 degrees Fahrenheit for sections less than 12

inches in any dimension or 55 degrees for any other section. Heated water and/or aggregate shall be used in accordance with ACI 306.

a. The placed concrete temperature shall be maintained at or above the specified temperatures for curing for at least 7 days.

3. Frozen concrete materials containing ice or snow shall not be used. Concrete shall not be placed on frozen subgrade or on subgrade containing frozen materials. The Contractor shall determine that the forms, reinforcing steel, and adjacent concrete surfaces are entirely free of frost, snow, and ice before placing any concrete.

4. The use of calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators shall not be allowed, unless authorized in writing by the Engineer.

5. Maintain temperature of concrete above 50 degrees for a minimum of 7 days.

6. Strength requirements may require additional protection and curing during cold weather due to delayed field strength gain.

7. Determine strength attainment, and the requirement for continued protection, from field test cylinders, cured along side the cast concrete structure.

8. Surface Temperature:

a. The actual temperature of concrete surface determines effectiveness of protection, regardless of air temperatures or whether the objective is durability or strength.
b. Provide a sufficient number of thermometers placed on concrete surfaces spaced throughout the work to allow inspection and monitoring of concrete surface temperatures representative of all the work.

9. External Heating Units:

a. Vent heating units and do not locally heat or dry concrete.
b. Do not exhaust flue gases directly into an enclosed area.
c. Ensure fire safety and fire prevention measures are enforced during use of heating units.

10. Maintain curing conditions which will foster normal strength development without excessive heat, and without critical saturation of concrete at the close of the protection period.

11. Limit rapid temperature changes, particularly before strength has developed sufficiently to withstand temperature stresses.

12. At end of the required period, discontinue protection in such a manner that the drop in temperature of any portion of concrete will be gradual and will not exceed, in 24 hours, 50 degrees F.

K. Hot Weather Placing:

1. When hot weather conditions exist that would seriously impair the quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.

2. The ingredients shall be cooled before mixing to maintain the concrete temperatures at the time of placement below 80 degrees Fahrenheit. Mixing water may be chilled or chopped ice may be used.

3. Reinforcing steel may be covered with watersoaked burlap if it becomes too hot, so that the steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.

4. The use of retarding admixtures will not be allowed, unless otherwise accepted in mix designs by the Engineer.

5. The forms shall be thoroughly wetted before placement of concrete. Make provisions for windbreaks, shading, fog sprays, sprinkling, or wet cover, when necessary.

6. Reflective Cracking:

a. Prevent reflective cracking due to differential temperatures between concrete and reinforcing steel.

b. If reinforcement is in direct sunlight or is more than 20 degrees F higher in temperature than concrete temperature before placement, wet reinforcement to cool it with water fog spray 10 minutes before placing concrete.

c. Verify temperature of reinforcing is not more than 20 degrees F higher than fresh concrete.

L. Ensure reinforcement, inserts, embedded parts, waterstops, formed expansion and contraction joints, and are not disturbed during concrete placement.

M. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.

N. Place concrete continuously between predetermined control and construction joints.

O. Do not interrupt successive placement; do not permit cold joints to occur.

P. Typical Joints:

1. Install joint fillers, primers and sealant in accordance with the manufacturer's instructions.

2. Separate slabs on grade from vertical surfaces with 1/2 inch thick joint filler.

3. Extend joint filler from bottom of slab to within 1/4 inch of finished slab surface.

4. Install joint devices in accordance with manufacturer's instructions.

5. Install joint device anchors. Maintain correct position to allow joint cover to be flush with floor and wall finish.

6. Install joint covers in one piece, longest practical length, when adjacent construction activity is complete.

7. Apply sealants in joint devices in accordance with manufacturer's recommendations.

Q. Construction Joints:

1. Construction joints shall be located and installed as shown on the Drawings in a manner that will not impair the strength and appearance of the structure. Construction joints, if not shown, shall be located only with approval of the Engineer and as follows:

a. The Contractor shall provide key-ways at least 1-1/2 inch deep in all construction joints in walls, slabs, and between walls and footings where water stop is not called out in the plans.

b. Construction joints shall be placed perpendicular to the main reinforcement and all reinforcement shall continue across construction joints.

c. Construction joints shall be prepared as specified in ACI Standard 318/350.

R. Expansion joints shall be located as shown on the Drawings. Expansion joints shall be held down to receive the joint sealant.

S. For bonding to new concrete horizontal construction joints, roughen the surface of the hardened concrete. Thoroughly clean and saturate with water, cover the horizontal surfaces only with at least two to three inches of grout, as hereinbefore specified, and immediately place concrete. New concrete is defined as less than 60 days old. Limit the concrete lift placed immediately on top of the grout to 12-inches thick and thoroughly vibrate to mix and consolidate the grout and concrete together.

3.4 CONCRETE FINISHING

A. Provide formed and un-formed concrete surfaces with finishes as Scheduled on the

project drawings in the General Structural Notes and Specifications sections.

B. Finish concrete slab surfaces in accordance with ACI 302, the General Structural Notes and Specifications sections on the project drawings and Section 03346 – Concrete Floor Finishing.

C. In areas required to drain pitch surface uniformly to drain as indicated on drawings.

3.5 CURING AND PROTECTION

A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

B. Maintain concrete with minimal moisture loss at relatively constant temperature for the period necessary for hydration of cement and hardening of concrete. Unless otherwise approved, concrete shall be maintained above 50° F and in a moist condition for a minimum of 7 days after placement.

C. Cure concrete surfaces in accordance with ACI 308 and Section 03390 – Concrete Curing.

3.6 FIELD QUALITY CONTROL

A. Field review and testing will be performed in accordance with ACI 301 and under provisions of Section 01400.

B. Provide free access to Work and cooperate with appointed firm.

C. Submit proposed mix design of each class of concrete to Engineer and testing firm for review prior to commencement of Work.

D. Tests of cement and aggregates may be performed to ensure conformance with specified requirements.

3.7 STRENGTH TEST OF CYLINDERS DURING WORK

A. Provide for test purposes, sets of four cylinders each, taken for each 40 cubic yards or portions placed each day with a minimum of 2 tests per pour. Test one cylinder per set at 7 days, two at 28 days, and retain one for backup.

B. Evaluation will be in accordance with ACI Standard Building Code Requirements for Reinforced Concrete (ACI 318/350), Section 4.7, "Evaluation and Acceptance of Concrete", and these Specifications. Where the term "building official" is used in Section 4.7 of ACI 318/350, term shall be redefined to "the Owner's representative".

C. Specimens will be made, cured, and tested by the Contractor's independent testing firm in accordance with ASTM C31 and ASTM C39.

D. Frequency of testing may be increased at discretion of Engineer.

E. Cold Weather Placement Tests:

1. During cold weather concreting, Contractor's independent testing firm will cast cylinders for field curing as follows. Use method which will produce greater number of specimens:

a. Six extra test cylinders from the last 100 cubic yards of concrete.

b. Minimum three specimens for each 2 hours of placing time or for each 100 yards.

2. These specimens shall be in addition to those cast by Contractor for lab testing.

3. Keep field test cylinders in same protective environment as the parts of the structure they represent, to determine if specified strength has been obtained and no further protection is needed. Do not place in insulated device that provides additional protection to the cylinder.

4. Test cylinders in accordance with applicable sections of ASTM C31 and C39.

5. Evaluation and Acceptance: As specified herein.

3.8 SLUMP TESTS

A. Take slump tests with each strength test and from each truck after pumping and as directed in accordance with ASTM C143.

3.9 AIR CONTENT

A. ASTM C 173, volumetric method for lightweight or normal weight concrete; ASTM C 231, pressure method for normal weight concrete; take air tests with each strength test and each truck and as directed.

3.10 CONCRETE TEMPERATURE

A. ASTM C1064; one test hourly when air temperature is 40 degrees F and below and when 80 degrees F and above, and one test for each set of compressive strength specimens.

3.11 TEST OF HARDENED CONCRETE

A. Acceptance shall be based on concrete cylinder tests in accordance with Paragraph 3.11. Contractor may provide additional test by coring per ASTM C42 or load tests for that portion of job where questionable concrete has been placed. Such additional testing will be accepted in lieu of cylinder tests. Results of rebound hammer tests will not be accepted except in defining problem areas.

3.12 COST OF TESTING

A. The Contractor shall bear all costs of testing required by this section including tests of hardened concrete where cylinder strengths indicate high or low strength concrete.

3.13 TEST RESULTS

A. Submit two (2) copies of all tests to Engineer within 24 hours of testing.

3.14 CURE BOX

A. Provide a cure box at the project site for initial cure of test cylinders. Construct and equip box to provide initial cure in accordance with ASTM C31. Do not place cold weather cylinders in the curebox after protection of concrete is in place.

3.15 PATCHING

A. Allow Engineer to review concrete surfaces immediately upon removal of forms.

B. Excessive honeycomb or embedded debris in concrete is not acceptable. Notify Engineer upon discovery.

C. Patch imperfections as directed by the Engineer and in accordance with ACI 301.

D. Patch cone holes at form ties to match adjacent concrete.

3.16 DEFECTIVE CONCRETE

A. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.

B. During the progress of the work, if the laboratory-cured values shown for each concrete design strength and quality as determined by compression cylinders fail to attain the requirements specified, suspend all concrete work. Concrete that has been placed in the work and does not meet the specified requirements will be reviewed by the Engineer and the Contractor. Any field testing such as core drilling required to verify in-place concrete strengths after compression tests fail to meet requirements shall be at the Contractor's expense. The Contractor shall, at his own expense, correct or remove the defective work in a manner approved by the Engineer.

C. The following criteria shall be followed in defining cracks by minimum measured crack width; using feeler gauges or other approved means:

- Cracks with maximum widths less than 0.015 inches (1/64") shall be considered hair-line cracks and shall be repaired or sealed as directed by the Project Engineer.
- Cracks equal to or greater than 0.015 inches (1/64") and less than or equal to .095 inches (3/32") in width at any point shall be considered medium cracks with mandatory repair by injection required.
- Any cracks equal to or greater than 0.095 inches (3/32") in width at any point shall be considered large cracks with mandatory repair by injection or as directed by the Project Engineer.
- Crack repair shall follow the guidelines of Section 03900 – Quality Assurance Procedures for Concrete Structure Cracks & Prevention and Section 03930 – Concrete Rehabilitation.

D. Repair or replacement of defective concrete will be determined by the Engineer.

E. Repair defects in formed concrete surfaces within 24 hours of removing forms.

F. Replace defective concrete within 48 hours.

G. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Engineer for each individual area.

H. Cut out and remove defective area.

I. Cut edges square to avoid feathering.

J. Comply with ACI 301, Chapter 9.

K. Perform repair work so as not to interfere with curing of adjacent concrete.

L. Adequately cure repair work.

M. The cost of all repairs, removal, replacement, etc., required by the provisions of this Article shall be borne by the Contractor.

END OF SECTION

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SECTION 03346
CONCRETE FLOOR FINISHING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Floor finishing

B. Floor surface treatment with sealer

1.2 RELATED SECTIONS

A. Section 03100 – Concrete Formwork

B. Section 03200 – Concrete Reinforcement

C. Section 03300 – Cast-in-Place Concrete

1.3 REFERENCES

A. ACI 301 - Structural Concrete for Buildings

B. ACI 302 – Concrete Floor and Slab Construction

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Sonneborn Building Products, Product Kure-N-Seal

B. Dayton Superior, Product Safe Cure & Seal

C. ChemMasters, Product Cure & Seal

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that the floor surfaces are acceptable to receive the work of this section.

3.2 FLOOR FINISHING

A. Finish concrete floor surfaces in accordance with ACI 301 and 302.

B. Refer to floor finish schedules listed in the General Concrete Notes and listed on the project drawings.

C. Steel trowel surfaces which are scheduled to be exposed.

D. In areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drains.

E. Apply a light broom finish to finished floor surfaces. Provide for all exterior walks, stairs, or exterior slab on grade unless otherwise specified.

3.3 FLOOR SURFACE TREATMENT

A. Apply sealer in accordance with manufacturer's instructions on all floor surfaces not receiving a surface hardener.

B. Apply a surface hardener to Class 6 floors as noted on the drawings.

3.4 TOLERANCES

A. Maximum variation of surface flatness for exposed concrete floors: 1/8 inch (3 mm) in 10 feet (3 meters).

END OF SECTION

SECTION 03390
CONCRETE CURING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes initial and final curing of horizontal and vertical concrete surfaces.

B. Related Sections:

1. Section 03100 – Concrete Forms & Accessories
2. Section 03300 - Cast-In-Place Concrete
3. Section 03346 - Concrete Floor Finishing

1.2 REFERENCES

A. American Concrete Institute:

1. ACI 301 - Specifications for Structural Concrete
2. ACI 302.1 - Guide for Concrete Floor and Slab Construction
3. ACI 308.1 - Standard Specification for Curing Concrete
4. ACI 318 - Building Code Requirements for Structural Concrete
5. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures

B. ASTM International:

1. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete
2. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
3. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete
4. ASTM D2103 - Standard Specification for Polyethylene Film and Sheeting

1.3 SUBMITTALS

A. Section 01300 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit data on curing compounds, mats, film, compatibilities, and limitations.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 308.

B. Maintain one copy of each document on site.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Section 01600 - Product Requirements: Product storage and handling requirements.

B. Deliver curing materials in manufacturer's packaging including application instructions.

2.1 MATERIALS

A. Membrane Curing Compound: ASTM C1315 Type I, Class A.

B. Absorptive Mats Type C: ASTM C171, cotton fabric, burlap-polyethylene, minimum 8 oz/sq yd bonded to prevent separation during handling and placing.

C. Polyethylene Film Type E: ASTM C171, 6 mil thick clear, white or black. Color use may depend on daily ambient temperatures per ACI 308.1 requirements.

D. Water: Potable, not detrimental to concrete.

3.1 EXAMINATION

A. Section 01300 - Administrative Requirements: Coordination and project conditions.

B. Verify substrate surfaces are ready to be cured.

3.2 INSTALLATION - HORIZONTAL SURFACES

A. Cure concrete in accordance with ACI 308.1.

B. Ponding: Maintain 100 percent coverage of water over floor slab areas, continuously for 5 days minimum.

C. Fog Spraying: Spray water using fog-spray equipment over floor slab areas and maintain wet for 7 days minimum. Direct discharge of the atomized water spray onto the surface of the concrete is unacceptable.

D. Absorptive Mat: Spread cotton fabric over floor slab areas. Spray with water until mats are saturated, and maintain in saturated condition for 7 days minimum.

E. Membrane Curing Compound: Apply curing compound in two coats with second coat applied at right angles to first.

3.3 INSTALLATION - VERTICAL SURFACES

A. Cure concrete in accordance with ACI 308.1.

B. Fog Spraying: Spray water using fog-spray equipment over floor slab areas and maintain wet for 7 days minimum. Direct discharge of the atomized water spray onto the surface of the concrete is unacceptable.

C. Membrane Curing Compound: Apply compound in two coats with second coat applied at right angles to first.

3.4 SURFACES INSIDE FORMWORK

A. Concrete surfaces protected by formwork require no special curing treatment as long as the formwork remains in place a minimum of 7 days or until the concrete has reached the specified strength.

B. If forms are removed prior to 7 days or the concrete attaining the specified strength, then all surfaces shall be cured as specified elsewhere in this section for the remainder of the required curing period.

C. Top or other exposed portions of walls and other concrete elements covered with protecting formwork require curing as specified elsewhere in this section.

D. In hot weather, wall forms shall be hosed down with water and covered with protective polyethylene Film to prevent excessive moisture loss.

3.5 PROTECTION OF FINISHED WORK

A. Section 01700 - Execution Requirement: Protecting finished Work.

B. Do not permit traffic over unprotected floor surface.

3.6 SCHEDULES

A. Liquid Retaining Structure Walls: In-form curing, fog spraying or membrane curing compound.

B. Liquid Retaining Structure Floor Slabs-on-grade: Ponding, moist absorptive mats or membrane curing.

C. Building foundation walls and retaining walls: In-form curing, fog spraying or membrane curing compound.

D. Non-liquid Retaining Structure Floor Slabs-on-grade: Moist absorptive mats, or membrane curing.

E. All other concrete: In-form curing, moist absorptive mats, fog spraying or membrane curing compound.

END OF SECTION

SECTION 03400
PRECAST CONCRETE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Precast concrete manhole sections, manhole frame, and covers.

B. Precast vaults and boxes.

1.2 RELATED SECTIONS

A. Section 01300 - Submittals.

B. Section 01400 - Quality Control.

C. Section 02223 - Backfilling for Pipelines and Structures.

D. Section 03300 - Cast-in-Place Concrete.

E. Section 15060 - Pipe and Pipe Fittings.

1.3 REFERENCES

A. ASTM International (ASTM):
   1. ASTM C 33 – Standard Specification for Concrete Aggregates
   2. ASTM C 443 – Standard Specification for Joints for Concrete Pipe and Manholes Using Rubber Gaskets
   3. ASTM C 478 – Standard Specification for Precast Reinforced Concrete Manhole Sections
   4. ASTM C 497 – Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile
   5. ASTM C 857 – Standard Practice for Minimum Structural Design Loading for Underground Utility Structures
   6. ASTM C 923 – Standard Specification for Resilient Connectors Between Reinforced Concrete Manholes Structures, Pipes, and Laterals
   7. ASTM C 990 – Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants

B. American Concrete Institute (ACI):
   1. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures and Commentary

1.4 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Submit manufacturer's product data and installation data in compliance with Section 01300.

C. Manufacturer to submit sealed structural calculations and shop drawings for all precast vaults, boxes, roof slabs and manhole sections. Shop drawings are to show sizes, dimensions, and all rebar locations. Calculations are to be sealed by a licensed Professional Engineer in the State of Utah.

PART 2 PRODUCTS

2.1 PRECAST MANHOLE SECTIONS

A. Conform to ASTM C-478 with a minimum wall thickness of four and one-quarter (4-1/4) inches.

2.2 PRECAST VAULTS AND BOXES

A. Conform to ASTM C-858 with a minimum wall thickness of 8 inches.

2.3 MANHOLE GASKETS

A. Conform to ASTM C-443.

2.4 GROUT

A. Conform to Section 03300, Part 2 of these Technical Specifications.

2.5 MANHOLE FRAME AND COVER

A. Twenty-four (24) inch diameter standard traffic rated manhole frame and cover.

2.6 MANHOLE LID

A. Flat top lid with diameter as shown on the plans rated for HL-93 traffic loading.

2.7 PRECAST MANHOLE BASE

A. Precast manhole base with diameter required on the plans sloped to drain (1/4 inch per foot) to the manhole outlet pipe.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify all materials delivered to the site are in compliance with these Specifications.

B. Verify manholes and vaults are ready to receive piping.

3.2 INSTALLATION

A. Install in accordance with the manufacturer's recommendations.

B. Place to the thickness shown on the Plan and compact Type A2 aggregate in compliance with Section 02207 and 02223 under the concrete base prior to installation.

C. Grout pipe entrance and exit openings water tight.

D. Place and install so no damage is inflicted to the structure, pipe, or valves.

E. Install so the walls and ceiling are plumb and true to line and grade.

F. Grout all joints water tight.

G. Cast utility vault hatches into precast portion of vault at vault manufacturer’s plant.

3.3 TESTING

A. All precast concrete manhole sections, boxes and vaults must be tested for water tightness by means of a vacuum test per ASTM C 1244 or ASTM C 1719 as applicable.
   1. Procedure:
      a. Plug Holes: Plug lift holes with non-shrink polymer type grout and pipes with plugs.
      b. Brace Plugs: Brace plugs to prevent them from being drawn into the manhole.
      c. Place Test Head: Inside the top of the structure and inflate seal in accordance with the manufacturer’s recommendations.
      d. Draw a Vacuum: To pressure required per test and shut off and vacuum pump.
      e. Measurement: With the valves closed, measure the time for the vacuum to drop.

B. Testing Schedule:
   1. Preliminary Testing: At the discretion of the Contractor, it is recommended that preliminary testing be done at any time prior to backfill and installation of other utilities for the repair area to be more accurately identified. A final test will still be required.

2. Final Testing: Perform final testing after backfilling and compaction and following installation of other utilities, but prior to surface restoration. If a test fails, the structure shall be repaired and retested at no cost to the Owner.

C. Failing precast concrete must be repaired and retested at no additional cost to the Owner.

END OF SECTION

SECTION 03410
TESTING CONCRETE STRUCTURES FOR WATER TIGHTNESS

PART 1 GENERAL

1.1 SUMMARY

A. Testing requirements for the process water system wet well for watertightness.

1.2 RELATED SECTIONS

A. Division 01300 - Submittals

B. Division 01400 - Quality Control

C. Section 03300 - Cast-In-Place Concrete

D. Section 03346 – Concrete Floor Finishing

1.3 REFERENCES

A. ACI 350R – Environmental Engineering Concrete Structures

B. ACI 350.1 R – Testing Reinforced Concrete Structures for Watertightness

1.4 QUALITY ASSURANCE

A. Testing: Provide watertightness testing for all water-containment structures.

B. Perform a watertightness test as required by Engineer on any additional structure when in the opinion of the Engineer the structure contains sufficient concrete defects that could impair the watertightness of the structure:

1. Testing to conform to requirements of this specification section with allowable leakage and other criteria as established by Engineer.

2. Pay for all labor and material costs resulting from this testing.

1.5 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Submit to Engineer results of watertightness testing indicating the following:

1. Level of water in structure and evaporation pan at commencement and duration of final test period.

2. Level of water in structure and evaporation pan at end of final test period.

3. Tabular results of leakage testing, including water depth change, water and air temperature, precipitation, evaporation, total loss, and loss due to leak.

4. Net leakage in percent of total volume during final test period (gross leakage minus that due to evaporation).

5. Area, methods, and materials of patching to correct leakage.

6. Results of retesting if required due to leakage exceeding allowed values.

C. Testing for watertightness, with accompanying results, to be witnessed by Engineer.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 PREPARATION BEFORE TESTING

A. Testing shall be performed prior to application of waterproofing, if required, prior to placement of exterior backfill soil, and prior to placement of exterior concrete masonry.

B. Notify the Engineer in at least 24 hours prior to the filling of any structure for leakage testing.

C. Testing shall be performed per the Contract Documents and as recommended by ACI 350.1 R.

D. Cleaning: Thoroughly clean interior of structure to be tested of all debris and dirt and hose down surfaces of all walls and slabs.

E. Patching shall be per Section 03300 and as follows:

1. Completely fill tie holes.

2. Fill voids and honeycombed areas with patching grout.

3. Cracks suspected to cause leakage shall be filled with epoxy adhesive.

4. Patching to be performed after concrete defective area is cleaned of all loose material to surface of sound concrete.

5. Finish wall surfaces per the General Concrete Notes and Specifications on the project drawings.

3.2 TESTING FOR LEAKAGE

A. All water-containment structures shall be subjected to leakage tests after the concrete has been cured and obtained its design strength and before backfill or other work that will cover the concrete surfaces of the walls is begun.

B. All water-containment structures shall be filled with water or plant effluent to 1 foot above the maximum liquid level shown on the Drawings prior to leak testing. After these structures have been kept full for 48 hours, it will be assumed for the purposes of the test that the absorption of moisture by the concrete in the basin is complete. The change in water surface shall then be measured for a 24-hour period. 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 later be patched or corrected in a manner acceptable to the Engineer prior to additional leakage testing. If the drop in water surface in the 24-hour period exceeds one gallon per thousand gallons of volume of liquid contained in the water-holding structure, after accounting for evaporation and precipitation in open basins, or if damp spots or any seepage is present on the walls or other areas exposed to view, the leakage shall be considered excessive and the leakage test will be considered to have failed. Evaporation shall be determined by floating an evaporation pan in the structure during the test period.

C. If the leakage is excessive or if damp spots and observed seepage are present on exposed surfaces, the water-containment structure shall be drained, all leaks and damp spots previously marked shall be repaired to the satisfaction of the Engineer. Cracks shall be sealed in accordance with Section 03300 – Cast-in-place Concrete – Defective Concrete. Any leakage or seepage through the joints shall be repaired to the satisfaction of the Engineer. The Contractor's method of repair shall be subject to the review and approval of the Engineer.

D. The water-containment structure 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 a 24-hour period with the basin full is less than one gallon per thousand gallons of the volume of liquid held in the basin and all damp spots and seepage disappear when the structures are 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 walls shall be required to pass the leakage test.

E. 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. Therefore, all other equipment (i.e., stop gates, sluice gates, etc.) or temporary bulkheads should be made watertight prior to the test.

F. All costs for testing the water-containment structures shall be borne by the Contractor. Water required for the testing shall be provided by the Contractor. Dispose of water such that new or existing construction is protected and to avoid interference with plant operation.

END OF SECTION

SECTION 03414
PRECAST POLYMER CONCRETE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Precast polymer concrete manhole sections, manhole frame, and covers.

B. Precast polymer concrete vaults and boxes.

1.2 RELATED SECTIONS

A. Section 01300 - Submittals.

B. Section 01400 - Quality Control.

C. Section 02223 - Backfilling for Pipelines and Structures.

D. Section 03300 - Cast-in-Place Concrete.

E. Section 15060 - Pipe and Pipe Fittings.

1.3 REFERENCES

A. ASTM International (ASTM):
1. ASTM C 33 – Standard Specification for Concrete Aggregates
2. ASTM C 443 – Standard Specification for Joints for Concrete Pipe and Manholes Using Rubber Gaskets
3. ASTM C 478 – Standard Specification for Precast Reinforced Concrete Manhole Sections
4. ASTM C 497 – Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile
5. ASTM C 579 – Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic, Surfacing, and Polymer Concretes
6. ASTM C 580 – Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic, Surfacing, and Polymer Concretes
7. ASTM C 857 – Standard Practice for Minimum Structural Design Loading for Underground Utility Structures
8. ASTM C 913 – Standard Specification for Precast Concrete Water and Wastewater Structures
9. ASTM C 923 – Standard Specification for Resilient Connectors Between Reinforced Concrete Manholes Structures, Pipes, and Laterals
10. ASTM C 990 – Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants
11. ASTM C 1244 – Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill

12. ASTM C 1719 – Standard Test Method for Installed Precast Concrete Tanks and Accessories by the Negative Air Pressure (Vacuum) Test Prior to Backfill
13. ASTM D 648 – Test Method for Deflection Temperature of Plastics Under Flexural Load in Edgewise Position
14. ASTM D 2584 – Test Method for Ignition Loss of Cured Reinforced Resins
15. ASTM D 6783 – Standard Specification for Polymer Concrete Pipe

B. American Concrete Institute (ACI):
1. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures and Commentary
2. ACI 440.1R – Guide for the Design and Construction of Structural Concrete Reinforced with Fiber-Reinforced Polymer (FRP) Bars
3. ACI 548.6R – Polymer Concrete-Structural Applications State-Of-The-Art Report

C. California Greenbook Standard Specifications for Public Works Construction, Section 211-2

1.4 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Submit manufacturer's product data and installation data in compliance with Section 01300.

C. Manufacturer to submit sealed structural calculations, summary of design criteria, shop drawings, and certification that design meets or exceeds the load and strength requirements for the particular application for all precast polymer concrete vaults, boxes, slabs and manhole sections. Shop drawings are to show sizes, dimensions, and all rebar locations. Calculations are to be sealed by a licensed Professional Engineer in the State of the project location.

D. Submit proof of independent chemical resistance testing conducted in accordance with industry standards.

1.5 WARRANTY

A. Provide and submit a 50-year corrosion warranty for all precast polymer concrete structures and fabrications.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Armorock Polymer Concrete

B. Or approved equal.

2.2 POLYMER CONCRETE MIX

A. Mix design for polymer concrete shall consist of thermosetting resin, sand, and aggregate. No Portland cement shall be allowed as part of the mix design matrix. All sand and aggregate shall be inert in an acidic environment.

B. Resin:
   1. The manufacturer shall use only polyester or vinyl ester resin systems designed for use with polymer concrete application. Resin content shall be a minimum of 7% by weight unless substantiating data can be provided from the manufacturer for an alternative mix design to meet the project application.

C. Filler:
   1. All aggregate, sand and quartz powder shall meet the requirements of ASTM C 33, where applicable.

D. Additives:
   1. Resin additives, such as curing agents, pigments, dyes, fillers and thixotropic agents, when used, shall not be detrimental to the precast component.

2.3 REINFORCMENT

A. As required, reinforcement shall be acid resistant reinforcement (FRP bar) in accordance with ACI 440.1R

2.4 POLYMER CONCRETE STRUCTURES

A. Each polymer concrete component shall be free of all defects, including indentations, cracks, foreign inclusions and resin starved areas that, due to their nature and degree or extent, detrimentally affect the strength and serviceability of the component part.

B. Each precast polymer concrete component to be marked with the manufacturer's name or trademark, location, and production date of the product. For components which may be exposed to view, markings shall be placed on the component to not be detrimental to the aesthetics of the structure.

C. Loading:
   1. Precast structures and components shall be designed for loads as indicated on the project Drawings. Where no loading criteria is specified, structures shall be designed for HL-93 traffic loading.
   2. Structures shall be designed to resist buoyancy forces with a safety factor of 1.5 minimum.

D. Precast Manhole Sections
   1. Conform to ASTM C-478 with a minimum wall thickness of four and one-quarter (4-1/4) inches.

E. Precast Manhole Base
   1. Precast manhole base with diameter required on the plans sloped to drain (1/4 inch per foot) to the manhole outlet pipe.

F. Precast Vaults and Boxes
   1. Conform to ASTM C-858 with a minimum wall thickness of 8 inches.

2.5 ACCESSORIES

A. Manhole Gaskets
   1. Conform to ASTM C-443.

B. Manhole Frame and Cover
   1. Twenty-four (24) inch diameter standard traffic rated manhole frame and cover.

C. Manhole Lid
   1. Flat top lid with diameter as shown on the plans rated for HL-93 traffic loading.

2.6 GROUT

A. Provide a polyester mortar compound or approved equal per precast structure manufacturer’s requirements. Conforms to Section 03300, Part 2 of these Technical Specifications as applicable.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify all materials delivered to the site are in compliance with these Specifications.

B. Verify manholes and vaults are ready to receive piping.

3.2 INSTALLATION

A. Install in accordance with the manufacturer's recommendations.

B. Place to the thickness shown on the Plan and compact Type A2 aggregate in compliance with Section 02207 and 02223 under the concrete base prior to installation.

C. Grout pipe entrance and exit openings watertight.

D. Place and install so no damage is inflicted to the structure, pipe, or valves.

E. Install so the walls and ceiling are plumb and true to line and grade.

F. Grout all joints watertight.

G. Cast utility vault hatches into precast portion of vault at vault manufacturer's plant.

3.3 TESTING

A. All precast polymer concrete manhole sections, boxes and vaults must be tested for water tightness by means of a vacuum test per ASTM C 1244 or ASTM C 1719 as applicable.
   1. Procedure:
      a. Plug Holes: Plug lift holes with non-shrink polymer type grout and pipes with plugs.
      b. Brace Plugs: Brace plugs to prevent them from being drawn into the manhole.
      c. Place Test Head: Inside the top of the structure and inflate seal in accordance with the manufacturer's recommendations.
      d. Draw a Vacuum: To pressure required per test and shut off and vacuum pump.
      e. Measurement: With the valves closed, measure the time for the vacuum to drop.

B. Testing Schedule:
   1. Preliminary Testing: At the discretion of the Contractor, it is recommended that preliminary testing be done at any time prior to backfill and installation of other utilities for the repair area to be more accurately identified. A final test will still be required.
   2. Final Testing: Perform final testing after backfilling and compaction and following installation of other utilities, but prior to surface restoration. If a test fails, the structure shall be repaired and retested at no cost to the Owner.

C. Failing precast polymer concrete must be repaired and retested at no additional cost to the Owner.

END OF SECTION

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SECTION 04220 - CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete masonry units (CMU's).
2. Decorative concrete masonry units.
3. Steel reinforcing bars.

1.2 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Owner will engage a qualified independent testing agency to perform preconstruction testing indicated below. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

1. Concrete Masonry Unit Test: For each type of unit required, according to ASTM C 140 for compressive strength.
2. Mortar Test (Property Specification): For each mix required, according to ASTM C 780 for compressive strength.
3. Grout Test (Compressive Strength): For each mix required, according to ASTM C 1019.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
B. Shop Drawings: For reinforcing steel. Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement. Show elevations of reinforced walls.
C. Samples: For each type and color of exposed masonry unit and colored mortar.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each type and size of product indicated. For masonry units include material test reports substantiating compliance with requirements.
B. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

1.5 QUALITY ASSURANCE

A. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.
B. Sample Panels: Build sample panels to verify selections made under sample submittals and to demonstrate aesthetic effects. Comply with requirements in Section 014000 "Quality Requirements" for mockups.

1. Build sample panels for typical exterior wall in sizes approximately 60 inches long by 48 inches high by full thickness.

1.6 PROJECT CONDITIONS

A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
B. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

B. Fire-Resistance Ratings: Where indicated, provide units that comply with requirements for fire-resistance ratings indicated as determined by testing according to ASTM E 119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

2.2 CONCRETE MASONRY UNITS

A. Regional Materials: CMUs shall be manufactured within 500 miles of Project site from aggregates and cement that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

B. Shapes: Provide shapes indicated and for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.

C. Integral Water Repellent: Provide units made with liquid polymeric, integral water repellent admixture that does not reduce flexural bond strength for exposed units.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. ACM Chemistries, Inc.; RainBloc.
    b. BASF Aktiengesellschaft; Rheopel Plus.
    c. Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block.

D. CMUs: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength as indicated per the General Structural Notes.
2. Density Classification: Lightweight or medium weight.

E. Decorative CMUs: ASTM C 90.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Amcor (An Old castle Company)
    b. Lehi Block.

2. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2000 psi.
3. Density Classification: Normal weight.
4. Pattern and Texture: As indicated on Drawings. See Legend on Building Exterior Elevation Sheets.

    a. Standard pattern, ground-face finish.
    b. Standard pattern, split-face finish.
    c. Standard pattern, split-ribbed finish.
    d. Scored vertically, standard finish.

2.3 MORTAR AND GROUT MATERIALS

A. Regional Materials: Aggregate for mortar and grout shall be extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

B. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

C. Hydrated Lime: ASTM C 207, Type S.

D. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

E. Masonry Cement: ASTM C 91.

F. Mortar Cement: ASTM C 1329.

G. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979. Use only pigments with a record of satisfactory performance in masonry mortar.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Davis Colors; True Tone Mortar Colors.
    b. Lanxess Corporation; Bayferrox Iron Oxide Pigments.
    c. Solomon Colors, Inc.; SGS Mortar Colors.

H. Aggregate for Mortar: ASTM C 144.

1. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
2. White-Mortar Aggregates: Natural white sand or crushed white stone.
3. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

I. Aggregate for Grout: ASTM C 404.

J. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Euclid Chemical Company (The); Accelguard 80.
    b. Grace Construction Products, W. R. Grace & Co. - Conn.; Morset.
    c. Sonneborn Products, BASF Aktiengesellschaft; Trimix-NCA.

K. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs, containing integral water repellent by same manufacturer.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. ACM Chemistries, Inc.; RainBloc for Mortar.
    b. BASF Aktiengesellschaft; Rheopel Mortar Admixture.
    c. Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block Mortar Admixture.

L. Water: Potable.

2.4 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.

B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.

1. Interior Walls: carbon steel.
2. Exterior Walls: Hot-dip galvanized steel.
3. Wire Size for Side Rods: 0.148-inch diameter.
4. Wire Size for Cross Rods: 0.148-inch diameter.
5. Wire Size for Veneer Ties: 0.148-inch diameter.
6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
7. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.

2.5 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.

1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 153/A 153M, Class B-2 coating.
2. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.
3. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

2.6 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing complying with Section 076200 "Sheet Metal Flashing and Trim and as follows:

1. Metal Drip Edge: Fabricate from stainless steel. Extend at least 3 inches into wall and 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.
2. Metal Sealant Stop: Fabricate from stainless steel. Extend at least 3 inches into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch and down into joint 1/4 inch to form a stop for retaining sealant backer rod.

B. Flexible Flashing: Use the following unless otherwise indicated:

1. Copper-Laminated Flashing: 7-oz./sq. ft. copper sheet bonded between 2 layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) Advanced Building Products Inc.; Copper Fabric Flashing.
        2) Dayton Superior Corporation, Dur-O-Wal Division; Copper Fabric Thru-Wall Flashing.
        3) Hohmann & Barnard, Inc.; H & B C-Fab Flashing.
        4) Phoenix Building Products; Type FCC-Fabric Covered Copper.
        5) Sandell Manufacturing Co., Inc.; Copper Fabric Flashing.
        6) York Manufacturing, Inc.; Multi-Flash 500.

2. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.040 inch.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) Advanced Building Products Inc.; Peel-N-Seal.

2) Carlisle Coatings & Waterproofing; CCW-705-TWF Thru-Wall Flashing.
3) Dayton Superior Corporation, Dur-O-Wal Division; Dur-O-Barrier Thru-Wall Flashing.
4) Fiberweb, Clark Hammerbeam Corp.; Aquaflash 500.
5) Grace Construction Products, W. R. Grace & Co. - Conn.; Perm-A-Barrier Wall Flashing.
6) Heckmann Building Products Inc.; No. 82 Rubberized-Asphalt Thru-Wall Flashing.
7) Hohmann & Barnard, Inc.; Textroflash.
8) W. R. Meadows, Inc.; Air-Shield Thru-Wall Flashing.
9) Polyguard Products, Inc.; Polyguard 400.
10) Sandell Manufacturing Co., Inc.; Sando-Seal.
11) Williams Products, Inc.; Everlastic MF-40.

C. Single-Wythe CMU Flashing System: System of CMU cell flashing pans and interlocking CMU web covers made from high-density polyethylene incorporating chemical stabilizers that prevent UV degradation. Cell flashing pans have integral weep spouts that are designed to be built into mortar bed joints and weep collected moisture to the exterior of CMU walls and that extend into the cell to prevent clogging with mortar.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Mortar Net USA, Ltd.; Blok-Flash.

D. Solder and Sealants for Sheet Metal Flashings: As specified in Section 076200 "Sheet Metal Flashing and Trim."

E. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.7 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270. Provide the following types of mortar for applications stated unless another type is indicated.
   1. For reinforced masonry, use Type S.

D. Pigmented Mortar: Use colored cement product.

   1. Pigments shall not exceed 10 percent of portland cement by weight.
   2. Pigments shall not exceed 5 percent of masonry cement by weight.
   3. Application: Use pigmented mortar for exposed mortar joints with the following units:

      a. Decorative CMUs.
      b. Pre-faced CMUs.

E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.

   1. Application: Use colored aggregate mortar for exposed mortar joints with the following units:

      a. Decorative CMUs.
      b. Pre-faced CMUs.

F. Grout for Unit Masonry: Comply with ASTM C 476.

   1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
   2. Proportion grout in accordance with ASTM C 476, for specified 28-day compressive strength indicated.
   3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

PART 3 - EXECUTION

3.1 TOLERANCES

A. Dimensions and Locations of Elements:

   1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch or minus 1/4 inch.

2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch.
3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
3. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.

3.2 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

C. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

D. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

E. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
F. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.
G. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

3.3 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.4 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

1. Space reinforcement not more than 16 inches o.c.
2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.

3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.
D. Provide continuity at corners by using prefabricated L-shaped units.

3.5 FLASHING

A. General: Install embedded flashing in masonry at lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.
B. Install flashing as follows unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
2. At lintels, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
3. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal drip edge.
4. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal flashing termination.

C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

3.6 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 48 inches.

3.7 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to meet specified requirements shall be done at Contractor's expense.

B. Inspections: Level 2 special inspections according to the "International Building Code."

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Prior to Construction: One set of tests.

D. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.

E. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.

F. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.

G. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for mortar air content.

H. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.

3.8 REPAIRING, POINTING, AND CLEANING

A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes.
2. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.9 MASONRY WASTE DISPOSAL

A. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Do not dispose of masonry waste as fill within 18 inches of finished grade.

B. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 04220

SECTION 05120
STRUCTURAL STEEL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Structural shapes

B. Channels and angles

C. Hollow structural sections

D. Structural pipe

E. Structural plates and bars

F. Floor plates

G. Fasteners, connectors, and anchors

H. Grout

1.2 RELATED SECTIONS

A. Division 1

B. Division 3

C. Division 4

D. Division 5

E. Division 9

1.3 REFERENCES

A. American Institute of Steel Construction

1. AISC Code of Standard Practice for Steel Buildings and Bridges
2. AISC Seismic Provisions for Structural Steel Buildings
3. AISC Specification for Allowable Stress Design of Single-Angle Members
4. AISC Specification for the Design of Steel Hollow Structural Sections
5. AISC Specification for Structural Steel Buildings Allowable Stress Design, and Plastic Design

B. ASTM International:

1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel
2. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
3. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
4. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
5. ASTM A193/A193M - Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
6. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
7. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
8. ASTM A354 - Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners
9. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
10. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
11. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts
12. ASTM A786/A786M - Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates
13. ASTM A992/A992M - Standard Specification for Structural Steel Shapes
14. ASTM B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
15. ASTM E94 - Standard Guide for Radiographic Examination
16. ASTM E164 - Standard Practice for Ultrasonic Contact Examination of Weldments
17. ASTM E165 - Standard Test Method for Liquid Penetrant Examination
18. ASTM E709 - Standard Guide for Magnetic Particle Examination
19. ASTM F436 - Standard Specification for Hardened Steel Washers
20. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

C. American Welding Society:

1. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination
2. AWS D1.1 - Structural Welding Code - Steel

D. Research Council on Structural Connections:

1. RCSC - Specification for Structural Joints Using ASTM A325 or A490 Bolts

E. SSPC: The Society for Protective Coatings:

1. SSPC - Steel Structures Painting Manual
2. SSPC Paint 15 - Steel Joist Shop Paint
3. SSPC Paint 20 - Zinc-Rich Primers (Type I - Inorganic and Type II - Organic)
4. SSPC SP 3 - Power Tool Cleaning
5. SSPC SP 6 - Commercial Blast Cleaning
6. SSPC SP 10 - Near-White Blast Cleaning

1.4 SUBMITTALS

A. Submit under provision of Section 01300.

B. Shop Drawings:

1. Indicate profiles, sizes, spacing, location of structural members, openings, attachments, and fasteners.
2. Connections.
3. Cambers.
4. Indicate welded connections with AWS A2.4 welding symbols. Indicate net weld lengths.

C. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with the following:

1. AISC Code of Standard Practice for Steel Buildings and Bridges.

1.6 QUALIFICATIONS

A. Fabricator: Company specializing in performing Work of this section with minimum five years experience.

B. Erector: Company specializing in performing Work of this section with minimum five years experience.

C. Shop Painter: Company specializing in performing Work of this section with minimum five years experience.

D. Welders and Welding Procedures: AWS D.1 qualified within previous 12 months.

1.7 COORDINATION

A. Coordinate work with all effected trades.

PART 2 PRODUCTS

2.1 STRUCTURAL STEEL

A. Structural W-Shapes: ASTM A992; Grade 50

B. Structural T-Shapes: Cut from structural W-shapes

C. Channels and Angles: ASTM A36

D. Square and Rectangular Hollow Structural Sections: ASTM A500, Grade B

E. Structural Pipe: ASTM A53/A53M, Grade B

F. Structural Plates and Bars: ASTM A36

G. Floor Plates: ASTM A786/A786M; raised pattern

2.2 FASTENERS, CONNECTORS, AND ANCHORS

A. High Strength Bolts: ASTM A325; Type 1

1. Finish: Unfinished

B. Nuts: ASTM A563 heavy hex type, Grade DH

1. Finish: Unfinished

C. Washers: ASTM F436; Type 1, circular. Furnish clipped washers where space limitations require

1. Finish: Unfinished

D. Anchor Rods: (Bolts set into concrete) ASTM F1554; Grade 55

1. Shape: Straight-Headed

2. Nuts for anchor rods to be ASTM A563, Grade A, Heavy Hex.

2.3 WELDING MATERIALS

A. Welding Materials: AWS D1.1; type required for materials being welded

2.4 ACCESSORIES

A. Grout for Steel Bearing Plates: Non-shrink type, pre-mixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing additives, capable of developing minimum compressive strength of 7,000 psi.

B. Shop and Touch-Up Primer and Paint: Per Division 9.

2.5 FABRICATION

A. Continuously seal joined members by continuous welds. Grind exposed welds smooth.

B. Fabricate connections for bolt, nut, and washer connectors.

C. Develop required camber for members.

2.6 FINISH

A. Prepare structural component surfaces in accordance with SSPC SP 3.

B. Painting and Coatings: Per Division 9. Do not prime surfaces that will be field welded, in contact with concrete, or high strength bolted.

2.7 SOURCE QUALITY CONTROL AND TESTS

A. Section 01400 - Quality Control: Construction observation and testing laboratory service.

B. Shop test bolted and welded connections as specified for field quality control tests.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify bearing surfaces are at correct elevation.

B. Verify anchors rods are set in correct locations and arrangements with correct exposure for steel attachment.

3.2 PREPARATION

A. Furnish templates for installation of anchor rods and embedments in concrete and masonry work.

3.3 ERECTION

A. Allow for erection loads, and for sufficient temporary bracing to maintain structure safe, plumb, and in alignment until completion of erection and installation of permanent bracing.

B. Field weld components indicated on shop drawings.

C. Field connect members with threaded fasteners; torque to required resistance.

D. Do not field cut or alter structural members without approval of Engineer.

E. After erection, touch up welds and abrasions to match shop finishes.

3.4 GROUT INSTALLATION

A. Grout under base plates in accordance with Section 03300.

B. Remove forms after grout is set. Trim grout edges to from smooth surface, splayed 45 degrees.

C. Tighten anchor bolts after grout has cured for a minimum of 3 days.

3.5 ERECTION TOLERANCES

A. Section 01400 - Quality Requirements: Tolerances.

B. Maximum Variation from Plumb: ¼ inch per story, non-cumulative.

C. Maximum Offset from Alignment: ¼ inch.

3.6 FIELD QUALITY CONTROL

A. Section 01400 - Quality Requirements.

B. Bolted Connections: Inspect in accordance with AISC specifications.

1. Visually inspect all bolted connections.

C. Welding:

1. Certify welders and conduct inspections and tests as required. Record types and locations of defects found in work. Record work required and performed to correct deficiencies.

2. Visually inspect all welds.

D. Correct defective bolted connections and welds.

END OF SECTION

SECTION 05210
STEEL JOIST FRAMING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Open web steel joists, with bridging, attached seats and anchors.
2. Loose bearing plates and anchor bolts for site placement.
3. Framed roof openings greater than 18 inches.

B. Related Requirements:

1. Section 05120 - Structural Steel Framing.
2. Section 05310 - Steel Floor Decking.
3. Section 05320 - Steel Roof Decking.

1.2 REFERENCE STANDARDS

A. American Institute of Steel Construction:

1. AISC 341 - Seismic Provisions for Structural Steel Buildings.

B. ASTM International:

1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
2. ASTM A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
3. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
4. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
5. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
6. ASTM A354 - Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners.
7. ASTM A449 - Standard Specification for Quenched and Tempered Steel Bolts and Studs.
8. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts.
9. ASTM B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.

10. ASTM F436 - Standard Specification for Hardened Steel Washers.
11. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
12. ASTM F2329 - Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.

C. American Welding Society:

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

D. Steel Joist Institute:

1. SJI K-1.1 - Standard Specifications for Open Web Steel Joists, K-series.
2. SJI LH/DLH-1.1 - Standard Specifications for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series.

E. SSPC: The Society for Protective Coatings:

1. SSPC - Steel Structures Painting Manual.
2. SSPC SP 1 - Solvent Cleaning.
3. SSPC SP 10 - Near-White Blast Cleaning.

1.3 SUBMITTALS

A. Section 01300 - Submittal Procedures: Submittal requirements.

B. Shop Drawings:

1. Indicate standard designations, configuration, sizes, spacing, locations of joists, joist leg extensions.
2. Joist coding, bridging, connections, attachments, and cambers.
3. Connection details.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

D. Welders' Certificates: Submit manufacturer's certificates, certifying welders employed on the Work, verifying AWS qualification within previous 12 months.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with the following:

1. SJI K-1.1, SJI LH/DLH-1.1, and SJI JG-1.1, including headers and other supplementary framing.

2. AISC 341 Seismic Provisions for Structural Steel Buildings.

1.5 QUALIFICATIONS

A. Fabricator: Company specializing in performing Work of this section with minimum five years of documented experience.

B. Erector: Company specializing in performing Work of this section with minimum five years of documented experience.

C. Design connections not detailed on drawings under direct supervision of Professional Engineer experienced in design of this Work and licensed in the State of Utah.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01600 - Product Requirements: Product storage and handling requirements.

PART 2 PRODUCTS

2.1 MATERIALS

A. Open Web Joists Members: SJI Type K or LH Longspan or DLH Deep Longspan as indicated on the Drawings.

B. Bolts: ASTM A325; Type 1, plain, or Type 3, plain; heavy hex, structural type.

C. Nuts: ASTM A563 heavy hex type.

1. Finish: Unfinished.

D. Washers: ASTM F436; Type 1, circular or beveled as required. Furnish clipped washers where space limitations require.

1. Finish: Unfinished.

E. Structural Steel For Supplementary Framing and Joist Leg Extensions: ASTM A36.

F. Welding Materials: AWS D1.1; type required for materials being welded.

G. Paint and Coatings:

1. Shop Primer: SSPC Paint 15, Type 1, red oxide.

2. Touch-Up Primer: Match shop primer.

3. Final coating system including prep, removal of existing primer systems, re-prime, stripe and finish coats shall be fully coordinated and applied per Section 09900.

2.2 FABRICATION

A. Furnish bottom and top chord extensions as indicated on Drawings.

B. Fabricate to achieve end bearing as indicated on the Drawings.

2.3 FINISHES

A. Prepare joist component surfaces in accordance with SSPC SP 2.

B. Shop prime joists and supplementary framing members. Do not prime surfaces that will be fireproofed, field welded, or in contact with concrete.

2.4 SOURCE QUALITY CONTROL

A. Section 01400 - Quality Requirements: Testing, inspection and analysis requirements.

B. Furnish shop testing and analysis of steel sections.

C. When fabricator is approved by authority having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.

1. Specified shop tests are not required for Work performed by approved fabricator.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01700 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify bearing plates are set to required location and elevation.

C. Verify bearing surfaces are ready to receive joists.

3.2 ERECTION

A. Erect and bear joists on supports.

B. Allow for erection loads. Install sufficient temporary bracing to maintain framing safe, plumb, and in alignment.

C. Coordinate placement of anchors in concrete construction for securing bearing plates or angles.

D. After joist alignment and installation of framing, field weld joist seat to bearing plates or angles.

E. Position and field weld joist chord extensions and wall attachments as detailed.

F. Frame floor and roof openings greater than 18 inches with supplementary framing.

G. Do not permit erection of decking until joists are braced, bridged, and secured or until completion of erection and installation of permanent bridging and bracing.

H. Do not field cut or alter structural members without approval of Engineer.

I. After erection, prime welds, abrasions, and surfaces not shop primed except surfaces to be in contact with concrete.

3.3 TOLERANCES

A. Section 01400 - Quality Requirements: Tolerances.

B. Maximum Variation From Plumb: ¼ inch.

C. Maximum Offset From Alignment: ¼ inch.

3.4 FIELD QUALITY CONTROL

A. Section 01400 - Quality Requirements: Requirements for inspecting, testing.

B. Section 01700 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Field inspect members, connections, welds, and tightening of high strength bolts in slip-critical connections.

END OF SECTION

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SECTION 05320
STEEL ROOF DECKING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel roof deck and accessories.
2. Framing for openings up to and including 18 inches.

B. Related Sections:

1. Section 05120 - Structural Steel Framing.
2. Section 05210 - Steel Joist Framing: Support framing for deck openings.
3. Section 09900- High Performance Coatings *(including preparation of decking for paint and coatings)*

1.2 REFERENCES

A. American Society of Civil Engineers:

1. ASCE 3 - Standard Practice for the Construction and Inspection of Composite Slabs.

B. ASTM International:

1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
2. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
3. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Baked Hardenable.

C. American Welding Society:

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

D. Steel Deck Institute:

1. SDI 29 - Design Manual for Composite Decks, Form Decks and Roof Decks.

E. SSPC: The Society for Protective Coatings:

1. SSPC Paint 15 - Steel Joist Shop Paint.

1.3 SUBMITTALS

A. Section 01300 - Submittal Procedures: Submittal requirements.

B. Shop Drawings: Indicate deck plan, support locations, Projections, openings and reinforcement, pertinent details, and accessories.

C. Product Data: Submit deck profile characteristics and dimensions, structural properties and finishes.

D. Manufacturer’s Installation Instructions: Submit manufacturer's installation instructions.

E. Manufacturer’s Certificates: Certify Products meet or exceed specified requirements.

F. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with ASCE 3 for composite decks.

1.5 QUALIFICATIONS

A. Installer: Company specializing in performing Work of this section with minimum five years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01600 - Product Requirements: Product storage and handling requirements.

B. Cut plastic wrap to encourage ventilation.

C. Store deck on dry wood sleepers; slope for positive drainage.

PART 2 PRODUCTS

2.1 MATERIALS

A. Sheet Steel: ASTM A653, Grade 33 Structural Quality; with G60 galvanized coating.

B. Bearing Plates or Angles: ASTM A36.

C. Welding Materials: AWS D1.1.

D. Touch-Up Primer for Galvanized Surfaces: SSPC Paint 20 Type I Inorganic.

2.2 ACCESSORIES

A. Flute Closures: Closed cell foam rubber 1 inch thick; profiled to fit tight to deck.

B. Sump Pans and plates: Fabricated of metal of same type and finish as deck.

2.3 FABRICATION

A. Metal Deck: Sheet steel, configured as follows:

1. Span Design: multiple.
2. Minimum Metal Thickness Excluding Finish: 20 gage. G-90 Galvanized Coating
3. Minimum Section Properties (per foot width): S=0.216 in^3, I=0.248 in^4.
4. Nominal Height: 1-1/2 inch fluted profile WR.
5. Formed Sheet Width: 24 inch minimum.
6. Side Joints: lapped.
7. Flute Sides: plain vertical face.

B. Related Deck Accessories: Metal closure strips, cover plates, cant strips, 22 gage thick galvanized sheet steel; of profile and size as indicated on drawings.

C. Roof Sump Pan or Plate: Fabricate of 14 gage sheet steel, flat bottom, sloped sides, recessed 1-1/2 inches below roof deck surface, bearing flange 3 inches wide, sealed watertight.

D. Fasteners: Galvanized hardened steel, self tapping.

E. Weld Washers: Mild steel, uncoated, 3/4 inch outside diameter, 1/8 inch thick.

PART 3 EXECUTION

3.1 INSTALLATION

A. Erect metal deck in accordance with SDI Manual.

B. Bear deck on steel supports with 1-1/2 minimum bearing. Align and level.

C. Fasten roof deck to steel support members at ends and intermediate supports as noted on the Drawings.

D. Weld in accordance with AWS D1.1.

E. Mechanically clinch or fasten male/female side laps as specified on the Drawings.

F. Seal deck joints, laps, ends, and penetrations with sealant to achieve permanent air seal consistent with air barrier system specified in Section 07270.

G. Reinforce steel deck openings from 6 to 18 inches in size with 2 x 2 x 1/4 inch steel angles. Place framing angles perpendicular to flutes; extend minimum two flutes beyond each side of opening and fusion weld or mechanically attach to deck at each flute.

H. Install 6 inch minimum wide sheet steel cover plates, of same thickness as deck, where deck changes direction. Fusion weld or Mechanically attach 12 inches oc maximum.

I. Install single row of foam flute closures above walls and partitions perpendicular to deck flutes.

J. Position roof sump pans with flange bearing on top surface of deck. Fusion weld at each deck flute.

K. Immediately after welding deck and other metal components in position, coat welds, burned areas, and damaged surface coating, with touch-up prime paint.

3.2 FIELD QUALITY CONTROL

A. Welding: Inspect welds in accordance with AWS D1.1.

END OF SECTION

SECTION 05500
METAL FABRICATIONS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes shop fabricated metal items.

1. Bollards
2. Ladders
3. Miscellaneous piping and duct support frames.
4. Structural supports for miscellaneous attachments.
5. Entry Canopies
6. Window Shades
7. Roof Access Ladders
8. Exterior Fire Extinguisher Support *(at Bulk Chemical Storage)*
9. Miscellaneous metal items and fabrications not otherwise covered in the plans or specifications.
10. Anchors for Equipment.
11. Garage door shelf angle and anchors.

B. Related Sections:

1. Division 1
2. Division 3
3. Division 4
4. Division 5
5. Division 9

1.2 REFERENCES

A. Aluminum Association:

1. AA DAF-45 - Designation System for Aluminum Finishes

B. American Architectural Manufacturers Association:

1. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum

C. ASTM International:

1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel

2. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

3. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

4. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

5. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

6. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.

7. ASTM A297/A297M - Standard Specification for Steel Castings, Iron-Chromium and Iron-Chromium-Nickel, Heat Resistant, for General Application

8. ASTM A283/283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates

9. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength

10. ASTM A312/A312M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes

11. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

12. ASTM A354 - Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners

13. ASTM A479/A479M - Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels

14. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

15. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing

16. ASTM A554 - Standard Specification for Welded Stainless Steel Mechanical Tubing

17. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts

18. ASTM A572/A572M - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

19. ASTM A992/A992M - Standard Specification for Structural Steel Shapes

20. ASTM B26/B26M - Standard Specification for Aluminum-Alloy Sand Castings

21. ASTM B85 - Standard Specification for Aluminum-Alloy Die Castings

22. ASTM B177 - Standard Guide for Chromium Electroplating on Steel for Engineering Use

23. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

24. ASTM B210 - Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes

25. ASTM B211 - Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire

26. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

27. ASTM B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel

28. ASTM F436 - Standard Specification for Hardened Steel Washers

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

D. American Welding Society:

1. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination

2. AWS D1.1 - Structural Welding Code - Steel

3. AWS D1.6 - Structural Welding Code - Stainless Steel

E. National Ornamental & Miscellaneous Metals Association:

1. NOMMA Guideline 1 - Joint Finishes

F. SSPC: The Society for Protective Coatings:

1. SSPC - Steel Structures Painting Manual

2. SSPC SP 1 - Solvent Cleaning

3. SSPC SP 10 - Near-White Blast Cleaning

4. SSPC Paint 15 - Steel Joist Shop Paint

5. SSPC Paint 20 - Zinc-Rich Primers (Type I - Inorganic and Type II - Organic)

1.3 SUBMITTALS

A. Section 01300 - Submittal Procedures: Submittal requirements.

B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable. Indicate welded connections using standard AWS A2.0 welding symbols. Indicate net weld lengths.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Division 1: Product storage and handling requirements.

B. Accept metal fabrications on site in labeled shipments. Inspect for damage.

C. Protect metal fabrications from damage by exposure to weather.

1.5 FIELD MEASUREMENTS

A. Verify field measurements are as indicated on drawings.

PART 2 PRODUCTS

2.1 MATERIALS - STEEL

A. Steel Sections: ASTM A992; Grade 50.

B. Steel Angle: ASTM A36

C. Steel Plate: ASTM A36.

D. Hollow Structural Sections: ASTM A500, Grade B.

E. Steel Pipe: ASTM A53, Grade B Schedule 40.

F. Sheet Steel: ASTM A653, Grade 33 Structural Quality with galvanized coating.

G. Bolts: ASTM A307; Grade A or B.

1. Finish: Hot dipped galvanized.

H. Nuts: ASTM A563 heavy hex type.

1. Finish: Hot dipped galvanized.

I. Washers: ASTM F436; Type 1.

1. Finish: Hot dipped galvanized.

J. Welding Materials: AWS D1.1; type required for materials being welded.

K. Shop and Touch-Up Primer: SSPC Paint 15, Type 1, red oxide.

L. Touch-Up Primer for Galvanized Surfaces: SSPC Paint 20 Type I Inorganic zinc rich.

2.2 MATERIALS - STAINLESS STEEL

A. Bars and Shapes: ASTM A276; Type 316.

B. Tubing: ASTM A269, seamless; Type 316.

C. Pipe: ASTM A312, seamless; Type 316.

D. Plate, Sheet and Strip: ASTM A480; Type 316.

E. Bolts, Nuts, and Washers: ASTM A354.

F. Welding Materials: AWS D1.6; type required for materials being welded.

2.3 MATERIALS - ALUMINUM

A. Extruded Aluminum: ASTM B221, Alloy 6063, Temper T5.

B. Sheet Aluminum: ASTM B209, Alloy 6063, Temper T5.

C. Aluminum-Alloy Drawn Seamless Tubes: ASTM B210, Alloy 6063, Temper T6.

D. Aluminum-Alloy Bars: ASTM B211, Alloy 6063, Temper T6.

E. Bolts, Nuts, and Washers: Stainless steel.

F. Welding Materials: AWS D1.1; type required for materials being welded.

2.4 MATERIALS – BLIND SIDE FASTENERS

A. Where bolted connections are indicated to be made to HSS shapes or other places where access is unavailable to the back side of the fastener provide Type HB - Hollo-Bolt by Lindapter or approved equal.

B. Bolt size shall be as indicated on the plans for the thickness of materials to be joined as indicated. Install bolts per the manufacturer's specifications. Provide stainless steel fasteners for all exterior applications and where indicated.

2.5 COORDINATION:

A. BOLLARDS

1. Bollards: Steel pipe, concrete filled, crowned cap, 6-inches diameter, length as indicated on Drawings; prime paint plus one coat of high-visibility paint. Color by Owner. Coordinate with typical bollard detail 02160 (CD-04).

2. Concrete Fill: Mix number M2500-GFM per General Concrete Notes on the project drawings and as referenced/specified in Section 03300.

3. Anchors: Concealed type as indicated on Drawings.

B. LADDERS

1. Fixed Ladders shall be in conformance with American National Standards Institute (ANSI) Standard A14.3 – Safety Requirements for Fixed Ladders; and

Occupational Safety and Health Administration (OSHA) Regulation 1910.27 – Standards for Fixed Ladders.

2. Fixed Ladder: Stainless Steel or Aluminum, welded construction:

3. Side Rails: 3/8" x 2" minimum side rails spaced at 16-inches clear, minimum.

4. Rungs: Minimum one-inch diameter solid rod with gritted surface or manufactured rungs with safety gripping surface, uniformly spaced 12-inches on center.

5. Mounting: Space rungs a minimum of 7-inches clear from wall surfaces; with mounting brackets and attachments.

6. Finish: Stainless Steel, Abrasive Blast finish. Aluminum, Clear anodized finish.

7. Ladder Walk-through Extensions: Where indicated on the plans or required by Safety Codes provide walk-through ladder rail extensions in conformance with ANSI and OSHA regulations. Same material and finish as ladder.

C. Miscellaneous piping and duct support frames.

1. Provide where indicated on the drawings or required to provide safe/stable support to piping and ducting for both gravity, dynamic and seismic loads.

2. Steel per Article 2.1 of this Specification.

3. Hot-dip galvanized where noted on the Drawings.

4. Three coat paint system per Section 09900 – High Performance Coatings, where not otherwise indicated on the Drawings.

D. Garage door shelf angle.

1. All stainless steel construction.

2.6 FABRICATION

A. Fit and shop assemble items in largest practical sections, for delivery to site.

B. Fabricate items with joints tightly fitted and secured.

C. Continuously seal joined members by continuous welds.

D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

E. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.

F. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.7 FACTORY APPLIED FINISHES - STEEL

A. Galvanizing: ASTM A123/A123M; minimum 2.0 oz/sq ft coating thickness; galvanize after fabrication.

B. Galvanizing for Fasteners, Connectors, and Anchors:
1. Hot-Dipped Galvanizing: ASTM A153/A153M.

C. Painted: Provide three coat paint system per Section 09900 – High Performance Coatings, where finish is not otherwise indicated on the Drawings.

2.8 FACTORY APPLIED FINISHES - STAINLESS STEEL

A. Satin Polished Finish: Number 4, satin directional polish parallel with long dimension of finished face.

2.9 FACTORY APPLIED FINISHES - ALUMINUM

A. Finish coatings to conform to AAMA 2603. Comply with AA DAF-45.

B. Exterior Aluminum Surfaces: AAMA A41 anodized, prepared with chemical pre-treatment, anodized to clear color.

2.10 FABRICATION TOLERANCES

A. Squareness: 1/8-inch maximum difference in diagonal measurements.

B. Maximum Offset Between Faces: 1/16-inch.

C. Maximum Misalignment of Adjacent Members: 1/16-inch.

D. Maximum Bow: 1/8-inch 48-inches.

E. Maximum Deviation from Plane: 1/16-inch in 48-inches.

PART 3 EXECUTION

3.1 EXAMINATION

A. Division 1: Coordination and project conditions.

B. Verify field conditions are acceptable and are ready to receive Work.

3.2 PREPARATION

A. Clean and strip galvanized steel items to bare metal where site welding is required. After welding coat affected surfaces with a cold galvanizing compound.

B. Supply steel items required to be cast into concrete or embedded in masonry with setting templates to appropriate sections.

3.3 INSTALLATION

A. Install items plumb and level, accurately fitted, free from distortion or defects.

B. Make provisions for erection stresses. Install temporary bracing to maintain alignment, until permanent bracing and attachments are installed.

C. Field weld components only as indicated on Drawings.

D. Perform field welding in accordance with AWS D1.1, D1.2 or D1.6 as required.

E. Obtain approval of Engineer prior to site cutting or making adjustments not scheduled.

F. After erection, touch up welds, abrasions, and damaged finishes with galvanizing repair paint to match shop finishes.

3.4 ERECTION TOLERANCES

A. Section 01400 - Quality Requirements: Tolerances.

B. Maximum Variation from Plumb: ¼-inch per story or for every 12 ft in height whichever is greater, non-cumulative.

C. Maximum Offset from Alignment: ¼-inch.

D. Maximum Out-of-Position: ¼-inch.

END OF SECTION

SECTION 05510
METAL STAIRS AND LADDERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Aluminum stair frame of structural sections, with open risers; open grate stair treads and landings.

2. Aluminum ladders.

B. Related Sections:

1. Section 03300 - Cast-In-Place Concrete
2. Section 05500 - Metal Fabrications
3. Section 05525 – Handrails & Railings
4. Section 05530 – Metal Gratings
5. Section 09900 – High-Performance and Coating

1.2 REFERENCES

A. Aluminum Association:

1. AA DAF-45 – Designation System for Aluminum Finishes

B. American Architectural Manufacturers Association:

1. AAMA 611 – Voluntary Specification for Anodized Architectural Aluminum.

C. American National Standards Institute:

1. ANSI A117.1 – Accessible and Usable Buildings and Facilities

D. ASTM International:

1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel
2. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
3. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
4. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

5. ASTM A283/283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates

6. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength

7. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

8. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

9. ASTM A501. - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing

10. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts

11. ASTM A572/A572M - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

12. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

13. ASTM B221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

14. ASTM B241/B241M – Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube.

15. ASTM B483/B483M – Standard Specification for Aluminum and Aluminum-Alloy Drawn Tubes for General Purpose Applications.

16. ASTM E935 – Standard Test Methods for Performance of Permanent Metal Railings Systems and Rails for Buildings.

17. ASTM B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel

18. ASTM F436 - Standard Specification for Hardened Steel Washers

19. ASTM E935 - Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings

20. ASTM E985 - Standard Specification for Permanent Metal Railing Systems and Rails for Buildings

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

E. American Welding Society:

1. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination

2. AWS D1.1 - Structural Welding Code – Steel

3. AWS D1.2 – Structural Welding Code – Aluminum

4. AWS D1.6 – Structural Welding Code – Stainless Steel

F. National Association of Architectural Metal Manufacturers:

1. NAAMM AMP 510 - Metal Stairs Manual
2. NAAMM MBG 531 - Metal Bar Grating Manual

G. National Ornamental & Miscellaneous Metals Association:

1. NOMMA Guideline 1 - Joint Finishes

H. SSPC: The Society for Protective Coatings:

1. SSPC Paint 20 - Zinc-Rich Primers (Type I - Inorganic and Type II - Organic)

1.3 DESIGN REQUIREMENTS

A. Fabricate stair assembly to support uniform live load of 100 lb/sq ft and concentrated load of 300-lbs. with deflection of stringer or landing framing not to exceed 1/240 of span. Test in accordance with ASTM E935.

B. Railing assembly, wall rails, and attachments to resist lateral force of 75 lbs at any point without damage or permanent set. Test in accordance with ASTM E935.

C. Fabricate stair assembly to NAAMM AMP 510, Class Industrial.

1.4 SUBMITTALS

A. Section 01300 - Submittal Procedures: Submittal requirements.

B. Shop Drawings: Indicate plans, elevations, sections, details, profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.

C. Shop Drawings: Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with ASTM E985 - Permanent Metal Railing Systems and Rails for Buildings.

B. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," for class of stair designated, unless more stringent requirements are indicated.

C. Finish joints in accordance with NOMMA Guideline 1.

1.6 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication. Verify finish elevations at top of intersecting landings and base support for all stairs.

PART 2 PRODUCTS

2.1 METALS, GENERAL

A. Provide materials with smooth, flat surfaces, unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.2 MATERIALS - STEEL

A. Steel Sections: ASTM A572/A572M; Grade 50.

B. Steel Plate: ASTM A36/A36M.

C. Hollow Structural Sections: ASTM A500, Grade B.

D. Steel Pipe: ASTM A53/A53M, Grade B Schedule 40.

E. Sheet Steel: ASTM A653/A653M, Grade 33 Structural Quality with galvanized coating.

F. Bolts: ASTM A307; Grade A or B.

1. Finish: Hot dipped galvanized.

G. Nuts: ASTM A563 heavy hex type.

1. Finish: Hot dipped galvanized.

H. Washers: ASTM F436; Type 1.

1. Finish: Hot dipped galvanized.

I. Welding Materials: AWS D1.1; type required for materials being welded.

J. Painting and Coatings: Per Section 09900.

K. Touch-Up Primer for Galvanized Surfaces: SSPC Paint 20 Type I Inorganic zinc rich.

2.3 MATERIALS - STAINLESS STEEL

A. Bars and Shapes: ASTM A276; Type 316.

B. Tubing: ASTM A269; Type 316.

C. Pipe: ASTM A312, seamless; Type 316.

D. Plate, Sheet and Strip: ASTM A480; Type 316.

E. Bolts: ASTM F593; Type 316

F. Nuts and Washers: ASTM F594; Type 316.

G. Welding Materials: AWS D1.6; type required for materials being welded.

2.4 MATERIALS - ALUMINUM

A. Extruded Aluminum: ASTM B221, Alloy 6063, Temper T5.

B. Sheet Aluminum: ASTM B209, Alloy 6063, Temper T5.

C. Aluminum-Alloy Drawn Seamless Tubes: ASTM B210, Alloy 6063, Temper T6.

D. Aluminum-Alloy Bars: ASTM B211, Alloy 6063, Temper T6.

E. Bolts, Nuts, and Washers: Stainless steel.

F. Welding Materials: AWS D1.1; type required for materials being welded.

2.5 COMPONENTS

A. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; consistent with design of stair structure.

B. Welding Materials:

1. Steel: AWS D1.1; type required for materials being welded.
2. Aluminum: AWS D1.2
3. Stainless Steel: AWS D1.6

C. Touch-Up Primer for Galvanized Surfaces: SSPC Paint 20 Type I Inorganic zinc rich.

D. Treads:

1. Treads shall be provided with material as called for on the project Drawings.
   a. Steel: Sized per span. Type 19-SL-4 Swage Locked by Grating Pacific, or approved equivalent; Galvanized finish. Provide with checkered safety plate nosing, or approved equivalent.
   b. Stainless Steel: Sized per span. Type 19-SLS-4 Swage Locked by Grating Pacific, or approved equivalent; 304 or 316 stainless steel with Commercial Clean finish. Provide with checkered safety plate nosing, or approved equivalent.

c. Aluminum: Sized per span. Type 19-SG-4 Swage Locked by Grating Pacific, or approved equivalent; Mill finish. Provide with corrugated aluminum nosing welded to grating.

d. FRP: Fiberglass reinforced polymer plastic "Safe-T-Span" pultruded grating treads by Fibergrate Composite Structures, or approved equivalent. Structural profiles shall be manufactured with a premium grade vinyl ester resin containing a UV inhibitor and with fire retardant additive to meet class 1 flame rating of ASTM E84 and the self-extinguishing requirement of ASTM D635. Treads to be gray in color with yellow nosing unless otherwise noted.

E. Gratings:

1. Gratings shall be provided with material as called for on the project Drawings.
   a. Steel: Sized per span. Type 19-SL-4 Swage Locked by Grating Pacific, or approved equivalent; Galvanized finish.
   b. Stainless Steel: Sized per span. Type 19-SLS-4 Swage Locked by Grating Pacific, or approved equivalent; 304 or 316 stainless steel with Commercial Clean finish.
   c. Aluminum: Sized per span. Type 19-SG-4 Swage Locked by Grating Pacific, or approved equivalent; Mill finish.
   d. FRP: Fiberglass reinforced polymer plastic "Safe-T-Span" pultruded grating by Fibergrate Composite Structures, or approved equivalent. Structural profiles shall be manufactured with a premium grade vinyl ester resin containing a UV inhibitor and with fire retardant additive to meet class 1 flame rating of ASTM E84 and the self-extinguishing requirement of ASTM D635. Grating to be gray in color unless otherwise noted.

F. Anchor bolts, nuts & washers to supporting concrete surface: Cast-in-place or drilled and epoxy set threaded anchor rods. Size and spacing as indicated on the drawings.

1. Anchor Bolts for connecting material:
   a. Steel: ASTM F1554, Grade 36.
   b. Stainless Steel: F593, Type 304 or 316.
   c. Aluminum: Stainless Steel bolts.

2.6 LADDERS

A. Fixed Ladders shall be in conformance with American National Standards Institute (ANSI) Standard A14.3 – Safety Requirements for Fixed Ladders; and Occupational Safety and Health Administration (OSHA) Regulation 1910.27 – Standards for Fixed Ladders

B. Fixed Ladder: Aluminum, welded construction:
1. Side Rails: As detailed on the Plans, side rails spaced at 24-inches clear, minimum.
2. Rungs: Manufactured rungs with safety gripping surface, uniformly spaced 12-inches on center.

3. Mounting: Space rungs a minimum of 7-inches clear form wall surfaces; with mounting brackets and attachments.

C. Ladder Walk-through Extensions: Where required by Safety Codes provide walk-through ladder rail extensions in conformance with ANSI and OSHA regulations. Same material and finish as ladder.

D. Pre-manufactured ships ladder assemblies:
1. Aluminum ships ladder units as shown on the drawings.
a. Provide Model 520 (w/ 75° angle) as manufactured by O'Keeffe's, manufactured for a 10' mezzanine.
b. Provide unit above or equivalent product by Precision Ladders, LLC, or approved equal. Documentation must be submitted prior to ordering or fabrication for review by Architect or Engineer.
2. Finishes:
a. Provide clear, anodized finish on pre-manufactured aluminum ships ladders.

2.7 FABRICATION

A. Provide complete stair and ladder assemblies, including metal framing, hangers, struts, railings, clips, brackets, bearing plates, and other components necessary to support and anchor stairs, ladders, and platforms on supporting structure.
1. Join components by continuous welding, unless otherwise indicated.

B. Fit and shop assemble components in largest practical sections for delivery to site. Provide disassembled units only as necessary for shipping and handling limitations. Clearly mark units for site assembly as needed and coordinated installation.

C. Fabricate components with joints tightly fitted and secured.

D. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

E. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

F. Form exposed work true to line and level with accurate angles and surfaces and straight edges.

G. Weld connections to comply with the following:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

H. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

I. Use concealed fasteners where possible. Where exposed mechanical fastenings are required, use flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.

J. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

K. Accurately form components required for anchorage of stairs, ladders, landings and railings to each other and to adjacent structure.

2.8 FABRICATION - OPEN GRATING STAIRS AND LANDINGS

A. Fabricate treads to required length with end plates bolted to supports;

B. Form continuous stringers with rolled steel or aluminum channels as indicated on the drawings;

C. Form landings from minimum specified bar grate type, safety nosing and end banding, welded together. Reinforce underside with angles to attain design load requirements.

D. Provide for attachment of aluminum handrails and railing. Provide aluminum handrails and railing per Section 05525.

2.9 FACTORY APPLIED FINISHES - STEEL

A. Galvanizing: ASTM A123/A123M; minimum 2.0 oz/sq ft coating thickness; galvanize after fabrication.

B. Galvanizing for Fasteners, Connectors, and Anchors:

1. Hot-Dipped Galvanizing: ASTM A153/A153M.

2.10 FACTORY APPLIED FINISHES - STAINLESS STEEL

A. Satin Polished Finish: Number 4, satin directional polish parallel with long dimension of finished face.

2.11 FACTORY APPLIED FINISHES - ALUMINUM

A. Finish coatings to conform to AAMA 2603. Comply with AA DAF-45.

B. Exterior Aluminum Surfaces: AAMA A41 anodized, prepared with chemical pre-treatment, anodized to clear color.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01300 - Administrative Requirements: Coordination and project conditions.

B. Verify field conditions are acceptable and are ready to receive work.

3.2 PREPARATION

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

B. Clean and strip galvanized steel items to bare metal where site welding is required. Touch up all welded areas with prime and finish coats of zinc-rich cold-galvanizing compound.

3.3 INSTALLATION

A. Install components plumb and level, accurately fitted, free from distortion or defects.

B. Install anchors, plates, angles and struts required for connecting stairs, ladders, and landings to structure.

C. Allow for erection loads. Install sufficient temporary bracing and anchors to maintain framing safe, plumb, and in alignment.

D. Field weld components indicated on Drawings.

1. Steel: Perform field welding in accordance with AWS D1.1.
2. Aluminum: Perform field welding in accordance with AWS D1.2.
3. Stainless Steel: Perform field welding in accordance with AWS D1.6.

E. Field bolt and weld to match shop bolting and welding. Conceal bolts and screws whenever possible.

F. Mechanically fasten joints butted tight, flush, and hairline. Grind welds smooth and flush.

G. Obtain approval of Engineer prior to site cutting or creating adjustments not scheduled.

3.4 ADJUSTING AND CLEANING

A. Immediately after erection, clean field welds, bolted connections, and abraded areas and provide touchup to surface finishes as required.

3.5 ERECTION TOLERANCES

A. Section 01400 - Quality Requirements: Tolerances.

B. Maximum Variation From Plumb: ¼-inch per story, non-cumulative.

C. Maximum Offset From Alignment: ¼-inch.

END OF SECTION

SECTION 05525
ALUMINUM HANDRAILS AND RAILINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes aluminum balusters, guard and hand railings and fittings.

B. Related Sections:

1. Section 01025 - Measurement and Payment
2. Section 01300 - Submittals.
3. Section 03300 - Cast-In-Place Concrete.
4. Section 05500 - Metal Fabrications.
5. Section 05510 - Galvanized Metal Stairs.

1.2 REFERENCES

A. American Architectural Manufacturers Association:

1. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum.

B. ASTM International:

1. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
2. ASTM B241/B241M - Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube.
3. ASTM B483/B483M - Standard Specification for Aluminum and Aluminum-Alloy Drawn Tubes for General Purpose Applications.
4. ASTM E935 - Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings.

C. National Ornamental & Miscellaneous Metals Association:

1. NOMMA Guideline 1 - Joint Finishes.

1.3 SUBMITTALS

A. Section 01300 - Submittal Procedures: Submittal requirements.

B. Shop Drawings: Indicate profiles, sizes, connection attachments, anchorage, size and type of fasteners, and accessories.

1.4 QUALITY ASSURANCE

A. Finish joints in accordance with NOMMA Guideline 1.

1.5 FIELD MEASUREMENTS

A. Verify field measurements for railing lengths, elevations and support locations prior to fabrication.

PART 2 PRODUCTS

2.1 ALUMINUM RAILING SYSTEM COMPONENTS

A. Guard Rails and Posts: 2-inch nominal outside diameter, extruded tubing conforming to B211. Hand Rails to be 1-1/2" nominal outside diameter, extruded tubing in conformance with current International Building Code profile requirements.

B. Fittings: Fabricated, machined or cast plates, angles and brackets as indicated on the drawings; aluminum.

C. Mounting: Brackets and flanges, with stainless steel anchors either cast in place or drilled in the field and set in place with approved construction adhesive into concrete support surfaces.

D. Splice Connectors: Concealed with locking set stainless steel screws; aluminum.

E. Exposed Fasteners: Flush countersunk stainless steel screws or bolts; consistent with design of railing.

F. Finish coatings to conform to AAMA 611.

G. Exterior Aluminum Surfaces: AAMA A41 anodized, prepared with chemical pre-treatment, anodized to clear color.

H. Apply two coats of bituminous paint to concealed aluminum surfaces in contact with cementitious or dissimilar materials.

2.2 MANUFACTURER

A. Unless otherwise directed all Guard and Hand Rail shall be fabricated utilizing the Speed-Rail System by Hollaender Manufacturing of Cincinnati, Ohio. (hollaender.com)

B. Railing extend, slopes and elevations shall be as detailed on the Drawings and as directed by the Engineer.

C. All posts and horizontals shall be aluminum pipe per section 2.1 of this Specification.

D. All fittings and connectors shall be Aluminum-Magnesium Allow as provided by Hollaender Mfg.

E. All components including vertical and horizontal pipe and fittings and connections shall be anodized coated. Color of anodizing shall be as directed and approved by the Owner.

2.3 FABRICATION

A. Fit and shop assemble components in largest practical sizes for delivery to site.

B. Fabricate components with joints tightly fitted and secured. Furnish spigots and sleeves to accommodate site assembly and installation.

C. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.

D. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

E. Exterior Components: Continuously seal joined pieces by continuous welds. Drill condensate drainage holes at bottom of members at locations not encouraging water intrusion.

F. Interior Components: Continuously seal joined pieces by continuous welds.

G. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

H. Accurately form components to suit stairs and landings, to each other and to adjacent structures and/or equipment.

I. Accommodate for expansion and contraction of members and building movement without damage to connections or members.

J. Extend handrails past last stair step with returns in conformance with current International Building Code requirements.

K. Close all open pipe ends with smooth aluminum plugs as furnished by the approved manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Div 1: Coordination and project conditions.

B. Verify field conditions are acceptable and are ready to receive work.

C. Verify concealed blocking and reinforcement is installed and correctly located to receive wall mounted handrails.

3.2 PREPARATION

A. Clean and strip aluminum where site welding is required.

B. Supply items required to be cast into concrete embedded in masonry with setting templates, to appropriate sections.

3.3 INSTALLATION

A. Install components plumb and level, accurately fitted, free from distortion or defects.

B. Anchor railings to structure with anchors as indicated on the drawings.

C. Field weld only where indicated on the drawings or approved by the Engineer. Grind field welds smooth and Touch-up welded areas with a field coating compatible with the railing finish.

D. Conceal bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.

E. Assemble with spigots and sleeves to accommodate tight joints and secure installation.

3.4 ERECTION TOLERANCES

A. Maximum Variation from Plumb: ¼-inch per story, non-cumulative.

B. Maximum Offset from Alignment: ¼-inch.

C. Maximum Out-of-Position: ¼-inch.

END OF SECTION

SECTION 05530
METAL GRATINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Formed floor gratings.
2. Perimeter closure.

B. Related Requirements:

1. Section 01025 - Measurement and Payment
2. Section 05500 - Metal Fabrications.
3. Section 09900 - Painting and Coating: Field-paint finishes.
4. Section 03300 - Cast-in-Place Concrete.

1.2 REFERENCE STANDARDS

A. ASTM International:

1. ASTM A36 - Standard Specification for Carbon Structural Steel.
2. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
3. ASTM A1011 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.

B. American Welding Society:

1. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.
2. AWS D1.1 - Structural Welding Code - Steel.

C. National Association of Architectural Metal Manufacturers:

1. NAAMM MBG 531 - Metal Bar Grating Manual.
2. NAAMM MBG 532 - Heavy-Duty Metal Bar Grating Manual.
3. NAAMM MBG 533 – Welding Standards for Fabrication of Steel, Stainless Steel and Aluminum Bar Grating.

D. SSPC: The Society for Protective Coatings:

1. SSPC - Steel Structures Painting Manual.
2. SSPC SP 1 - Solvent Cleaning.

3. SSPC SP 10 - Near-White Blast Cleaning.
4. SSPC Paint 15 - Steel Joist Shop Primer/Metal Building Primer.
5. SSPC Paint 20 - Zinc-Rich Coating, Type I - Inorganic and Type II - Organic.

1.3 COORDINATION

A. Coordinate Work of this Section with placement of ledgers and supports.

1.4 SUBMITTALS

A. Section 01300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit span and deflection tables.

C. Shop Drawings: Indicate details of gratings, plates, component supports, anchorages, openings, fasteners, perimeter construction details, and tolerances. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.

D. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for gratings.

1.5 QUALIFICATIONS

A. Welders and Welding Procedures: AWS D.1 qualified within previous 12 months for employed weld types.

B. Licensed Professional: Professional engineer experienced in design of specified Work and licensed at Project location.

1.6 EXISTING CONDITIONS

A. Field Measurements: Verify field measurements prior to fabrication. Indicate field measurements on Shop Drawings.

PART 2 PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Design Live Load – Main Finish Floor:

1. Uniform load of 250 lb./sq. ft. minimum; concentrated load of force 3000 lb.

B. Design Live Load – Pedestrian Platforms:

1. Uniform load of 100 lb./sq. ft. minimum; concentrated load of force 300 lb.

C. Design Live Load – Vehicle:

1. Light Vehicle: Wheel Load of 3,860 lb. minimum.

2. Medium Vehicle: Wheel Load of 8,730 lb. minimum.

3. Heavy Vehicle: Wheel Load of 20,800 lb. minimum.

D. Maximum Allowable Deflection under Live Load: 1/240 of span; size components for single span.

E. Maximum Center to Center Bar Spacing:

1. Main Finish Floor: 1-3/16 inch. (19 Space)

2. Pedestrian: 1-3/16 inch. (19 Space)

3. Vehicle: 1-3/8 inch (22 Space)

2.2 GRATINGS AND FLOOR PLATES

A. Manufacturer List:

1. McNichols

2. Grating Pacific

3. Marco

4. Substitutions per Section 01600.

2.3 MATERIALS

A. Steel: ASTM A1011 Grade 36.

B. Stainless Steel: Type 304 or 316

C. Aluminum: ASTM 6061-T6 (Pedestrian grating only)

D. Welding Materials:

1. Type required for materials being welded.

2. Steel: AWS D1.1

3. Aluminum: AWS D1.2

4. Stainless Steel: AWS D1.6

2.4 FABRICATION

A. Grating Type: NAAMM MBG 531

1. Steel: Type W, Welded.

2. Stainless Steel: Type WS, Welded.

3. Aluminum: Type SG, Swage Locked.

B. Fabricate framing for openings.

C. Top Surface: Plain.

D. Bearing Bar: As shown on Drawings

E. Crossbar: As shown on Drawings

2.5 FINISHES

A. Steel: Galvanized per ASTM A123; hot-dip galvanize after fabrication.

B. Stainless Steel: Abrasive Blast Finish

C. Aluminum: Mill Finish

2.6 ACCESSORIES

A. Fasteners:

1. Pedestrian Grating:

a. Saddle Clips or J-hooks:

1) Steel Grating: Galvanized steel.

2) Stainless Steel or Aluminum Grating: Stainless steel.

2. Vehicle Grating:

a. Weld Lugs:

1) Same material as grating.

B. Perimeter Closure: Same material as grating.

C. Edge Banding: 3/1-inch at edges and at intermediate panel edges.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01700 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that opening sizes and dimensional tolerances are acceptable.

C. Verify that supports are correctly positioned.

3.2 INSTALLATION

A. Place frames in correct position, plumb and level.

B. Mechanically cut galvanized finish surfaces only as approved by the Engineer. Do not flame cut.

C. Anchor by bolting through saddle clips or J-hooks.

D. Set perimeter closure flush with top of grating and surrounding construction.

E. Secure to prevent movement.

3.3 TOLERANCES

A. Conform to NAAMM MBG 531.

END OF SECTION

SECTION 06100 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Framing with dimension lumber.
2. Framing with timber.
3. Framing with engineered wood products.
4. Shear wall panels.
5. Rooftop equipment bases and support curbs.
6. Wood blocking, cants, and nailers.
7. Wood furring and grounds.
8. Wood sleepers.
9. Utility shelving.
10. Plywood backing panels.

1.3 DEFINITIONS

A. Boards or Strips: Lumber of less than 2 inches nominal size in least dimension.
B. Dimension Lumber: Lumber of 2 inches nominal size or greater but less than 5 inches nominal size in least dimension.
C. Exposed Framing: Framing not concealed by other construction.
D. OSB: Oriented strand board.
E. Timber: Lumber of 5 inches nominal size or greater in least dimension.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D5664.
4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

B. Fastener Patterns: Full-size templates for fasteners in exposed framing.

1.5 INFORMATIONAL SUBMITTALS

A. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
B. Evaluation Reports: For the following, from ICC-ES:

1. Wood-preservative-treated wood.
2. Fire-retardant-treated wood.
3. Engineered wood products.
4. Shear panels.
5. Power-driven fasteners.
6. Post-installed anchors.
7. Metal framing anchors.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Stack wood products flat with spacers beneath and between each bundle to provide air circulation. Protect wood products from weather by covering with

waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. For exposed lumber indicated to receive a stained or natural finish, [mark grade stamp on end or back of each piece] [or] [omit grade stamp and provide certificates of grade compliance issued by grading agency].
3. Dress lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content of Lumber: 15 percent for 2-inch nominal thickness or less; 19 percent for more than 2-inch nominal thickness unless otherwise indicated.

C. Engineered Wood Products: Acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.

1. Allowable design stresses, as published by manufacturer, shall meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.

2. For exposed items indicated to receive a stained or natural finish, chemical formulations shall not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.

D. Application: Treat items indicated on Drawings, and the following:

1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
4. Wood framing members that are less than 18 inches above the ground in crawlspaces or unexcavated areas.
5. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.

1. Treatment shall not promote corrosion of metal fasteners.
2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.

3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201 at 92 percent relative humidity. Use where exterior type is not indicated.
4. Design Value Adjustment Factors: Treated lumber shall be tested according to ASTM D5664 and design value adjustment factors shall be calculated according to ASTM D6841. For enclosed roof framing, framing in attic spaces, and where high temperature fire-retardant treatment is indicated, provide material with adjustment factors of not less than 0.85 modulus of elasticity and 0.75 for extreme fiber in bending for Project's climatological zone.

C. Kiln-dry lumber after treatment to maximum moisture content of 19 percent. Kiln-dry plywood after treatment to maximum moisture content of 15 percent.
D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.

1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by testing agency.

E. For exposed items indicated to receive a stained or natural finish, chemical formulations shall not bleed through, contain colorants, or otherwise adversely affect finishes.

F. Application: Treat all rough carpentry unless otherwise indicated. Items are indicated on Drawings, and the following as well:

1. Framing for raised platforms.
2. Framing for stages.
3. Concealed blocking.
4. Framing for non-load-bearing partitions.
5. Framing for non-load-bearing exterior walls.
6. Roof construction.
7. Plywood backing panels.

2.4 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Nailers.
3. Rooftop equipment bases and support curbs.
4. Cants.
5. Furring.
6. Grounds.

7. Utility shelving.

B. Dimension Lumber Items: Construction or No. 2 grade lumber of any of the following species:

1. Hem-fir (north); NLGA.
2. Mixed southern pine or southern pine; SPIB.
3. Spruce-pine-fir; NLGA.
4. Hem-fir; WCLIB or WWPA.
5. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
6. Western woods; WCLIB or WWPA.
7. Northern species; NLGA.
8. Eastern softwoods; NeLMA.

C. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
D. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.
E. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.5 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: Plywood, DOC PS 1, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

2.6 FASTENERS

A. General: Fasteners shall be of size and type indicated and shall comply with requirements specified in this article for material and manufacture.

1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.

B. Nails, Brads, and Staples: ASTM F1667.
C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 as appropriate for the substrate.

1. Material: Carbon-steel components, zinc plated to comply with ASTM B633, Class Fe/Zn 5.
2. Material: Stainless steel with bolts and nuts complying with ASTM F593 and ASTM F594, Alloy Group 1 or 2.

2.7 MISCELLANEOUS MATERIALS

A. Sill-Sealer Gaskets: Glass-fiber-resilient insulation, fabricated in strip form, for use as a sill sealer; 1-inch nominal thickness, compressible to 1/32 inch; selected from manufacturer's standard widths to suit width of sill members indicated.
B. Sill-Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to suit width of sill members indicated.

C. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch.
D. Adhesives for Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with ASTM D3498 that is approved for use indicated by adhesive manufacturer.

E. Water-Repellent Preservative: NWWDA-tested and -accepted formulation containing 3-iodo-2-propynyl butyl carbamate, combined with an insecticide containing chloropyrifos as its active ingredient.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
B. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.
C. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.

D. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.
E. Install shear wall panels to comply with manufacturer's written instructions.
F. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.
G. Install sill sealer gasket to form continuous seal between sill plates and foundation walls.
H. Do not splice structural members between supports unless otherwise indicated.
I. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

    1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.

J. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:

    1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
    2. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal thickness.
    3. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 sq. ft. and to solidly fill space below partitions.
    4. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 feet o.c.

K. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
L. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

    1. Use inorganic boron for items that are continuously protected from liquid water.

2. Use copper naphthenate for items not continuously protected from liquid water.

M. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

N. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code (IBC).
2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
3. ICC-ES evaluation report for fastener.

O. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

P. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced, and with adjacent rows staggered.

1. Comply with approved fastener patterns where applicable. Before fastening, mark fastener locations, using a template made of sheet metal, plastic, or cardboard.
2. Use finishing nails unless otherwise indicated. Countersink nail heads and fill holes with wood filler.
3. Use common nails unless otherwise indicated. Drive nails snug but do not countersink nail heads.

3.2 INSTALLATION OF WOOD BLOCKING AND NAILERS

A. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.3 INSTALLATION OF WOOD FURRING

A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.

B. Furring to Receive Plywood or Hardboard Paneling: Install 1-by-3-inch nominal-size furring horizontally and vertically at 24 inches o.c.

C. Furring to Receive Gypsum Board or Plaster Lath: Install 1-by-2-inch nominal-size furring vertically at 16 inches o.c.

3.4 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

B. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet enough that moisture content exceeds that specified, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06100

SECTION 06160 - SHEATHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Mezzanine floor sheathing.
2. Pony-wall sheathing.
3. Sheathing joint and penetration treatment.

B. Related Requirements:

1. Section 06 1000 "Rough Carpentry" for plywood backing panels.
2. Section 07 2500 "Weather Barriers" for water-resistive barrier applied over wall sheathing.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review air-barrier and water-resistant glass-mat gypsum sheathing requirements and installation, special details, transitions, mockups, air-leakage testing, protection, and work scheduling that covers air-barrier and water-resistant glass-mat gypsum sheathing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.

2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.
3. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D5516.
4. For products receiving waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
5. For air-barrier and water-resistant glass-mat gypsum sheathing, include manufacturer's technical data and tested physical and performance properties of products.

B. Shop Drawings: For air-barrier and water-resistant glass-mat gypsum sheathing assemblies.

1. Show locations and extent of sheathing, accessories, and assemblies specific to Project conditions.
2. Include details for sheathing joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
3. Include details of interfaces with other materials that form part of air barrier.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer including list of ABAA-certified installers and supervisors employed by Installer, who work on Project and testing and inspecting agency.

B. Product Certificates: From air-barrier and water-resistant glass-mat gypsum sheathing manufacturer, certifying compatibility of sheathing accessory materials with Project materials that connect to or that come in contact with the sheathing.

C. Product Test Reports: For each air-barrier and water-resistant glass-mat gypsum sheathing assembly, indicating compliance with specified requirements, for tests performed by a qualified testing agency.

D. Evaluation Reports: For the following, from ICC-ES:

1. Wood-preservative-treated plywood.
2. Fire-retardant-treated plywood.
3. Foam-plastic sheathing.
4. Air-barrier and water-resistant glass-mat gypsum sheathing.

E. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer of air-barrier and water-resistant glass-mat gypsum sheathing.

1. Installer shall be licensed by ABAA according to ABAA's Quality Assurance Program and shall employ ABAA-certified installers and supervisors on Project.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance Ratings: As tested according to ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

B. Air-Barrier and Water-Resistant Glass-Mat Gypsum Sheathing Performance: Air-barrier and water-resistant glass-mat gypsum sheathing assembly, and seals with adjacent construction, shall be capable of performing as a continuous air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, tie-ins to installed waterproofing, tie-ins to other installed air barriers, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

2.2 WOOD PANEL PRODUCTS

A. Emissions: Products shall meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and

Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.
C. Factory mark panels to indicate compliance with applicable standard.

2.3 PRESERVATIVE-TREATED PLYWOOD

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.

C. Application: Treat all plywood unless otherwise indicated.

2.4 FIRE-RETARDANT-TREATED PLYWOOD

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
B. Fire-Retardant-Treated Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.

1. Use treatment that does not promote corrosion of metal fasteners.
2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201/D3201M at 92 percent relative humidity. Use where exterior type is not indicated.

4. Design Value Adjustment Factors: Treated lumber plywood shall be tested according to ASTM D5516 and design value adjustment factors shall be calculated according to ASTM D6305. Span ratings after treatment shall be not less than span ratings specified. For roof sheathing and where high-temperature fire-retardant treatment is indicated, span ratings for temperatures up to 170 deg F shall be not less than span ratings specified.

C. Kiln-dry material after treatment to a maximum moisture content of 15 percent. Do not use material that is warped or does not comply with requirements for untreated material.

D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.

E. Application: Treat all plywood unless otherwise indicated.

2.5 MEZZANINE FLOOR AND PONY-WALL SHEATHING

A. General: Use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.
   1. Use treatment that does not promote corrosion of metal fasteners.
   2. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated. Type and Thickness: Type X, 5/8 inch thick.
   3. Size: 48 by 96 inches.
   4. Thickness: ½" or ¾" as indicated on the drawings.

C. Kiln-dry material after treatment to a maximum moisture content of 15 percent. Do not use material that is warped or does not comply with requirements for untreated material.

D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.

2.6 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

   1. For roof, parapet and wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.

B. Nails, Brads, and Staples: ASTM F1667.
C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
D. Screws for Fastening Sheathing to Wood Framing: ASTM C1002.
E. Screws for Fastening Wood Structural Panels to Cold-Formed Metal Framing: ASTM C954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.
F. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached.

   1. For steel framing less than 0.0329 inch thick, use screws that comply with ASTM C1002.
   2. For steel framing from 0.033 to 0.112 inch thick, use screws that comply with ASTM C954.

G. Screws for Fastening Composite Nail Base Insulated Roof Sheathing to Metal Roof Deck: Steel drill screws, in type and length recommended by sheathing manufacturer for thickness of sheathing to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B117. Provide washers or plates if recommended by sheathing manufacturer.

2.7 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

A. Sealant for Glass-Mat Gypsum Sheathing: Elastomeric, medium-modulus, neutral-curing silicone joint sealant compatible with joint substrates formed by gypsum sheathing and other materials, recommended by sheathing manufacturer for application indicated and complying with requirements for elastomeric sealants specified in Section 07 9200 "Joint Sealants."
B. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant complying with ASTM C834, compatible with sheathing tape and sheathing and recommended by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.

1. Sheathing Tape: Self-adhering glass-fiber tape, minimum 2 inches wide, 10 by 10 or 10 by 20 threads/inch, of type recommended by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing and with a history of successful in-service use.

C. Sheathing Tape for Foam-Plastic Sheathing: Pressure-sensitive plastic tape recommended by sheathing manufacturer for sealing joints and penetrations in sheathing.

2.8 MISCELLANEOUS MATERIALS

A. Adhesives for Field Gluing Panels to Wood Framing: Formulation complying with [APA AFG-01] [ASTM D3498] that is approved for use with type of construction panel indicated by manufacturers of both adhesives and panels.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.
B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.
C. Securely attach to substrate by fastening as indicated, complying with the following:

1. Table 2304.9.1, "Fastening Schedule," in the ICC's International Building Code.
2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in the ICC's International Residential Code for One- and Two-Family Dwellings.
3. ICC-ES evaluation report for fastener.

D. Use common wire nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.

E. Coordinate wall, parapet and roof sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.
G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 SHEATHING INSTALLATION

A. Comply with with manufacturer's written instructions.
   1. Fasten gypsum sheathing to cold-formed metal framing with screws.
   2. Install boards with a 3/8-inch gap where non-load-bearing construction abuts structural elements.
   3. Install boards with a 1/4-inch gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.

B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.

C. Horizontal Installation: Abut ends of boards over centers of studs, and stagger end joints of adjacent boards not less than one stud spacing. Attach boards at perimeter and within field of board to each steel stud.
   1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of boards.

D. Vertical Installation: Install board vertical edges centered over studs. Abut ends and edges of each board with those of adjacent boards. Attach boards at perimeter and within field of board to each stud.
   1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of boards.

E. Seal sheathing joints according to sheathing manufacturer's written instructions.
   1. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing joints and apply and trowel silicone emulsion sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.

3.3 FIELD QUALITY CONTROL

A. ABAA Quality Assurance Program: Perform examinations, preparation, installation, testing, and inspections under ABAA's Quality Assurance Program.

B. Testing and Inspecting Agency: Engage a qualified testing agency to perform tests and inspections.

C. Inspections: Air-barrier and water-resistant glass-mat gypsum sheathing, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:

1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
2. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
3. Termination mastic has been applied on cut edges.
4. Strips and transition strips have been firmly adhered to substrate.
5. Compatible materials have been used.
6. Transitions at changes in direction and structural support at gaps have been provided.
7. Connections between assemblies (sheathing and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
8. All penetrations have been sealed.

D. Tests: As determined by testing agency from among the following tests:

1. Air-Leakage-Location Testing: Air-barrier sheathing assemblies will be tested for evidence of air leakage according to ASTM E1186, chamber pressurization or depressurization with smoke tracers.
2. Air-Leakage-Volume Testing: Air-barrier assemblies will be tested for air-leakage rate according to ASTM E783.

E. Air barriers will be considered defective if they do not pass tests and inspections.
F. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.
G. Prepare test and inspection reports.

END OF SECTION 06160

SECTION 06640 – FIBERGLASS REINFORCED PANELING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Provide fiberglass reinforced plastic (FRP) panels for wall applications.
B. Related Sections:

1. Section 061000 "Rough Carpentry" for wood furring for installing plastic paneling.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer’s literature including product characteristics, accessories and limitations for each type of product.
B. Selection Samples: For plastic paneling and trim accessories, in manufacturer's standard sizes and finishes.

1.4 QUALITY ASSURANCE

A. Manufacturer: Minimum of 5-years experience manufacturing similar products.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install plastic paneling until spaces are enclosed and weathertight and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.6 WARRANTY

A. Manufacturer’s Warranty: Provide manufacturer’s standard warranty against defects in manufacturing.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Panolam FRP by Panolam Industries International, Inc., Shelton, CT 06484. Obtain plastic paneling and trim accessories from single manufacturer. Panels shall comply with the following:
   1. Classic Collection: White
   2. Surface Texture: Embossed
   3. Fire Rating ASTM E 84: Class A
   4. Thickness: 0.090 Inches
   5. Barcol Hardness ASTM D2583: 35 typical
   6. Water Absorption ASTM D570: 0.2 percent typical
   7. Accessories: Color matched dividers, outside corners, inside corners, end caps and fastening rivets.
   8. Adhesive: As recommended by manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install products in strict accordance with manufacturer’s instructions and approved submittals.
   1. Clean substrate of dirt, dust, waxes, and other bond breaking substances prior to beginning installation.
   2. Install panels with bottom edge located to clear top of resilient base.
   3. Apply adhesive uniformly using adhesive manufacturers recommended trowel to the entire back of panels completely to the edge (100% coverage).
   4. Lay FRP panels in place leaving approximately 1/8 inch between panels and 1/4 inch space top and bottom.
   5. Follow adhesive manufacturer’s recommendations for set and application times.

6. Apply pressure to entire panel face with laminate type roller, removing trapped air and ensure proper adhesion between surfaces.

3.3 ADJUSTING AND CLEANING

A. Replace installations out of plumb and not aligned with adjacent panels and construction.
B. Clean panel face to remove soiling, stains, dust, and dirt using clean rags, and cleaning agents as instructed by manufacturer.
C. Leave installation clean, free of residue and debris resulting from work of this section.

END OF SECTION 06640

SECTION 071416 - COLD FLUID-APPLIED WATERPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Waterproofing membrane for below grade concrete walls.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

   1. Include construction details, material descriptions, and tested physical and performance properties of waterproofing.
   2. Include manufacturer's written instructions for evaluating, preparing, and treating substrate.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field quality-control reports.
C. Sample Warranties: For special warranties.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended in writing by waterproofing manufacturer.

1. Do not apply waterproofing to a damp or wet substrate, when relative humidity exceeds 85 percent, or when temperatures are less than 5 deg F above dew point.
2. Do not apply waterproofing in snow, rain, fog or mist, or when such weather conditions are imminent during application and curing period.

B. Maintain adequate ventilation during application and curing of waterproofing materials.

1.7 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace waterproofing that fails in materials or workmanship within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

B. Installer's Special Warranty: Specified form, signed by Installer, covering Work of this Section, for warranty period of two years.

1. Warranty includes removing and reinstalling protection board, drainage panels, etc.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Waterproofing System: Obtain waterproofing materials and protection course, from single source from single manufacturer.

2.2 SINGLE-COMPONENT, WATER-BASED, POLYMER-MODIFIED, COLD APPLIED, WATER-PROOFING MEMBRANE

A. Single-Component, water-based, polymer-modified, cold applied, waterproofing membrane: ASTM C 836/C 836M

1. Mel-Rol LM by W.R. Meadows, Inc.
2. Provide named product or comparable product by another manufacturer.

2.3 AUXILIARY MATERIALS

A. General: Provide auxiliary materials recommended in writing by waterproofing manufacturer for intended use and compatible with one another and with waterproofing.

2.4 PROTECTION COURSE

A. Protection Course: Molded-polystyrene board insulation, ASTM C 578, Type I, 0.90-lb/cu. ft. minimum density, 1-inch minimum thickness.

2.5 MOLDED-SHEET DRAINAGE PANELS

A. Dimple-raised, molded polystyrene sheet bonded to high strength polypropylene fabric.

1. Mel-Drain 5012, rolled matrix drainage system by W.R. Meadows, Inc.
2. Provide named product or comparable product by another manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

1. Verify that concrete has cured and aged for minimum time period recommended in writing by waterproofing manufacturer.
2. Verify that substrate is visibly dry and within the moisture limits recommended in writing by manufacturer. Test for capillary moisture by plastic sheet method according to ASTM D 4263.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.
B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.
C. Close off deck drains and other deck penetrations to prevent spillage and migration of waterproofing fluids.
D. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, acid residues, and other penetrating contaminants or film-forming coatings from concrete.

1. Abrasive blast clean concrete surfaces uniformly to expose top surface of fine aggregate according to ASTM D 4259 with a self-contained, recirculating, blast-cleaning apparatus. Remove material to provide a sound surface free of laitance, glaze, efflorescence, curing compounds, concrete hardeners, or form-release agents. Remove remaining loose material and clean surfaces according to ASTM D 4258.

E. Remove fins, ridges, and other projections, and fill honeycomb, aggregate pockets, holes, and other voids.

3.3 PREPARATION AT TERMINATIONS, PENETRATIONS, AND CORNERS

A. Prepare surfaces at terminations and penetrations through waterproofing and at expansion joints, drains, sleeves, and corners according to waterproofing manufacturer's written instructions.
B. Apply waterproofing in two separate applications, and embed a joint reinforcing strip in the first preparation coat when recommended by waterproofing manufacturer.

3.4 JOINT AND CRACK TREATMENT

A. Prepare, treat, rout, and fill joints and cracks in substrate according to waterproofing manufacturer's written instructions. Before coating surfaces, remove dust and dirt from joints and cracks according to ASTM D 4258.

1. Comply with ASTM C 1193 for joint-sealant installation.
2. Apply bond breaker on sealant surface, beneath preparation strip.
3. Prime substrate along each side of joint and apply a single thickness of preparation strip at least 6 inches wide along each side of joint. Apply waterproofing in two separate applications and embed a joint reinforcing strip in the first preparation coat.

B. Install sheet flashing and bond to deck and wall substrates where required according to waterproofing manufacturer's written instructions.

1. Extend sheet flashings for 4 inches onto perpendicular surfaces and items penetrating substrate.

3.5 WATERPROOFING APPLICATION

A. Apply waterproofing according to manufacturer's written instructions.
B. Apply primer over prepared substrate unless otherwise instructed in writing by waterproofing manufacturer.

C. Waterproofing Applications: Mix materials and apply waterproofing by spray, roller, notched squeegee, trowel, or other application method suitable to slope of substrate.

1. Apply waterproofing in 2 coats to obtain a seamless membrane free of entrapped gases and pinholes, with a dry film thickness of 60 mils.
2. Apply waterproofing to prepared wall terminations and vertical surfaces.
3. Verify manufacturer's recommended wet film thickness of waterproofing every 100 sq. ft.

D. Cure waterproofing, taking care to prevent contamination and damage during application and curing.

E. Install protection course with butted joints over waterproofing before starting subsequent construction operations.

1. For horizontal applications, install protection course loose laid over fully cured membrane.
2. For vertical applications, set protection course in nominally cured membrane, which will act as an adhesive. If membrane cures before application of protection course, use adhesive.

3.6 MOLDED-SHEET DRAINAGE PANEL INSTALLATION

A. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate, according to manufacturer's written instructions. Use adhesive or another method that does not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.

1. For vertical applications, install protection course before installing drainage panels.

3.7 PROTECTION

A. Do not permit foot or vehicular traffic on unprotected membrane.

B. Protect waterproofing from damage and wear during remainder of construction period.

C. Protect installed insulation drainage panels from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

D. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

END OF SECTION 071416

SECTION 07190 - WATER REPELLENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes penetrating water-repellent treatments for the following vertical and horizontal surfaces:

1. Cast-in-place concrete.
2. Precast concrete.
3. Concrete unit masonry.

B. Related Requirements:
1. Section 04 2000 "Unit Masonry" for integral water-repellent admixture for unit masonry assemblies.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include manufacturer's printed statement of VOC content.
2. Include manufacturer's standard colors.
3. Include manufacturer's recommended number of coats for each type of substrate and spreading rate for each separate coat.

B. Samples: For each type and color of water repellent and substrate indicated, 12 by 12 inches in size, with specified water-repellent treatment applied to half of each Sample.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Applicator.

B. Product Certificates: For each type of water repellent.

C. Preconstruction Test Reports: For water-repellent-treated substrates.

D. Field quality-control reports.
E. Sample Warranty: For special warranty.

1.5 QUALITY ASSURANCE

A. Applicator Qualifications: An employer of workers trained and approved by manufacturer.

B. Mockups: Prepare mockups of each required water repellent on each type of substrate required to demonstrate aesthetic effects, for preconstruction testing, and to set quality standards for materials and execution.

1. Locate mockups on masonry sample panels in locations that enable viewing under same conditions as the completed Work.

   a. Size: 10 sq. ft. each.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.6 FIELD CONDITIONS

A. Limitations: Proceed with application only when the following existing and forecasted weather and substrate conditions permit water repellents to be applied according to manufacturers' written instructions and warranty requirements:

1. Concrete surfaces and mortar have cured for not less than 28 days.
2. Building has been closed in for not less than 30 days before treating wall assemblies.
3. Ambient temperature is above 40 deg F and below 100 deg F and will remain so for 24 hours.
4. Substrate is not frozen and substrate-surface temperature is above 40 deg F and below 100 deg F.
5. Rain or snow is not predicted within 24 hours.
6. Not less than 72 hours have passed since surfaces were last wet.
7. Windy conditions do not exist that might cause water repellent to be blown onto vegetation or surfaces not intended to be treated.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and Applicator agrees to repair or replace materials that fail to maintain water repellency specified in "Performance Requirements" Article within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Performance: Water repellents shall meet the following performance requirements as determined by preconstruction testing on manufacturer's standard substrates representing those indicated for this Project.

B. Water Absorption: Minimum 90 percent reduction of water absorption after 24 hours for treated compared to untreated specimens when tested according to the following:

1. Cast-in-Place Concrete: ASTM C642.
2. Precast Concrete: ASTM C642.
3. Cast Stone: ASTM C1195.
4. Concrete Masonry Units: ASTM C140.
5. Clay Brick: ASTM C67.
6. Natural Stone: ASTM C97/C97M.
7. Portland Cement Plaster (Stucco): ASTM D6532.

C. Water-Vapor Transmission: Comply with one or both of the following:

1. Maximum 10 percent reduction water-vapor transmission of treated compared to untreated specimens, according to ASTM E96/E96M.
2. Minimum 80 percent water-vapor transmission of treated compared to untreated specimens, according to ASTM D1653.

D. Water Penetration and Leakage through Masonry: Minimum 90 percent reduction in leakage rate of treated compared to untreated specimens, according to ASTM E514/E514M.

E. Durability: Maximum 5 percent loss of water-repellent performance after 2500 hours of weathering according to ASTM G154 compared to water-repellent-treated specimens before weathering.

2.2 PENETRATING WATER REPELLENTS

A. Silane/Siloxane-Blend, Penetrating Water Repellent: Clear, silane and siloxane blend with 400 g/L or less of VOCs.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Advanced Chemical Technologies, Inc.
b. AWRC Corporation.
c. BASF Corporation.
d. Chemical Products Industries, Inc.
e. Conproco Corporation.
f. Degussa Corp.
g. Euclid Chemical Company (The); an RPM company.
h. Fabrikem Manufacturing Ltd.
i. Fox Industries, Inc.
j. Karnak Corporation.
k. Kryton International Inc.
l. Laticrete International, Inc.
m. Pecora Corporation.
n. Price Research, Ltd.
o. PROSOCO, Inc.
p. Rainguard Products Company.
q. SaverSystems.
r. Sika Corporation.
s. Symons by Dayton Superior.
t. Tamms; a brand of Euclid Chemical Company; an RPM Company.
u. TK Products.
v. Tnemec Inc.
w. V-Seal Concrete Sealers & Specialty Coatings.
x. Wacker Chemical Corporation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements and conditions affecting performance of the Work.

1. Verify that surfaces are clean and dry according to water-repellent manufacturer's requirements. Check moisture content in three representative locations by method recommended by manufacturer.
2. Verify that there is no efflorescence or other removable residues that would be trapped beneath the application of water repellent.
3. Verify that required repairs are complete, cured, and dry before applying water repellent.

B. Test pH level according to water-repellent manufacturer's written instructions to ensure chemical bond to silica-containing or siliceous minerals.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. New Construction and Repairs: Allow concrete and other cementitious materials to age before application of water repellent, according to repellent manufacturer's written instructions.

B. Cleaning: Before application of water repellent, clean substrate of substances that could impair penetration or performance of product according to water-repellent manufacturer's written instructions and as follows:

1. Cast-in-Place Concrete, Precast Concrete and Concrete Unit Masonry: Remove oil, curing compounds, laitance, and other substances that inhibit penetration or performance of water repellents according to ASTM E1857.

C. Protect adjoining work, including mortar and sealant bond surfaces, from spillage or blow-over of water repellent. Cover adjoining and nearby surfaces of aluminum and glass if there is the possibility of water repellent being deposited on surfaces. Cover live vegetation.

D. Coordination with Mortar Joints: Do not apply water repellent until pointing mortar for joints adjacent to surfaces receiving water-repellent treatment has been installed and cured.

E. Coordination with Sealant Joints: Do not apply water repellent until sealants for joints adjacent to surfaces receiving water-repellent treatment have been installed and cured.

1. Water-repellent work may precede sealant application only if sealant adhesion and compatibility have been tested and verified using substrate, water repellent, and sealant materials identical to those required.

3.3 APPLICATION

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect the substrate before application of water repellent and to instruct Applicator on the product and application method to be used.

B. Apply coating of water repellent on surfaces to be treated using 15 psi-pressure spray with a fan-type spray nozzle to the point of saturation. Apply coating in dual passes of uniform, overlapping strokes. Remove excess material; do not allow material to puddle beyond saturation. Comply with manufacturer's written instructions for application procedure unless otherwise indicated.

1. Precast Concrete: At Contractor's option, first application of water repellent may be completed before installing units. Mask mortar and sealant bond surfaces to prevent water repellent from migrating onto joint surfaces. Remove masking after repellent has cured.

C. Apply a second saturation coating, repeating first application. Comply with manufacturer's written instructions for limitations on drying time between coats and after rainstorm wetting of surfaces between coats. Consult manufacturer's technical representative if written instructions are not applicable to Project conditions.

3.4 FIELD QUALITY CONTROL

A. Testing of Water-Repellent Material: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when water repellent is being applied:

1. Owner will engage the services of a qualified testing agency to sample water-repellent material being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
2. Testing agency will perform tests for compliance of water-repellent material with product requirements.
3. Owner may direct Contractor to stop applying water repellents if test results show material being used does not comply with product requirements. Contractor shall remove noncomplying material from Project site, pay for testing, and correct deficiency of surfaces treated with rejected materials, as approved by Architect.

B. Coverage Test: In the presence of Architect, hose down a dry, repellent-treated surface to verify complete and uniform product application. A change in surface color will indicate incomplete application.

1. Notify Architect seven days in advance of the dates and times when surfaces will be tested.

2. Reapply water repellent until coverage test indicates complete coverage.

3.5 CLEANING

A. Immediately clean water repellent from adjoining surfaces and surfaces soiled or damaged by water-repellent application as work progresses. Correct damage to work of other trades caused by water-repellent application, as approved by Architect.
B. Comply with manufacturer's written cleaning instructions.

END OF SECTION 07190

SECTION 07210 - THERMAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Extruded polystyrene foam-plastic board insulation (at perimeter foundation wall below grade and at other places indicated on drawings).
2. Polyisocyanurate foam-plastic board insulation (in cavity walls, furred CMU walls, above grade locations that are not scheduled for spray applied foam type insulation).
3. Glass-fiber blanket insulation.
4. Glass-fiber board insulation.
5. Mineral-wool blanket insulation.
6. Mineral-wool board insulation.
7. Loose-fill insulation.
8. Spray-applied cellulosic insulation.

B. Related Requirements:

1. Section 04 2000 "Unit Masonry" for insulation installed in masonry cells.
2. Section 06 1600 "Sheathing" for foam-plastic board sheathing installed directly over wood or steel framing.
3. Section 07 1326 "Self-Adhering Sheet Waterproofing"
4. Section 07 2119 "Foamed-in-Place Insulation" for spray-applied polyurethane foam insulation.
5. Section 07 5419 "Polyvinyl-Chloride (PVC) Roofing"for insulation specified as part of roofing construction.
6. Section 09 2900 "Gypsum Board" for sound attenuation blanket used as acoustic insulation.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Extruded polystyrene foam-plastic board insulation.

2. Polyisocyanurate foam-plastic board insulation.
3. Glass-fiber blanket insulation.
4. Glass-fiber board insulation.
5. Mineral-wool blanket insulation.
6. Mineral-wool board insulation.
7. Loose-fill insulation.

1.4 INFORMATIONAL SUBMITTALS

A. Installer's Certification: Listing type, manufacturer, and R-value of insulation installed in each element of the building thermal envelope.

1. For blown-in or sprayed fiberglass and cellulosic-fiber loose-fill insulation, indicate initial installed thickness, settled thickness, settled R-value, installed density, coverage area, and number of bags installed.
2. Sign, date, and post the certification in a conspicuous location on Project site.

B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

C. Research Reports: For foam-plastic insulation, from ICC-ES.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect foam-plastic board insulation as follows:

1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD INSULATION

A. Extruded Polystyrene Board Insulation, Type IV: ASTM C578, Type IV, 25-psi minimum compressive strength; unfaced.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. DiversiFoam Products.
    b. Dow Chemical Company (The).
    c. Kingspan Insulation Limited.
    d. Owens Corning.

2. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
3. Smoke-Developed Index: Not more than 450 when tested in accordance with ASTM E84.
4. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.

2.2 POLYISOCYANURATE FOAM-PLASTIC BOARD INSULATION

A. Polyisocyanurate Board Insulation, Foil Faced: ASTM C1289, foil faced, Type I, Class 1 or 2.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Atlas EPS; a Division of Atlas Roofing Corporation.
    b. Atlas Roofing Corporation.
    c. Carlisle Coatings & Waterproofing Inc.
    d. Dow Chemical Company (The).
    e. Firestone Building Products.
    f. Hunter Panels.
    g. Johns Manville; a Berkshire Hathaway company.
    h. Rmax, Inc.
2. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
3. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

B. Glass-Fiber Blanket Insulation, Unfaced: ASTM C665, Type I; passing ASTM E136 for combustion characteristics.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. CertainTeed Corporation.
    b. Johns Manville; a Berkshire Hathaway company.
    c. Knauf Insulation.

d. Owens Corning.

2. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
3. Smoke-Developed Index: Not more than 50 when tested in accordance with ASTM E84.
4. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

2.3 MINERAL-WOOL BLANKET INSULATION

A. Mineral-Wool Blanket Insulation, Unfaced: ASTM C665, Type IA (blankets without membrane facing); consisting of fibers; passing ASTM E136 for combustion characteristics.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Johns Manville; a Berkshire Hathaway company.
b. Rockwool International.
c. Thermafiber, Inc.; an Owens Corning company.

2. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
3. Smoke-Developed Index: Not more than 50 when tested in accordance with ASTM E84.
4. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

B. Mineral-Wool Blanket Insulation, Reinforced-Foil Faced: ASTM C665, Type III (reflective faced); Category 1 (membrane is a vapor barrier), faced with foil scrim, foil-scrim kraft, or foil-scrim polyethylene.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Thermafiber, Inc.; an Owens Corning company.

2. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
3. Smoke-Developed Index: Not more than 50 when tested in accordance with ASTM E84.
4. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

2.4 LOOSE-FILL INSULATION

A. Cellulosic-Fiber Loose-Fill Insulation: ASTM C739, chemically treated for flame-resistance, processing, and handling characteristics.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. GreenFiber.
    b. Hamilton Manufacturing Inc.
    c. Nu-Wool Co., Inc.

2.5 INSULATION FASTENERS

A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. AGM Industries, Inc.
    b. Gemco.
2. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
3. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation.

B. Adhesively Attached, Angle-Shaped, Spindle-Type Anchors: Angle welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Gemco.
2. Angle: Formed from 0.030-inch-thick, perforated, galvanized carbon-steel sheet with each leg 2 inches square.
3. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation.

C. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as

required to hold insulation securely in place, but not less than 1-1/2 inches square or in diameter.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. AGM Industries, Inc.
    b. Gemco.
2. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:

    a. Crawl spaces.
    b. Ceiling plenums.
    c. Attic spaces.
    d. <Insert location>.

D. Insulation Standoff: Spacer fabricated from galvanized mild-steel sheet for fitting over spindle of insulation anchor to maintain air space of 1 inch between face of insulation and substrate to which anchor is attached.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Gemco.

E. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates without damaging insulation, fasteners, or substrates.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. AGM Industries, Inc.
    b. Gemco.

2.6 ACCESSORIES

A. Insulation for Miscellaneous Voids:

1. Glass-Fiber Insulation: ASTM C764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E84.
2. Spray Polyurethane Foam Insulation: ASTM C1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84.

B. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

C. Asphalt Coating for Cellular-Glass Block Insulation: Cutback asphalt or asphalt emulsion of type recommended by manufacturer of cellular-glass block insulation.

D. Eave Ventilation Troughs: Preformed, rigid fiberboard or plastic sheets designed and sized to fit between roof framing members and to provide ventilation between insulated attic spaces and vented eaves.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications.
B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Install insulation with manufacturer's R-value label exposed after insulation is installed.
D. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
E. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.3 INSTALLATION OF SLAB INSULATION

A. On vertical slab edge and foundation surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.

1. If not otherwise indicated, extend insulation a minimum of 36 inches below exterior grade line.

B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

1. If not otherwise indicated, extend insulation a minimum of 24 inches in from exterior walls.

3.4 INSTALLATION OF FOUNDATION WALL INSULATION

A. Butt panels together for tight fit.

B. Anchor Installation: Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:

1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions.
2. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application.
3. Apply insulation standoffs to each spindle to create cavity width indicated on Drawings between concrete substrate and insulation.
4. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation.
5. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

C. Adhesive Installation: Install with adhesive or press into tacky waterproofing or dampproofing according to manufacturer's written instructions.

3.5 INSTALLATION OF CAVITY-WALL INSULATION

A. Foam-Plastic Board Insulation: Install pads of adhesive spaced approximately 24 inches o.c. both ways on inside face and as recommended by manufacturer.

1. Fit courses of insulation between wall ties and other obstructions, with edges butted tightly in both directions, and with faces flush.
2. Press units firmly against inside substrates.

3. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Section 04 2000 "Unit Masonry."

3.6 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:

1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
4. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.

B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:

1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft..
2. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

C. Loose-Fill Insulation: Apply according to ASTM C1015 and manufacturer's written instructions.

1. Level horizontal applications to uniform thickness as indicated, lightly settle to uniform density, but do not compact excessively.
2. For cellulosic-fiber loose-fill insulation, comply with CIMA's Bulletin #2, "Standard Practice for Installing Cellulose Insulation."

3.7 INSTALLATION OF CURTAIN-WALL INSULATION

A. Install board insulation in curtain-wall construction according to curtain-wall manufacturer's written instructions.

1. Hold insulation in place by securing metal clips and straps or integral pockets within window frames, spaced at intervals recommended in writing by insulation manufacturer to hold insulation securely in place without touching spandrel glass.

2. Maintain cavity width of dimension indicated on Drawings between insulation and glass.
3. Install insulation to fit snugly without bowing.

3.8 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.
B. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 07210

SECTION 07260 - UNDER-SLAB VAPOR RETARDER

PART 1 – GENERAL

1.1 SUMMARY

A. Products Supplied Under This Section
   1. Vapor retarder, seam tape, mastic, and pipe boots for installation under concrete slabs.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. ASTM E 1745- 11Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs.
   2. ASTM E 154- 08 Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.
   3. ASTM F 1249-06 (2011) Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor.
   4. ASTM D 882-10 Standard Test Method for Tensile Properties of Thin Plastic Sheeting.
   5. ASTM D 1709-09 Standard Test Methods for Impact Resistance of Plastic Film by the Free-Falling Dart Method.
   6. ASTM E 1643- 11Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.

B. American Concrete Institute (ACI):
   1. ACI 302.2R-06 Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials.

1.3 SUBMITTALS

A. Quality Control / Assurance
   1. Manufacturer’s samples, literature
   2. Manufacturer’s installation instructions for placement, seaming and pipe boot installation

PART 2 – PRODUCTS

2.1 MATERIALS

A. Vapor Retarder must have all of the following qualities:
   1. Maintain permeance of less than 0.01 Perms [grains/(ft^2 · hr · inHg)] as tested in accordance with conditioning tests per ASTM E 1745 Section 7.1.1-7.1.5.
   2. Other performance criteria:
      a. Strength: ASTM E 1745 Class A.
      b. Thickness: 15 mils minimum

B. Basis-of-Design Product:
   1. Stego Wrap, 15 mil thickness.

C. Other Approved Products:
   1. Perminator, 15 mil thickness, by W.R. Meadows

2.2 ACCESSORIES

A. Seam Tape:
   1. Permeance less than 0.3 perms per ASTM F 1249 or ASTM E 96

C. Vapor Proofing Mastic:
   1. Permeance less than 0.3 perms per ASTM F 1249 or ASTM E 96

E. Pipe Boots
   1. Construct pipe boots from vapor retarder material, pressure sensitive tape and/or mastic per manufacturer's instructions.

F. Perimeter Edge/Seal
   1. Provide products to terminate the vapor retarder at the perimeter of the building per installation standard ASTM E 1643.

PART 3 – EXECUTION

3.1 PREPARATION

A. Ensure that subsoil is approved by Architect or Geotechnical Engineer.
   1. Level and tamp or roll aggregate, sand or granular base.

3.2 INSTALLATION

A. Install vapor retarder in accordance with manufacturer's instructions and ASTM E 1643-98 (2005).
   1. Unroll vapor retarder with the longest dimension parallel with the direction of the concrete pour.
   2. Extend vapor barrier over footings and grade beams to a distance acceptable to the structural engineer or stop at impediments such as dowels and waterstops.
   3a. Seal vapor retarder to slab perimeter/edge using Stego Crete Claw (Proprietary Product) and remove dirt, debris, and mud from Crete Claw prior to concrete placement.

OR

3b. Seal vapor retarder to footing/grade beam with double sided tape, termination bar, or both.

4. Overlap joints 6 inches and seal with manufacturer's tape.
5. Seal all penetrations (including pipes) per manufacturer's instructions.
6. No penetration of the vapor retarder is allowed except for reinforcing steel and permanent utilities.
7. Repair damaged areas by cutting patches of vapor retarder, overlapping damaged area 6 inches and taping all four sides with tape.

END OF SECTION 07260

SECTION 07411 - STANDING-SEAM METAL ROOF PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Standing-seam metal roof panels
B. Trim and accessories for standing-seam roof systems

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

B. Shop Drawings:

1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.

C. Samples for Initial Selection: For each type of metal panel indicated with factory-applied color finishes.

1. Include similar Samples of trim and accessories involving color selection.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.

1. Metal Panels: 12 inches long by actual panel width. Include clips, fasteners, closures, and other metal panel accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.
B. Product Test Reports: For each product, for tests performed by a qualified testing agency.
C. Sample Warranties: For special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panels to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
D. Retain strippable protective covering on metal panels during installation.

1.8 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.9 COORDINATION

A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

    a. Structural failures including rupturing, cracking, or puncturing.
    b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

    a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
    b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
    c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 10 years from date of Substantial Completion.

C. Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.

1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Solar Reflectance Index: Not less than 29 when calculated according to ASTM E 1980.

B. Energy Performance: Provide roof panels with an aged Solar Reflectance Index of not less than 0.64 when tested according to CRRC-1.

C. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592:

1. Deflection Limits: For wind loads, no greater than 1/180 of the span.

D. Air Infiltration: Air leakage of not more than 1.1 cfm/sq. ft. when tested according to ASTM E 1680 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft.

E. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 1646 at the following test-pressure difference:

1. Test-Pressure Difference: 20.0 psf

F. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E 2140.

G. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.

1. Uplift Rating: U.L Class 90 Rating

H. FM Global Listing: Provide metal roof panels and component materials that comply with requirements in FM Global 4471 as part of a panel roofing system and that are listed in FM Global's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.

1. Fire/Windstorm Classification: Class 1-120.

I. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F ambient; 180 deg F material

2.2 STANDING-SEAM METAL ROOF PANELS

A. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.

1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1514.

B. Vertical-Rib, Seamed-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and a flat pan between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and mechanically seaming panels together.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide **Berridge Double-Lock Zee-Lock** standing seam system or comparable product by one of the following:
   a. Berridge Manufacturing Company.
   b. CENTRIA Architectural Systems.
   c. Englert, Inc.
   d. Firestone Metal Products, LLC.
   e. Garland Company, Inc. (The)
   f. IMETCO.
   g. MBCI; a division of NCI Building Systems, L.P.
   h. Fabral Metal Wall and Roof Systems

3. Metallic-Coated Steel Sheet: Aluminum-Zinc Alloy Coated steel sheet, 22-Gauge, ASTM 792-08, Grade 40, yield strength 40 ksi min. Sheets shall be prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

   a. Exterior Finish: Finish shall be full strength fluoropolymer coating applied by the manufacturer on a continuous coil coating line, with a top side dry film thickness of 0.75 ± 0.05 mil over 0.20 ± 0.05 mil prime coat, to provide a total top side dry film thickness of 0.95 ± 0.10 mil. Bottom side shall be coated with a primer (non-metallics only) and beige urethane coating with a total dry film thickness of 0.35 ± 0.05 mil. Finish shall conform to all tests for adhesion, flexibility, and longevity as specified by the finish supplier.
   b. Color: To be chosen from manufacturer’s selection of premium finish, metallic colors.

4. Clips: standard clips to accommodate the system described.
5. Joint Type: Double folded.
6. Panel Coverage: 12 inches.
7. Joint Height: 2.0 inches

2.3 UNDERLAYMENT MATERIALS

A. Provide 2 layers Ice & Water Shield underlayment installed over solid plywood sheathing and fastened in place.

1. Provide Grace Ice & Water Shield (40 mil) or equivalent.

2.4 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C 645; cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90 (Z275 hot-dip galvanized) coating designation or ASTM A 792/A 792M, Class AZ50 (Class AZM150) coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels.

1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

D. Panel Fasteners: Self-tapping screws designed to withstand design loads.

E. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
2. Joint Sealant: ASTM C 920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

2.5 FABRICATION

A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.

C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.

3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

    a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal panel manufacturer for application, but not less than thickness of metal being secured.

2.6 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
C. Steel Panels and Accessories:
    1. Metallic Fluoropolymer: AAMA 621. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.

    1. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.

2. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.

    a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.

3.3 UNDERLAYMENT INSTALLATION

A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches (152 mm) staggered 24 inches (610 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps with roller. Cover underlayment within 14 days.

    1. Apply over the entire roof surface.

B. Slip Sheet: Apply slip sheet over underlayment before installing metal roof panels.
C. Flashings: Install flashings to cover underlayment.

3.4 METAL PANEL INSTALLATION

A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

    1. Shim or otherwise plumb substrates receiving metal panels.

2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
3. Install screw fasteners in predrilled holes.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as metal panel work proceeds.
6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners:

1. Steel Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.

C. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.

D. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

E. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.

1. Install clips to supports with self-tapping fasteners.
2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
4. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.
5. Watertight Installation:

    a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommend in writing by manufacturer as needed to make panels watertight.

b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
c. At panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with sealant and fastened together by interlocking clamping plates.

F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal roof panel manufacturers; or, if not indicated, types recommended by metal roof panel manufacturer.

G. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof and weather-resistant performance.

3.5 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal panel units within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect metal roof panel installation, including accessories. Report results in writing.
B. Remove and replace applications of metal roof panels where tests and inspections indicate that they do not comply with specified requirements.
C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

D. Prepare test and inspection reports.

3.7 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.
B. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07411

SECTION 07461 - METAL SIDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes aluminum siding and soffit.

1.3 COORDINATION

A. Coordinate siding installation with flashings and other adjoining construction to ensure proper sequencing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
B. Samples for Initial Selection: For aluminum siding and soffit including related accessories.
C. Samples for Verification: For each type, color, texture, and pattern required.

1. 12-inch- long-by-actual-width Sample of siding and soffit

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of aluminum siding and soffit
B. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of product, including related accessories, to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Furnish full lengths of aluminum siding and soffit including related accessories, in a quantity equal to 2 percent of amount installed.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with labels intact until time of use.
B. Store materials on elevated platforms, under cover, and in a dry location.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace products that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including cracking, fading, and deforming.
b. Hail damage, including denting.
c. Deterioration of metals, metal finishes, and other materials, including chalking, beyond normal weathering.

2. Warranty Period: 25 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain products, including related accessories, from single source from single manufacturer.

a. EDCO Products Inc.
b. Gentek Building Products, Inc.
c. Norandex Building Materials Distribution, Inc.
d. Quality Edge.
e. Rollex Corporation.
f. United States Seamless.

2.2 METAL SIDING

A. Metal Siding: Formed product, in continuous lengths without end joints, made from galvanized steel complying with ASTM A653/A653M, G90 coating.

B. Vertical Pattern: 6-inch exposure in V-groove board style.
C. Texture: Smooth.

D. Finish: Manufacturer's standard finish.

1. Color: As selected by Architect from manufacturer’s full range of colors.

2.3 METAL SOFFIT

A. Metal Soffit: Same as above.

2.4 ACCESSORIES

A. Siding Accessories, General: Provide starter strips, edge trim, outside and inside corner caps, and other items as recommended by siding manufacturer for building configuration.

1. Provide accessories made from same material as adjacent siding unless otherwise indicated.

B. Flashing: Provide metal flashing complying with Section 076200 "Sheet Metal Flashing and Trim" at window and door heads and where indicated.
C. Fasteners:

1. For fastening to wood, use siding nails of sufficient length to penetrate a minimum of 1 inch into substrate.
2. For fastening to metal, use ribbed bugle-head screws of sufficient length to penetrate a minimum of 1/4 inch, or three screw-threads, into substrate.
3. For fastening aluminum, use aluminum fasteners. Where fasteners are exposed to view, use prefinished aluminum fasteners in color to match item being fastened.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of aluminum siding and soffit and related accessories.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of projections and substances detrimental to application.

3.3 INSTALLATION

A. General: Comply with manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.

    1. Center nails in elongated nailing slots without binding siding to allow for thermal movement.

B. Install aluminum siding and soffit and related accessories according to AAMA 1402.
C. Install joint sealants as specified in Section 079200 "Joint Sealants" and to produce a weathertight installation.
D. Where aluminum siding contacts dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape or installing nonconductive spacers as recommended by manufacturer for this purpose.

3.4 ADJUSTING AND CLEANING

A. Remove damaged, improperly installed, or otherwise defective materials and replace with new materials complying with specified requirements.
B. Clean finished surfaces according to manufacturer's written instructions and maintain in a clean condition during construction.

END OF SECTION 07461

SECTION 07620 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following sheet metal flashing and trim:
   1. Manufactured through-wall flashing
   2. Manufactured reglets.
   3. Formed low-slope roof flashing and trim.
   4. Formed wall sheet metal fabrications
   5. Formed equipment support flashing.

1.3 PERFORMANCE REQUIREMENTS

A. General: Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing, rattling, leaking, and fastener disengagement.

B. Fabricate and install roof edge flashing and copings capable of resisting the following forces according to recommendations in FMG Loss Prevention Data Sheet 1-49:
   1. Wind Zone 1: For velocity pressures of 21 to 30 lbf/sq. ft.: 60-lbf/sq. ft. perimeter uplift force, 90-lbf/sq. ft. corner uplift force, and 30-lbf/sq. ft. outward force.

C. Thermal Movements: Provide sheet metal flashing and trim that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of sheet metal and trim thermal movements. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

D. Water Infiltration: Provide sheet metal flashing and trim that do not allow water infiltration to building interior.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: Show layouts of sheet metal flashing and trim, including plans and elevations. Distinguish between shop- and field-assembled work. Include the following:
   1. Identify material, thickness, weight, and finish for each item and location in Project.
   2. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.
   3. Details for fastening, joining, supporting, and anchoring sheet metal flashing and trim, including fasteners, clips, cleats, and attachments to adjoining work.
   4. Details of expansion-joint covers, including showing direction of expansion and contraction.

C. Samples for Initial Selection: For each type of sheet metal flashing and trim indicated with factory-applied color finishes.
   1. Include similar Samples of trim and accessories involving color selection.

1.5 QUALITY ASSURANCE

A. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual." Conform to dimensions and profiles shown unless more stringent requirements are indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver sheet metal flashing materials and fabrications undamaged. Protect sheet metal flashing and trim materials and fabrications during transportation and handling.

B. Unload, store, and install sheet metal flashing materials and fabrications in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack materials on platforms or pallets, covered with suitable weathertight and ventilated covering. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.

1.7 COORDINATION

A. Coordinate installation of sheet metal flashing and trim with interfacing and adjoining construction to provide a leakproof, secure, and noncorrosive installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 SHEET METALS

A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation; structural quality, mill phosphatized for field painting where indicated.

B. Prepainted, Metallic-Coated Steel Sheet: Steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
   1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.
   2. Exposed Finishes: Apply the following coil coating:
      a. Metallic Fluoropolymer: AAMA 621. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
         1) Color: As selected by Architect from manufacturer's full range.

C. Lead Sheet: ASTM B 749, Type L51121, copper-bearing lead sheet.
D. Stainless-Steel Sheet: ASTM A 240/A 240M Type 304 dead soft, fully annealed; with smooth, flat surface.

2.3 UNDERLAYMENT MATERIALS

A. Felts: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.

2.4 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads.
   1. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws, gasketed, with hex washer head.

C. Solder for Lead: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead.

D. Solder for Zinc: ASTM B 32, 60 percent lead and 40 percent tin with low antimony, as recommended by manufacturer.

E. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane or silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

F. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.5 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated. Shop fabricate items where practicable. Obtain field measurements for accurate fit before shop fabrication.

B. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.

C. Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
   1. Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.

D. Expansion Provisions: Where lapped or bayonet-type expansion provisions in the Work cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with elastomeric sealant concealed within joints.

E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
   1. Thickness: As recommended by SMACNA's "Architectural Sheet Metal Manual" for application but not less than thickness of metal being secured.

2.6 MANUFACTURED SHEET METAL FLASHING AND TRIM

A. Reglets: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated.
   1. Manufacturers:
      a. Cheney Flashing Company, Inc.
      b. Fry Reglet Corporation.
      c. Hickman, W. P. Company.
      d. Keystone Flashing Company, Inc.

   2. Material: Galvanized steel, 0.0217 inch thick.
   3. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
   4. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.

2.7 ROOF-DRAINAGE SHEET METAL FABRICATIONS

A. Parapet Scuppers: Fabricate scuppers to dimensions required, with closure flange trim to exterior, 4-inch-wide wall flanges to interior, and base extending 4 inches beyond cant or tapered strip into field of roof. Fabricate from the following materials:

   1. Galvanized Steel: 0.028 inch thick.

2.8 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. Copings: Fabricate in minimum 96-inch-long, but not exceeding 10-foot-long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and drill elongated holes for fasteners on interior leg. Miter corners, seal, and solder or weld watertight.
   1. Joint Style: Standing seam joint.
      a. Galvanized Steel: 0.0396 inch thick in concealed areas.
      b. Prepainted, Metallic-Coated Steel: 0.0396 inch thick in exposed areas.

B. Roof and Roof-to-Wall Transition Expansion-Joint Cover: Fabricate from the following materials. Shop fabricate interior and exterior corners.
   1. Galvanized Steel: 0.034 inch thick.

C. Base Flashing: Fabricate from the following material:
   1. Galvanized Steel: 0.0276 inch thick.

D. Counterflashing: Fabricate from the following material:
   1. Galvanized Steel: 0.0217 inch thick.

E. Flashing Receivers: Fabricate from the following material:
   1. Galvanized Steel: 0.0217 inch thick.

F. Roof-Penetration Flashing: Fabricate from the following material:
   1. Galvanized Steel: 0.0276 inch thick.

G. Roof-Drain Flashing: Fabricate from the following material:
   1. Lead: 4.0 lb/sq. ft., hard tempered.

2.9 MISCELLANEOUS SHEET METAL FABRICATIONS

A. Equipment Support Flashing: Fabricate from the following material:
   1. Galvanized Steel: 0.0276 inch thick.

2.10 WALL SHEET METAL FABRICATIONS

A. Through-Wall Flashing (Drip plates): Fabricate continuous flashings in minimum 96-inch-long, but not exceeding 12-foot-long, sections, at bottom of veneers and at shelf angles. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches beyond each side of wall openings; and form with 2-inch-high, end dams. Fabricate from the following materials:
   1. Stainless Steel: 0.016 inch thick.

B. Opening Flashings in Frame Construction: Fabricate head, sill, and similar flashings to extend 4 inches beyond wall openings. Form head and sill flashing with 2-inch-high, end dams. Fabricate from the following materials:
   1. Stainless Steel: 0.016 inch thick.

2.11 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations

in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of work.
   1. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
   2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
   1. Torch cutting of sheet metal flashing and trim is not permitted.

B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by fabricator or manufacturers of dissimilar metals.
   1. Coat side of lead sheet metal flashing and trim with bituminous coating where flashing and trim will contact wood, ferrous metal, or cementitious construction.
   2. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene underlayment.
   3. Bed flanges in thick coat of asphalt roofing cement where required for waterproof performance.

C. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
D. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and elastomeric sealant.
E. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.

1. Space cleats not more than 12 inches apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.

F. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with elastomeric sealant concealed within joints.

G. Fasteners: Use fasteners of sizes that will penetrate substrate not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws.
   1. Galvanized or Prepainted, Metallic-Coated Steel: Use stainless-steel fasteners.

H. Seal joints with elastomeric sealant as required for watertight construction.

I. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pretin edges of sheets to be soldered to a width of 1-1/2 inches except where pretinned surface would show in finished Work.
   1. Do not solder prepainted sheet.

3.3 ROOF FLASHING INSTALLATION

A. General: Install sheet metal roof flashing and trim to comply with performance requirements and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight.

B. Copings: Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for specified wind zone and as indicated.
   1. Interlock exterior bottom edge of coping with continuous cleats anchored to substrate at 16-inch centers.
   2. Anchor interior leg of coping with screw fasteners and washers at 18-inch centers.

C. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending a minimum of 4 inches over base flashing. Install stainless-steel draw band and tighten.

D. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints a minimum of 4 inches and bed with elastomeric sealant.
   1. Secure in a waterproof manner by means of snap-in installation and sealant or lead wedges and sealant.

E. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Install flashing as follows:
   1. Seal with elastomeric sealant and clamp flashing to pipes penetrating roof except for lead flashing on vent piping.

3.4 WALL FLASHING INSTALLATION

A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to SMACNA recommendations and as indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.
B. Through-Wall Flashing: Installation of manufactured through-wall flashing is specified in Division 4 Section "Unit Masonry Assemblies."

3.5 MISCELLANEOUS FLASHING INSTALLATION

A. Equipment Support Flashing: Coordinate installation of equipment support flashing with installation of roofing and equipment. Weld or seal flashing with elastomeric sealant to equipment support member.

3.6 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
B. Clean and neutralize flux materials. Clean off excess solder and sealants.
C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain in a clean condition during construction.
D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07620

SECTION 07720 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Roof hatches.

1.3 SUBMITTALS

A. Product Data: For each type of roof accessory indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: Show fabrication and installation details for roof accessories. Show layouts of roof accessories including plans and elevations. Indicate dimensions, weights, loadings, required clearances, method of field assembly, and components. Include plans, elevations, sections, details, and attachments to other work.

1.4 QUALITY ASSURANCE

A. Sheet Metal Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" details for fabrication of units, including flanges and cap flashing to coordinate with type of roofing indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Pack, handle, and ship roof accessories properly labeled in heavy-duty packaging to prevent damage.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify required openings for each type of roof accessory by field measurements before fabrication and indicate measurements on Shop Drawings.

1.7 COORDINATION

A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed in other Part 2 articles.

2.2 ROOF HATCHES

A. Roof Hatches: Fabricate roof hatches with insulated double-wall lids and curb frame with integral deck mounting flange and lid frame counterflashing. Fabricate with welded or mechanically fastened and sealed corner joints. Provide continuous weathertight perimeter gasketing and equip with corrosion-resistant or hot-dip galvanized hardware.
   1. Manufacturers:
      a. Babcock-Davis; a Cierra Products Inc. Company.
      b. Bilco Company (The).
      c. Dur-Red Products.
      d. J. L. Industries, Inc.
      e. Metallic Products Corporation.
      f. Milcor Inc.; a Gibraltar Company.
      g. Roof Products & Systems Corporation.
      h. Elmdor.
      i. Precision Ladders, LLC
   2. Loads: Fabricate roof hatches to withstand 40-lbf/sq. ft. external and 20-lbf/sq. ft. internal loads.
   3. Type and Size: Single-leaf lid, 48 by 48 inches.
   4. Curb and Lid Material: Aluminum-zinc alloy-coated steel sheet, 0.079 inch thick.
   5. Interior Lid Liner: Manufacturer's standard metal liner of same material and finish as outer metal lid.
   6. Fabricate units to minimum height of 12 inches, unless otherwise indicated.
   7. Hardware: Galvanized steel spring latch with turn handles, butt- or pintle-type hinge system, and padlock hasps inside and outside.
   8. Safety Railing System: Manufacturer's standard complete system including rails, clamps, fasteners, safety barrier at railing opening, and all accessories required for a complete installation.
      a. Height: 42 inches above finished roof deck.
      b. Pipe or Tube: 1-1/4-inch ID galvanized pipe or 1-5/8-inch OD galvanized tube.
      c. Fabricate joints that will be exposed to weather in a watertight manner.

d. Close exposed ends of handrail and railing members with prefabricated end fittings.
e. Fasteners: Manufacturer's standard.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of work.
   1. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored and is ready to receive roof accessories.
   2. Verify dimensions of roof openings for roof accessories.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install roof accessories according to manufacturer's written instructions. Anchor roof accessories securely in place and capable of resisting forces specified. Use fasteners, separators, sealants, and other miscellaneous items as required for completing roof accessory installation. Install roof accessories to resist exposure to weather without failing, rattling, leaking, and fastener disengagement.
B. Install roof accessories to fit substrates and to result in watertight performance.
C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
D. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.
E. Roof Hatch Installation:
   1. Check roof hatch for proper operation. Adjust operating mechanism as required. Clean and lubricate joints and hardware.
   2. Attach safety railing system to roof hatch curb.

3.3 CLEANING

A. Clean exposed surfaces according to manufacturer's written instructions.

END OF SECTION 07720

SECTION 07725 - SNOW GUARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Rail-Type, Seam-Mounted Snow Guards.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product, include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
B. Shop Drawings: Include roof plans showing layouts and attachment details of snow guards.
   1. Include details of rail-type snow guards.
C. Samples:
   1. Rail-Type Snow Guards: 12” section with installation hardware.
      a. For units with factory-applied finishes, submit color to match metal roofing.
D. Delegated-Design Submittal: For snow guards, include analysis reports signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Include calculation of number and location of snow guards.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that the engineer is licensed in the state in which the Project is located.

B. Product Test Reports: For each type of snow guard, for tests performed by a qualified testing agency, indicating load at failure of attachment to roof system identical to roof system used on this Project.

1.5 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit adhesive-mounted snow guards to be installed, and adhesive cured, according to adhesive manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 4000 "Quality Requirements," to design snow guards, including attachment to roofing material and roof deck, as applicable for attachment method, based on the following:

1. Roof snow load.
2. Snow drifting
3. Roof slope.
4. Roof type.
5. Roof dimensions.
6. Roofing substrate type and thickness.
7. Snow guard type.
8. Snow guard fastening method and strength.
9. Snow guard spacing.
10. Coefficient of Friction Between Snow and Roof Surface: 0.
11. Factor of Safety: 2.

B. Performance Requirements: Provide snow guards that withstand exposure to weather and resist thermally induced movement without failure, rattling, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

C. Structural Performance: Snow guards shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Snow Loads: As determined by structural engineer.

2.2 RAIL-TYPE SNOW GUARDS

A. Rail-Type, Seam-Mounted Snow Guards:

1. Manufacturers:
   a. Alpine Snow Guards
   b. Rocky Mountain Snow Guards
   c. Sno Gem

2. Description: Snow guard rails fabricated from metal pipes, bars, or extrusions, anchored to brackets and equipped with one rail. Basis of Design: Sno Gem 2” iClad-S.
3. Brackets and Baseplate: ASTM B209 aluminum; mill finished.
4. Bars: ASTM B221 aluminum; mill finish.

   a. Profile: Square with integral track to accept color-matching inserts of material and finish used for metal roof.

5. Seam clamps: ASTM B221 aluminum extrusion or ASTM B85/B85M aluminum casting with stainless steel set screws incorporating round nonpenetrating point; designed for use with applicable roofing system to which clamp is attached.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, snow guard attachment, and other conditions affecting performance of the Work.

1. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and prepare substrates for bonding snow guards.
B. Prime substrates according to snow guard manufacturer's written instructions.

3.3 INSTALLATION

A. Install snow guards according to manufacturer's written instructions.

1. Space rows as indicated on Drawings.
2. Space rows as recommended by manufacturer.

B. Attachment for Standing-Seam Metal Roofing:

1. Do not use fasteners that will penetrate metal roofing or fastening methods that void metal roofing finish warranty.
2. Pad-Type, Flat-Mounted Snow Guards:

    a. Mechanically attach to metal roofing according to manufacturer's instructions.
    b. Solder to copper roofing according to manufacturer's instructions.

3. Rail-Type, Seam-Mounted Snow Guards:

    a. Install brackets to vertical ribs in straight rows.
    b. Secure with stainless steel set screws, incorporating round nonpenetrating point, on same side of standing seam.
    c. Torque set screw according to manufacturer's instructions.
    d. Install cross members to brackets.

END OF SECTION 07725

SECTION 07841 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Penetration firestopping systems for the following applications:

a. Penetrations in fire-resistance-rated walls.
b. Penetrations in horizontal assemblies.
c. Penetrations in smoke barriers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly. Obtain approval of authorities having jurisdiction prior to submittal.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.
B. Product Test Reports: For each penetration firestopping system, for tests performed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping system when ambient or substrate temperatures are outside limits permitted by penetration firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.
B. Install and cure penetration firestopping materials per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.7 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be installed according to specified firestopping system design.
B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:

    a. Penetration firestopping systems shall bear classification marking of a qualified testing agency.

        1) UL in its "Fire Resistance Directory."
        2) Intertek Group in its "Directory of Listed Building Products."
        3) FM Approval in its "Approval Guide."

2.2 PENETRATION FIRESTOPPING SYSTEMS

A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. 3M Fire Protection Products.
    b. A/D Fire Protection Systems Inc.
    c. Construction Solutions.
    d. Grabber Construction Products.
    e. Hilti, Inc.
    f. HOLDRITE.
    g. NUCO Inc.
    h. Passive Fire Protection Partners.
    i. Specified Technologies, Inc.
    j. STC Sound Control.
    k. Tremco, Inc.

B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.
2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
3. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to UL 1479.

D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479, based on testing at a positive pressure differential of 0.30-inch wg.

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at and no more than 50-cfm cumulative total for any 100 sq. ft. at both ambient and elevated temperatures.

E. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E84.

F. Manufactured Piping Penetration Firestopping System: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. <Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   a. ProVent Systems, Inc.
2. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.
3. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
4. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to UL 1479.
5. Sleeve: Molded-PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
6. Stack Fitting: ASTM A48/A48M, gray-iron, hubless-pattern wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
7. Special Coating: Corrosion resistant on interior of fittings.

G. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.

1. Permanent forming/damming/backing materials.
2. Substrate primers.
3. Collars.
4. Steel sleeves.

2.3 FILL MATERIALS

A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer sleeve lined with an intumescent strip, a flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced intumescent elastomeric sheet bonded to galvanized-steel sheet.
E. Intumescent Putties: Nonhardening, water-resistant, intumescent putties containing no solvents or inorganic fibers.
F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.
I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants.

2.4 MIXING

A. Penetration Firestopping Materials: For those products requiring mixing before application, comply with penetration firestopping system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Before installing penetration firestopping systems, clean out openings immediately to comply with manufacturer's written instructions and with the following requirements:

    1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping materials.
    2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
    3. Remove laitance and form-release agents from concrete.

B. Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 INSTALLATION

A. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.
B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.

    1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.

C. Install fill materials by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with minimum 0.375-inch strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet from end of wall and at intervals not exceeding 30 feet.

B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E2174.
B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.
C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping material and install new materials to produce systems complying with specified requirements.

END OF SECTION 07841

SECTION 07920 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes sealants for the following applications, including those specified by reference to this Section:
   1. Exterior joints in the following surfaces and nontraffic horizontal surfaces:
      a. Perimeter joints between dissimilar materials and frames of doors and windows.
      b. Other joints as indicated.
   2. Exterior joints in the following horizontal traffic surfaces:
      a. Control, expansion, and isolation joints in cast-in-place concrete slabs.
      b. Other joints as indicated.
   3. Interior joints in the following vertical surfaces and horizontal nontraffic surfaces:
      a. Vertical control joints on exposed surfaces of interior unit masonry and concrete walls and partitions.
      b. Perimeter joints between interior wall surfaces and frames of interior doors, windows, and elevator entrances.
      c. Joints between plumbing fixtures and adjoining walls, floors, and counters.
      d. Other joints as indicated.

1.3 PERFORMANCE REQUIREMENTS

A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

1.4 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.
B. Store and handle materials in compliance with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with installation of joint sealants under the following conditions:

    1. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer.

B. Joint-Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.
C. Joint-Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

PART 2 - PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products indicated for each type in the sealant schedules at the end of Part 3.

2.2 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range for this characteristic.

2.3 ELASTOMERIC JOINT SEALANTS

A. Elastomeric Sealant Standard: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant in the Elastomeric Joint-Sealant Schedule at the end of Part 3, including those referencing ASTM C 920 classifications for type, grade, class, and uses.

2.4 ACOUSTICAL JOINT SEALANTS

A. Acoustical Sealant for Exposed and Concealed Joints: For each product of this description indicated in the Acoustical Joint-Sealant Schedule at the end of Part 3, provide manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834 and the following:
   1. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

2.5 JOINT-SEALANT BACKING

A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

2.6 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants with joint substrates.
C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint sealant manufacturer's written instructions and the following requirements:
   1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
   2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air. Porous joint surfaces include the following:
      a. Concrete.
      b. Masonry.
      c. Unglazed surfaces of ceramic tile.
   3. Remove laitance and form-release agents from concrete.

B. Joint Priming: Prime joint substrates where recommended in writing by joint sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations of ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Acoustical Sealant Application Standard: Comply with recommendations of ASTM C 919 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.

D. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

E. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and back of joints.

F. Install sealants by proven techniques to comply with the following and at the same time backings are installed:
   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses provided for each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

G. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
   1. Remove excess sealants from surfaces adjacent to joint.
   2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.

3.4 CLEANING

A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from the original work.

3.6 ELASTOMERIC JOINT-SEALANT SCHEDULE

A. Multicomponent Nonsag Polysulfide Sealant: Where joint sealants of this type are indicated, provide products complying with the following:

   1. Products: Provide one of the following:
      a. cm-60; W.R Meadows, Inc.
      b. T-2235-M; Morton International, Inc.

c. T-2282; Morton International, Inc.
d. Thiokol 2P; Morton International, Inc.
e. GC-5 Synthacalk; Pecora Corporation.
f. Two-Part Sealant; Sonneborn Building Products Div., ChemRex Inc.

2. Type and Grade: M (multicomponent) and NS (nonsag).
3. Class: 25.
4. Uses Related to Exposure: T (traffic)

3.7 LATEX JOINT-SEALANT SCHEDULE

A. Latex Sealant: Where joint sealants of this type are indicated, provide products complying with the following:
1. Products: Provide one of the following:
a. Chem-Calk 600; Bostik Inc.
b. NuFlex 330; NUCO Industries, Inc.
c. LC 160 All Purpose Acrylic Caulk; Ohio Sealants, Inc.
d. AC-20; Pecora Corporation.
e. PSI-701; Polymeric Systems, Inc.
f. Sonolac; Sonneborn Building Products Div., ChemRex, Inc.
g. Tremflex 834; Tremco.

3.8 ACOUSTICAL JOINT-SEALANT SCHEDULE

A. Acoustical Sealant for Exposed and Concealed Joints: At all sound partitions and where joint sealants of this type are indicated, provide products complying with the following:
1. Products: Provide one of the following:
a. AC-20 FTR Acoustical and Insulation Sealant; Pecora Corporation.
b. SHEETROCK Acoustical Sealant; USG Corp., United States Gypsum Co.

B. Acoustical Sealant for Concealed Joints: At all sound partitions and where joint sealants of this type are indicated, provide products complying with the following:
1. Products: Provide one of the following:
a. Pro-Series SC-170 Rubber Base Sound Sealant; Ohio Sealants, Inc.
b. BA-98; Pecora Corporation.
c. Tremco Acoustical Sealant; Tremco.

END OF SECTION 07920

SECTION 08111 – HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Interior hollow metal doors.
   2. Interior hollow metal door frames with hinge reinforcement
   3. Interior hollow metal window frames.
   4. Interior sidelight frames
   5. Fire-rated door and frame assemblies.
   6. Exterior hollow metal doors
   7. Exterior hollow metal door frames

1.3 DEFINITIONS

A. Steel Sheet Thicknesses: Thickness dimensions, including those referenced in ANSI A250.8, are minimums as defined in referenced ASTM standards for both uncoated steel sheet and the uncoated base metal of metallic-coated steel sheets.

1.4 SUBMITTALS

A. Product Data: For each type of door and frame indicated, include door designation, type, level and model, material description, core description, construction details, label compliance, sound and fire-resistance ratings, and finishes.

B. Shop Drawings: Show the following:
   1. Elevations of each door design.
   2. Frame details for each frame type including dimensioned profiles.
   3. Details and locations of reinforcement and preparations for hardware.
   4. Details of each different wall opening condition.
   5. Details of anchorages, accessories, joints, and connections.
   6. Coordination of glazing frames and stops with glass and glazing requirements.

C. Door Schedule: Use same reference designations indicated on Drawings in preparing schedule for doors and frames.

1.5 QUALITY ASSURANCE

A. Steel Door and Frame Standard: Comply with ANSI A 250.8, unless more stringent requirements are indicated.

B. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252.

C. Fire-Rated Window Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 257.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver doors and frames cardboard-wrapped or crated to provide protection during transit and job storage. Provide additional protection to prevent damage to finish of factory-finished doors and frames.
B. Inspect doors and frames on delivery for damage, and notify shipper and supplier if damage is found. Minor damages may be repaired provided refinished items match new work and are acceptable to Architect. Remove and replace damaged items that cannot be repaired as directed.
C. Store doors and frames at building site under cover. Place units on minimum 4-inch- high wood blocking. Avoid using nonvented plastic or canvas shelters that could create a humidity chamber. If door packaging becomes wet, remove cartons immediately. Provide minimum 1/4-inch spaces between stacked doors to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    1. Steel Doors and Frames:
        a. Amweld Building Products, Inc.

b. Benchmark Commercial Doors; a division of General Products Co., Inc.
c. Ceco Door Products; a United Dominion Company.
d. Curries Company.
e. Kewanee Corporation (The).
f. Pioneer Industries Inc.
g. Republic Builders Products.
h. Steelcraft; a division of Ingersoll-Rand.

2.2 MATERIALS

A. Hot-Rolled Steel Sheets: ASTM A 569/A 569M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
B. Cold-Rolled Steel Sheets: ASTM A 366/A 366M, Commercial Steel (CS), or ASTM A 620/A 620M, Drawing Steel (DS), Type B; stretcher-leveled standard of flatness.

2.3 DOORS

A. General: Provide doors of sizes, thicknesses, and designs indicated.
B. Interior Doors: Provide doors complying with requirements indicated below by referencing ANSI 250.8 for level and model and ANSI A250.4 for physical-endurance level:
   1. Level 2 and Physical Performance Level B (Heavy Duty), Model 1 (Full Flush).

C. Exterior Doors: Provide doors complying with requirements indicated below by referencing ANSI A250.8 for level and model and ANSI A250.4 for physical-endurance level:
   1. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 1 (Full Flush).

2.4 FRAMES

A. General: Provide steel frames for doors, transoms, sidelights, borrowed lights, and other openings that comply with ANSI A250.8 and with details indicated for type and profile. Conceal fastenings, unless otherwise indicated.

B. Frames of 0.053-inch- thick steel sheet for:
   1. Level 2 steel doors.
   2. Wood doors where indicated.

C. Hinge Reinforcements: High frequency hinge reinforcements are to be installed on all hollow metal frames in this project, as follows:
   1. Provide 7 ga. hinge reinforcement, projection welded to the frame at the factory.
   2. Form 10 ga. auxiliary hinge reinforcement to match contour of door frame.
   3. Arc weld the auxiliary hinge reinforcement to the standard hinge reinforcement and to the frame in 3 locations.

D. Door Silencers: Except on weather-stripped frames, fabricate stops to receive three silencers on strike jambs of single-door frames and two silencers on heads of double-door frames.

E. Supports and Anchors: Fabricated from not less than 0.042-inch- thick, electrolytic zinc-coated or metallic-coated steel sheet.
   1. Wall Anchors in Masonry Construction: 0.177-inch- diameter, steel wire complying with ASTM A 510 (ASTM A 510M) may be used in place of steel sheet.

F. Inserts, Bolts, and Fasteners: Manufacturer's standard units. Where zinc-coated items are to be built into exterior walls, comply with ASTM A 153/A 153M, Class C or D as applicable.

2.5 PERFORMANCE REQUIREMENTS

A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
   1. Smoke- and Draft-Control Assemblies: Provide assemblies with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.
   2. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

B. Fire-Rated, Borrowed-Lite Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9.

2.6 FABRICATION

A. General: Fabricate steel door and frame units to comply with ANSI A250.8 and to be rigid, neat in appearance, and free from defects including warp and buckle.

Where practical, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory assembled before shipment, to assure proper assembly at Project site.

B. Exterior Door Construction: For exterior locations and elsewhere as indicated, fabricate doors, panels, and frames from metallic-coated steel sheet. Close top and bottom edges of doors flush as an integral part of door construction or by addition of 0.053-inch-thick, metallic-coated steel channels with channel webs placed even with top and bottom edges.

C. Interior Door Faces: Fabricate exposed faces of doors and panels, including stiles and rails of nonflush units, from the following material:
   1. Cold-rolled steel sheet.

D. Core Construction: Manufacturer’s standard core construction that produces a door complying with SDI standards.

E. Clearances for Non-Fire-Rated Doors: Not more than 1/8 inch at jambs and heads, except not more than 1/4 inch between pairs of doors. Not more than 3/4 inch at bottom.

F. Clearances for Fire-Rated Doors: As required by NFPA 80.

G. Single-Acting, Door-Edge Profile: Square edge.

H. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."

I. Fabricate concealed stiffeners, reinforcement, edge channels, louvers, and moldings from either cold- or hot-rolled steel sheet.

J. Hardware Preparation: Prepare doors and frames to receive mortised and concealed hardware according to final door hardware schedule and templates provided by hardware supplier. Comply with applicable requirements in ANSI A250.6 and ANSI A115 Series specifications for door and frame preparation for hardware.

K. Frame Construction: Fabricate frames to shape shown.
   1. Fabricate frames with mitered or coped and continuously welded corners.
   2. For exterior applications, fabricate frames with mitered or coped and continuously welded corners and seamless face joints.
   3. Provide welded frames with temporary spreader bars.

L. Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for surface-applied hardware may be done at Project site.

M. Locate hardware as indicated on Shop Drawings or, if not indicated, according to ANSI A250.8.

N. Glazing Stops: Manufacturer's standard, formed from 0.032-inch- (0.8-mm-) thick steel sheet.
   1. Provide screw-applied, removable, glazing stops on inside of glass, louvers, and other panels in doors.

O. Astragals: As required by NFPA 80 to provide fire ratings indicated.

2.7 FINISHES

A. Prime Finish: Manufacturer's standard, factory-applied coat of rust-inhibiting primer complying with ANSI A250.10 for acceptance criteria.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install steel doors, frames, and accessories according to Shop Drawings, manufacturer's data, and as specified.

B. Placing Frames: Comply with provisions in SDI 105, unless otherwise indicated. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.
   1. Except for frames located in existing walls or partitions, place frames before construction of enclosing walls and ceilings.
   2. In masonry construction, provide at least three wall anchors per jamb; install adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Acceptable anchors include masonry wire anchors and masonry T-shaped anchors.
   3. In metal-stud partitions, provide at least three wall anchors per jamb; install adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Attach wall anchors to studs with screws.
   4. Install fire-rated frames according to NFPA 80.

C. Door Installation: Comply with ANSI A250.8. Fit hollow-metal doors accurately in frames, within clearances specified in ANSI A250.8. Shim as necessary to comply with SDI 122 and ANSI/DHI A115.1G.
   1. Fire-Rated Doors: Install within clearances specified in NFPA 80.

3.2 ADJUSTING AND CLEANING

A. Prime-Coat Touchup: Immediately after installation, sand smooth any rusted or damaged areas of prime coat and apply touch up of compatible air-drying primer.

END OF SECTION 08111

SECTION 08331 - OVERHEAD COILING DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Insulated service doors.

B. Related Requirements:

   1. Section 05500 "Metal Fabrications" for miscellaneous steel supports, door-opening framing, corner guards, and bollards.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and size of overhead coiling door and accessory.

   1. Include construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
   3. Include description of automatic-closing device and testing and resetting instructions.

B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.

   1. Include plans, elevations, sections, and mounting details.
   2. Include details of equipment assemblies, and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
   4. For exterior components, include details of provisions for assembly expansion and contraction and for excluding and draining moisture to the exterior.

5. Show locations of controls, locking devices, detectors or replaceable fusible links, and other accessories.
6. Include diagrams for power, signal, and control wiring.

C. Samples for Initial Selection: Manufacturer's finish charts showing full range of colors and textures available for units with factory-applied finishes.

1. Include similar Samples of accessories involving color selection.

D. Samples for Verification: For each type of exposed finish on the following components, in manufacturer's standard sizes:

1. Curtain slats, including full vision window secured to slat.
2. Bottom bar with sensor edge.
3. Guides.
4. Brackets.
5. Hood.
6. Locking device(s).
7. Include similar Samples of accessories involving color selection.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Oversize Construction Certification: For door assemblies required to be fire-rated and that exceed size limitations of labeled assemblies.

C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Special warranty.

B. Maintenance Data: For overhead coiling doors to include in maintenance manuals.

C. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

1. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of doors that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain overhead coiling doors from single source from single manufacturer.

1. Obtain operators and controls from overhead coiling-door manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Sound-Control Doors: Assemblies tested in a laboratory for sound-transmission-loss performance according to ASTM E90, calculated according to ASTM E413, and rated for not less than the STC value indicated.

B. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" and ICC A117.1.

C. Structural Performance, Exterior Doors: Capable of withstanding the following design wind loads:

1. Design Wind Load: As indicated on Drawings.
2. Testing: According to ASTM E330/E330M.
3. Deflection Limits: Design overhead coiling doors to withstand design wind load without evidencing permanent deformation or disengagement of door components.
4. Operability under Wind Load: Design overhead coiling doors to remain operable under design wind load, acting inward and outward.

D. Windborne-Debris Impact Resistance: Provide glazed and impact-protective overhead coiling doors that pass ASTM E1886 missile-impact and cyclic-pressure tests according to ASTM E1996 for Wind Zone 3 for enhanced protection.

1. Large-Missile Test: For overhead coiling doors located within 30 feet of grade.

E. Seismic Performance: Overhead coiling doors shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Component Importance Factor: 1.5.

2.3 DOOR ASSEMBLY

A. Insulated Service Door: Overhead coiling door formed with curtain of interlocking metal slats.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ACME Rolling Doors.
b. Advanced Door Technologies.
c. Alpine Overhead Doors, Inc.
d. Alumatec Pacific Products.
e. ASTA Door Corporation.
f. C.H.I. Overhead Doors, Inc.
g. City-Gates.
h. Clopay Building Products.
i. Cookson Company.
j. Cornell.
k. Dynamic Closures Corporation.
l. ENTREMATIC.
m. Lawrence Roll-Up Doors, Inc.
n. McKeon Rolling Steel Door Company, Inc.
o. Metro Door.
p. Overhead Door Corporation.
q. Raynor.
r. Southwestern Rolling Steel Door Co.
s. Wayne-Dalton Corp.

B. Operation Cycles: Door components and operators capable of operating for not less than 100,000. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

1. Include tamperproof cycle counter.

C. Air Infiltration: Maximum rate of 0.4 cfm/sq. ft. at 15 and 25 mph when tested according to ASTM E283.

D. STC Rating: 26.

E. Curtain R-Value: 5.0 deg F x h x sq. ft./Btu.
F. Door Curtain Material: Aluminum.

G. Door Curtain Slats: Flat profile slats of 3-1/4-inch center-to-center height.
   1. Insulated-Slat Interior Facing: Metal.
   2. Gasket Seal. Manufacturer's standard continuous gaskets between slats.

H. Bottom Bar: Two angles, each not less than 1-1/2 by 1-1/2 by 1/8 inch thick; fabricated from aluminum extrusions and finished to match door.

I. Curtain Jamb Guides: Aluminum with exposed finish matching curtain slats.

J. Hood: Aluminum.

   1. Shape: Square.
   2. Mounting: Face of wall.

K. Locking Devices: Equip door with locking device assembly.

   1. Locking Device Assembly: Single-jamb side locking bars, operable from inside with thumbturn and outside with cylinder.
   2. Provide operator with manufacturer's standard removable operating arm.

L. Electric Door Operator:

   1. Usage Classification: Medium duty, up to 12 cycles per hour and up to 50 cycles per day.
   2. Operator Location: Top of hood.
   3. Safety: Listed according to UL 325 by a qualified testing agency for commercial or industrial use; moving parts of operator enclosed or guarded if exposed and mounted at 8 feet or lower.
   4. Motor Exposure: Interior.
   5. Motor Electrical Characteristics:

      a. Horsepower: 1/2 hp.
      b. Voltage: 115-V ac, single phase, 60 Hz.

   6. Emergency Manual Operation: Crank type.
   7. Obstruction-Detection Device: Automatic electric sensor edge on bottom bar.

      a. Sensor Edge Bulb Color: As selected by Architect from manufacturer's full range.

   8. Control Station(s): Interior mounted as indicated on Drawings.

9. Other Equipment: Audible and visual signals.

M. Curtain Accessories: Equip door with weatherseals, push/pull handles.
N. Door Finish:

1. Aluminum Finish: Clear anodized.
2. Interior Curtain-Slat Facing: Match finish of exterior curtain-slat face.

2.4 MATERIALS, GENERAL

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.5 DOOR CURTAIN MATERIALS AND CONSTRUCTION

A. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:
   1. Aluminum Door Curtain Slats: ASTM B209 sheet or ASTM B221 extrusions, alloy and temper standard with manufacturer for type of use and finish indicated; thickness of 0.050 inch; and as required.
   2. Insulation: Fill slats for insulated doors with manufacturer's standard thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E84 or UL 723. Enclose insulation completely within slat faces.
   3. Metal Interior Curtain-Slat Facing: Match metal of exterior curtain-slat face, with

B. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain, and a continuous bar for holding windlocks.

2.6 HOODS

A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting

that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.

1. Aluminum: 0.040-inch-thick aluminum sheet complying with ASTM B209, of alloy and temper recommended by manufacturer and finisher for type of use and finish indicated.

B. Removable Metal Soffit: Formed or extruded from same metal and with same finish as curtain if hood is mounted above ceiling unless otherwise indicated.

2.7 LOCKING DEVICES

A. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.

B. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.

1. Lock Cylinders: As standard with manufacturer and keyed to building keying system.
2. Keys: Three for each cylinder.

C. Chain Lock Keeper: Suitable for padlock.

D. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

2.8 CURTAIN ACCESSORIES

A. Smoke Seals: Equip each fire-rated door with replaceable smoke-seal perimeter gaskets or brushes for smoke and draft control as required for door listing and labeling by a qualified testing agency.

B. Weatherseals for Exterior Doors: Equip each exterior door with weather-stripping gaskets fitted to entire exterior perimeter of door for a weather-resistant installation unless otherwise indicated.

1. At door head, use 1/8-inch-thick, replaceable, continuous-sheet baffle secured to inside of hood or field-installed on the header.
2. At door jambs, use replaceable, adjustable, continuous, flexible, 1/8-inch-thick seals of flexible vinyl, rubber, or neoprene.

C. Astragal for Interior Doors: Equip each door bottom bar with a replaceable, adjustable, continuous, compressible gasket of flexible vinyl, rubber, or neoprene as a cushion bumper.

D. Push/Pull Handles: Equip each push-up-operated or emergency-operated door with lifting handles on each side of door, finished to match door.

E. Pull-Down Strap: Provide pull-down straps for doors more than 84 inches high.
F. Poll Hooks: Provide pole hooks and poles for doors more than 84 inches high.

2.9 COUNTERBALANCE MECHANISM

A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

B. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, seamless carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 in./ft. of span under full load.
C. Counterbalance Spring: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.

1. Fire-Rated Doors: Equip with auxiliary counterbalance spring and prevent tension release from main counterbalance spring when automatic-closing device operates.

D. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.
E. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.10 ELECTRIC DOOR OPERATORS

A. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and operation-cycles requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, control stations, control devices, integral gearing for locking door, and accessories required for proper operation.

1. Comply with NFPA 70.

2. Control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24-V ac or dc.

B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.

C. Door Operator Location(s): Operator location indicated for each door.

1. Top-of-Hood Mounted: Operator is mounted to the right or left door head plate with the operator on top of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Headroom is required for this type of mounting.
2. Front-of-Hood Mounted: Operator is mounted to the right or left door head plate with the operator on coil side of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Front clearance is required for this type of mounting.
3. Wall Mounted: Operator is mounted to the inside front wall on the left or right side of door and connected to door drive shaft with drive chain and sprockets. Side room is required for this type of mounting. Wall-mounted operator can also be mounted above or below shaft; if above shaft, headroom is required.
4. Bench Mounted: Operator is mounted to the right or left door head plate and connected to the door drive shaft with drive chain and sprockets. Side room is required for this type of mounting.
5. Through-Wall Mounted: Operator is mounted on other side of wall from coil side of door.

D. Motors: Reversible-type motor with controller (disconnect switch) for motor exposure indicated for each door assembly.

1. Electrical Characteristics: Minimum as indicated for each door assembly. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. and not more than 12 in./sec., without exceeding nameplate ratings or service factor.
2. Operating Controls, Controllers, Disconnect Switches, Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
3. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.

E. Limit Switches: Equip each motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.

F. Obstruction-Detection Devices: External entrapment protection consisting of indicated automatic safety sensor capable of protecting full width of door opening.

1. Electric Sensor Edge: Automatic safety sensor edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor activates device. Connect to control circuit using manufacturer's standard take-up reel or self-coiling cable.

    a. Self-Monitoring Type: Four-wire-configured device designed to interface with door operator control circuit to detect damage to or disconnection of sensor edge.

G. Control Station: Three-button control station in fixed location with momentary-contact push-button controls labeled "Open" and "Stop" and sustained- or constant-pressure push-button control labeled "Close."

1. Interior-Mounted Units: Full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.

H. Emergency Manual Operation: Equip each electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed 25 lbf.

I. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.

J. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.

K. Audible and Visual Signals: Audible alarm and visual indicator lights in compliance with the accessibility standard.

2.11 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM/NOMMA 500 for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.12 ALUMINUM FINISHES

A. Mill Finish: Manufacturer's standard.

B. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates areas and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.
B. Examine locations of electrical connections.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.
B. Install overhead coiling doors, hoods, controls, and operators at the mounting locations indicated for each door.
C. Accessibility: Install overhead coiling doors, switches, and controls along accessible routes in compliance with the accessibility standard.

D. Fire-Rated Doors: Install according to NFPA 80.
E. Smoke-Control Doors: Install according to NFPA 80 and NFPA 105.

F. Power-Operated Doors: Install automatic garage doors openers according to UL 325.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and to furnish reports to Architect.
B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Test door release, closing, and alarm operations when activated by smoke detector or building's fire-alarm system. Test manual operation of closed door. Reset door-closing mechanism after successful test.
2. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, section 5.2.

C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.
E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in NFPA 80 and NFPA 101.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. After electrical circuitry has been energized, operate doors to confirm proper motor rotation and door performance.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

3.5 ADJUSTING

A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.

1. Adjust exterior doors and components to be weather resistant.

B. Lubricate bearings and sliding parts as recommended by manufacturer.

C. Adjust seals to provide tight fit around entire perimeter.

3.6 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of coiling-door Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

1. Perform maintenance, including emergency callback service, during normal working hours.
2. Include 24-hour-per-day, seven-day-per-week, emergency callback service.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

END OF SECTION 08331

SECTION 08541 - FIBERGLASS WINDOWS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes fiberglass-framed windows.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, glazing and fabrication methods, dimensions of individual components and profiles, hardware, and finishes for fiberglass windows.

B. Shop Drawings: For fiberglass windows.

1. Include plans, elevations, sections, hardware, accessories, insect screens, operational clearances, and details of installation, including anchor, flashing, and sealant installation.

C. Samples: For each exposed product and for each color specified, 2 by 4 inches in size.

D. Samples for Initial Selection: For units with factory-applied finishes.

1. Include Samples of hardware and accessories involving color selection.

E. Samples for Verification: For fiberglass windows and components required, prepared on Samples of size indicated below:

1. Exposed Finishes: 2 by 4 inches.
2. Exposed Hardware: Full-size units.

F. Product Schedule: For fiberglass windows. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer and Installer.
B. Product Test Reports: For each type of fiberglass window, for tests performed by a qualified testing agency.

C. Field quality-control reports.
D. Sample Warranties: For manufacturer's warranties.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer capable of fabricating fiberglass windows that meet or exceed performance requirements indicated and of documenting this performance by test reports and calculations.
B. Installer Qualifications: An installer acceptable to fiberglass window manufacturer for installation of units required for this Project.
C. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

    1. Build mockup of typical wall area as shown on Drawings.
    2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
    3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace fiberglass windows that fail in materials or workmanship within specified warranty period.

    1. Failures include, but are not limited to, the following:

        a. Failure to meet performance requirements.
        b. Structural failures including excessive deflection, water leakage, and air infiltration.
        c. Faulty operation of movable sash and hardware.
        d. Deterioration of materials and finishes beyond normal weathering.
        e. Failure of insulating glass.

    2. Warranty Period:

a. Window: 10 years from date of Substantial Completion.
b. Glazing Units: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain fiberglass windows from single source from single manufacturer.

2.2 WINDOW PERFORMANCE REQUIREMENTS

A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

1. Window Certification: WDMA certified with label attached to each window.

B. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:

1. Minimum Performance Class: R.
2. Minimum Performance Grade: 15.

C. Thermal Transmittance: NFRC 100 maximum whole-window U-factor of 0.30 Btu/sq. ft. x h x deg F.

D. Solar Heat-Gain Coefficient (SHGC): NFRC 200 maximum whole-window SHGC of 0.40.

E. Sound Transmission Class (STC): Rated for not less than 26 STC when tested for laboratory sound transmission loss according to ASTM E90 and determined by ASTM E413.

F. Outside-Inside Transmission Class (OITC): Rated for not less than 22 OITC when tested for laboratory sound transmission loss according to ASTM E90 and determined by ASTM E1332.

G. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone 3 for basic protection.

1. Large-Missile Test: For glazing located within 30 feet of grade.
2. Small-Missile Test: For glazing located between 30 feet and 60 feet above grade.

2.3 FIBERGLASS WINDOWS

A. Basis of Design: Milgard (www.milgard.com).
B. Operating Types: Provide the following operating types in locations indicated on Drawings:
   1. Fixed.

C. Frames and Sashes: Pultruded fiberglass complying with AAMA/WDMA/CSA 101/I.S.2/A440 and with exposed exterior fiberglass surfaces finished with manufacturer's standard enamel coating complying with AAMA 613.

   1. Exterior Color: Match color of adjacent finish on building exterior.
   2. Interior Finish: Match color of adjacent finish on building exterior.

D. Glass: Clear annealed glass, ASTM C1036, Type 1, Class 1, q3.

   1. Kind: Fully tempered.

E. Windborne-Debris-Impact-Resistant Laminated Glass: ASTM C1172 with two plies of float glass.

   1. Float Glass: Annealed.
   2. Inner Ply: Clear.
   3. Interlayer: 0.090 inch.
   4. Outer Ply: Match color of adjacent building windows.
   5. Low-E Coating: Pyrolytic on second surface.

F. Glazing System: Manufacturer's standard factory-glazing system that produces weathertight seal.

G. Hardware, General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with adjacent materials; designed to smoothly operate, tightly close, and securely lock fiberglass windows, and sized to accommodate sash weight and dimensions.

   1. Exposed Hardware Color and Finish: Match color of adjacent building windows.

H. Weather Stripping: Provide full-perimeter weather stripping for each operable sash unless otherwise indicated.
I. Fasteners: Noncorrosive and compatible with window members, trim, hardware, anchors, and other components.

1. Exposed Fasteners: Do not use exposed fasteners to greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

2.4 FABRICATION

A. Fabricate fiberglass windows in sizes indicated. Include a complete system for installing and anchoring windows.
B. Glaze fiberglass windows in the factory.

C. Mullions: Provide mullions and cover plates, matching window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections. Provide mullions and cover plates capable of withstanding design wind loads of window units.

D. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation. Allow for scribing, trimming, and fitting at Project site.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Verify rough opening dimensions, levelness of sill plate, and operational clearances.
C. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure weathertight window installation.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E2112.

B. Install windows level, plumb, square, true to line, without distortion, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.

B. Testing Services: Testing and inspecting of installed windows shall take place as follows:

1. Testing Methodology: Testing of windows for air infiltration and water resistance shall be performed according to AAMA 502.
2. Air-Infiltration Testing:

    a. Test Pressure: That required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance class indicated.
    b. Allowable Air-Leakage Rate: 1.5 times the applicable AAMA/WDMA/CSA 101/I.S.2/A440 rate for product type and performance class rounded down to one decimal place.

3. Water-Resistance Testing:

    a. Test Pressure: Two-thirds times test pressure required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance grade indicated.
    b. Allowable Water Infiltration: No water penetration.
4. Test Reports: Prepared according to AAMA 502.

C. Windows will be considered defective if they do not pass tests and inspections.
D. Prepare test and inspection reports.

3.4 ADJUSTING, CLEANING, AND PROTECTION

A. Adjust operating sashes and hardware for a tight fit at contact points and weather stripping for smooth operation and weathertight closure.
B. Clean exposed surfaces immediately after installing windows. Remove excess sealants, glazing materials, dirt, and other substances.

1. Keep protective films and coverings in place until final cleaning.

C. Remove and replace sashes if glass has been broken, chipped, cracked, abraded, or damaged during construction period.
D. Protect window surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written instructions.

END OF SECTION 08541

SECTION 08630 - SKYLIGHTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes skylights with metal framing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for metal-framed skylights.

B. Shop Drawings: For metal-framed skylights.

1. Include plans, elevations, sections, and attachment details.
2. Indicate structural loadings and reactions to be transmitted to supporting curbs.
3. Include details of provisions for assembly expansion and contraction and for draining moisture within the assembly to the exterior.
4. Include full-size isometric details of each vertical-to-horizontal intersection of assembly, showing the following:

    a. Joinery including concealed welds.
    b. Anchorage.
    c. Expansion provisions.
    d. Glazing.
    e. Flashing and drainage.

C. Samples for Initial Selection: For units with factory-applied finishes.
D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Compatibility and Adhesion Test Reports: For structural-sealant-glazed skylights, test reports from sealant manufacturer indicating that joint sealants have been tested for each material that will come in contact with sealants.

C. Product Test Reports: For metal-framed skylights, for tests performed by a qualified testing agency.

D. Field quality-control reports.

E. Sample Warranties: For special warranties.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of metal-framed skylights required for this Project.

B. Structural-Sealant Glazing: Comply with recommendations in ASTM C 1401, "Guide for Structural Sealant Glazing," for joint design and quality-control procedures.

1. Joint designs are reviewed and approved by structural-sealant manufacturer.
2. Quality-control program development and reporting comply with ASTM C 1401 recommendations for material qualification procedures, preconstruction sealant-testing program, and procedures and intervals for fabrication and installation reviews and checks.
3. Perform manufacturer's standard tests for compatibility and adhesion of sealants with each material that will come in contact with sealants.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of metal framed skylights that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including, but not limited to, excessive deflection.
b. Noise or vibration caused by thermal movements.
c. Deterioration of metals, and other materials beyond normal weathering.
d. Adhesive or cohesive sealant failures.

e. Water leakage.

2. Warranty Period: 10 years from date of Substantial Completion.

B. Special Aluminum-Finish Warranty: Manufacturer agrees to repair or replace components on which finishes fail within specified warranty period. Warranty does not include normal weathering.

1. Failures include, but are not limited to, checking, crazing, peeling, chalking, and fading of finishes.
2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design metal-framed skylights.
B. Structural Loads: As indicated on Drawings.
C. Deflection of Framing Members: At design wind pressure, as follows:

1. Deflection Normal to Glazing Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding L/175 of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19.1 mm), whichever is less.
2. Deflection Parallel to Glazing Plane: Limited to L/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller.

D. Lateral Bracing of Framing Members: Compression flanges of flexural members are laterally braced by cross members with minimum depth equal to 50 percent of flexural member that is braced. Glazing does not provide lateral support.
E. Structural-Test Performance: Metal-framed skylights tested according to ASTM E 330, as follows:

1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified deflection limits.
2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

F. Windborne-Debris-Impact-Resistance Performance: Metal-framed skylights that pass missile-impact and cyclic-pressure tests when tested according to ASTM E 1886 and testing information in ASTM E 1996 for Wind Zone 2.

1. Large-Missile Test: For glazed openings located within 30 feet (9.1 m) of grade.
2. Small-Missile Test: For glazed openings located more than 30 feet (9.1 m) above grade.

G. Air Infiltration: Metal-framed skylights with maximum air leakage through fixed glazing and framing areas of 0.06 cfm/sq. ft. (0.03 L/s per sq. m) of when tested according to ASTM E 283 at a minimum static-air-pressure difference of 1.57 lbf/sq. ft. (75 Pa)] [6.24 lbf/sq. ft. (300 Pa).

H. Water Penetration under Static Pressure: Metal-framed skylights that do not evidence water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).

I. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

J. Condensation Resistance: Metal-framed skylights with fixed glazing and framing areas having condensation-resistance factor (CRF) of not less than 45 when tested according to AAMA 1503.

1. Haze Factor: Greater than 90 percent when tested according to ASTM D 1003.

K. Structural Sealant: Capable of withstanding tensile and shear stresses imposed without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.

L. Energy Performance: Provide metal-framed skylights with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below and certified and labeled according to NFRC:

1. Thermal Transmittance (U-Factor): Fixed glazing and framing areas shall have U-factor of not more than **0.50 Btu/sq. ft. x h x deg F** as determined according to NFRC 100.
2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than **0.40** as determined according to NFRC 200.

2.2 SKYLIGHTS

A. Skylights: Glazed skylight assemblies supported by aluminum framing.
Basis of Design: Velux Fixed Skylight FS M08 – aluminum frame.
   1. See size, location and quantity on drawings.

B. Aluminum Framing Systems: Manufacturer's standard extruded-aluminum members of thickness required and reinforced as required to support imposed loads.

C. Aluminum: Alloy and temper as recommended in writing by manufacturer for type of use and finish indicated.

   1. Sheet and Plate: ASTM B 209 (ASTM B 209M).
   2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
   3. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
   4. Structural Profiles: ASTM B 308/B 308M.

D. Pressure Caps: Manufacturer's standard aluminum components that mechanically retain glazing.

   1. Include snap-on aluminum trim that conceals fasteners.

E. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning skylight components.

F. Fasteners and Accessories: Manufacturer's standard, corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

   1. At pressure caps, use ASTM A 193/A 193M stainless-steel screws.
   2. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
   3. Reinforce members as required to receive fastener threads.
   4. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.

G. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.

H. Anchor Bolts: ASTM A 307, Grade A, galvanized steel.

I. Concealed Flashing: Manufacturer's standard, corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.

J. Exposed Flashing and Closures: Manufacturer's standard aluminum components not less than 0.060 inch (1.524 mm)] thick.
K. Framing Sealants: As recommended in writing by manufacturer.
L. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.3 GLAZING

A. Glazing: Insulated glass units consisting of 9/16” laminated glass with 090” SGP interlayer. See additional information on insulated glass units in Section 088000 "Glazing”
B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.
C. Spacers and Setting Blocks: Manufacturer's standard elastomeric types.
D. Structural Glazing Sealants:

1. Structural Sealant: ASTM C 1184, neutral-curing silicone formulation compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant, and approved by structural-sealant manufacturer for use in metal-framed skylights indicated.

    a. Color: As selected by Architect from manufacturer's full range.

2. Weatherseal Sealant: ASTM C 920 for Type S, Grade NS, Class 25, Uses NT, G, A, and O; neutral-curing silicone formulation compatible with structural sealant and other components with which it comes in contact; and recommended in writing by structural- and weatherseal-sealant and metal-framed skylight manufacturers for this use.

    a. Color: Matching structural sealant.

3. Bond-Breaker Tape: Manufacturer's standard tetrafluoroethylene-fluorocarbon or polyethylene material to which sealants will not develop adhesion.

2.4 FABRICATION

A. Where practical, fit and assemble metal-framed skylights in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Fabricate aluminum components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Internal guttering systems or other means to drain water passing joints and moisture migrating within skylight to exterior.
4. Physical and thermal isolation of glazing from framing members.
5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.

C. Fabricate aluminum sill closures with weep holes and for installation as continuous component.

D. Reinforce aluminum components as required to receive fastener threads.

E. Factory-Glazed, Metal-Framed Skylights:

1. Factory install glazing to comply with requirements in Section 088000 "Glazing."

F. Structural-Sealant-Glazed, Metal-Framed Skylights: Prepare surfaces that will contact structural sealant according to structural-sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

G. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.5 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm

2.6 SOURCE QUALITY CONTROL

A. Structural-Sealant Glazing: Perform quality-control procedures complying with ASTM C 1401 recommendations including, but not limited to, material qualification procedures, sealant testing, and fabrication reviews and checks.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Comply with manufacturer's written instructions.

1. Do not install damaged components.
2. Fit joints between aluminum components to produce hairline joints free of burrs and distortion.
3. Rigidly secure nonmovement joints.
4. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
5. Seal joints watertight unless otherwise indicated.

B. Metal Protection: Where aluminum will contact dissimilar materials, protect against galvanic action by painting contact surfaces with protective coating or by installing nonconductive spacers as recommended in writing by manufacturer for this purpose.
C. Install continuous aluminum sill closure with weatherproof expansion joints and locked and sealed or welded corners. Locate weep holes at rafters.
D. Install components to drain water passing joints, and moisture migrating within skylight to exterior.
E. Install components plumb and true in alignment with established lines and elevations.
F. Glazing: Install glazing as specified in Section 088000 "Glazing."

G. Structural-Sealant Glazing:

1. Prepare surfaces that will contact structural sealant according to structural-sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

2. Install weatherseal sealant according to weatherseal-sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind weatherseal sealant as recommended in writing by weatherseal-sealant manufacturer.

H. Erection Tolerances: Install metal-framed skylights to comply with the following maximum tolerances:

1. Alignment: Limit offset from true alignment to 1/32 inch (0.8 mm) where surfaces abut in line, edge to edge, at corners, or where a reveal or protruding element separates aligned surfaces by less than 3 inches (76 mm); otherwise, limit offset to 1/8 inch (3.2 mm).
2. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet (3.2 mm in 3.7 m) but no greater than 1/2 inch (13 mm) over total length.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

1. Water-Spray Test: Before installation of interior finishes has begun, skylights shall be tested according to AAMA 501.2 and shall not evidence water penetration.
2. Water Penetration under Static Pressure: Before installation of interior finishes has begun, areas shall be tested according to ASTM E 1105.

    a. Test Procedures: Test under [uniform and cyclic static-air pressure.

    b. Water Penetration: None.

3. Structural-Sealant Compatibility and Adhesion: Structural sealant shall be tested according to ASTM C 1401.

    a. Destructive test method, Method A, Hand Pull Tab (Destructive) in ASTM C 1401, Appendix X2, shall be used.

        1) A minimum of one area on each skylight face shall be tested.
        2) Repair installation areas damaged by testing.

4. Structural-Sealant Glazing Inspection: After installation of metal-framed skylights is complete, structural-sealant glazing shall be inspected and evaluated according to ASTM C 1401 recommendations for quality-control procedures.

B. Repair or remove work where test results and inspections indicate that it does not comply with specified requirements.

C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
D. Prepare test and inspection reports.

3.4 CLEANING AND PROTECTION

A. Clean exposed surfaces immediately after installing skylights. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.
B. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.
C. Protect skylights from contact with contaminating substances resulting from construction operations. If contaminating substances do contact skylight surfaces, remove contaminants immediately according to manufacturer's written instructions.

END OF SECTION 08630

SECTION 08710 - DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Commercial door hardware for the following:

    a. Swinging doors.
    b. Fire-rated swinging doors.
    c. Other doors to the extent indicated.

2. Cylinders for doors specified in other Sections.
3. Electrified door hardware.

B. Related Sections include the following:

1. Division 08 Section "Hollow Metal Doors and Frames"
2. Division 08 Section "Overhead Coiling Doors"
3. Division 28 Section "Fire Detection and Alarm" for connections to building fire alarm system.

C. Products furnished, but not installed, under this Section include the following. Coordinating, purchasing, delivering, and scheduling remain requirements of this Section.

1. Thresholds, weather stripping, and cylinders for locks specified in other Sections.

1.3 REFERENCED STANDARDS

A. Provide hardware in accordance with the following standards in addition to those specified in Division 01 Section “References”.

1. American National Standards Institute (ANSI), A117.1: Accessible and Usable Buildings and Facilities, edition as adopted by local Authority Having Jurisdiction (AHJ).

2. Builders Hardware Manufacturer's Association (BHMA)

    a. ANSI/BHMA A156.2: Bored and Preassembled Locks and Latches, 2011 edition
    b. ANSI/BHMA A156.3: Exit Devices, 2008 edition
    c. ANSI/BHMA A156.4: Door Controls - Closers, 2008 edition
    d. ANSI/BHMA A156.13: Mortise Locks and Latches, 2012 edition
    e. ANSI/BHMA A156.15: Release Devices – Closer Holder, Electromagnetic, and Electromechanical, 2011 edition
    f. ANSI/BHMA A156.18: Materials and Finishes, 2006 edition

3. Door and Hardware Institute (DHI)

    a. Recommended Locations for Architectural Hardware for Flush Wood Doors, 1993 edition
    b. Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames, 2004 edition
    c. Installation Guide for Doors and Hardware, 1994 edition
    d. Keying Systems and Nomenclature, 2003 edition
    e. Sequence and Format for the Hardware Schedule, 2001 edition

4. National Fire Protection Association (NFPA)

    a. NFPA 70: National Electrical Code, edition as adopted by local AHJ.
    b. NFPA 80: Standard for Fire Doors and Other Opening Protectives, edition as adopted by local AHJ.
    c. NFPA 252: Standard Methods of Fire Tests of Door Assemblies, edition as adopted by local AHJ.

1.4 SUBMITTALS

A. Product Data: Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.
B. Shop Drawings: Details of electrified door hardware, indicating the following:

    1. Wiring Diagrams: Power, signal, and control wiring. Include the following:

        a. System schematic.
        b. Point-to-point wiring diagram.
        c. Riser diagram.
        d. Elevation of each door.

    2. Detail interface between electrified door hardware and fire alarm, access control, security, building control system.
    3. Operation Narrative: Describe the operation of doors controlled by electrified door hardware.

C. Samples for Verification: For exposed door hardware of each type, in specified finish, full size. Tag with full description for coordination with the door hardware sets. Submit Samples before, or concurrent with, submission of the final door hardware sets, if requested.

    1. Samples will be returned to Contractor. Units that are acceptable and remain undamaged through submittal, review, and field comparison process may, after final check of operation, be incorporated into the Work, within limitations of keying requirements.

D. Qualification Data: For Installer
E. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for locks, latches, and closers as requested.
F. Maintenance Data: For each type of door hardware to include in maintenance manuals. Include final hardware and keying schedule.
G. Warranty: Special warranty specified in this Section.
H. Door Hardware Sets: Prepared by or under the supervision of Architectural Hardware Consultant, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final door hardware sets with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

    1. Format: Use same scheduling sequence and format and use same door numbers as in the Contract Documents.
    2. Content: Include the following information:

        a. Identification number, location, hand, fire rating, and material of each door and frame.
        b. Type, style, function, size, quantity, and finish of each door hardware item.
        c. Complete designations of every item required for each door or opening including name and manufacturer.
        d. Fastenings and other pertinent information.
        e. Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
        f. Explanation of abbreviations, symbols, and codes contained in schedule.
        g. Mounting locations for door hardware.
        h. Door and frame sizes and materials.
        i. Description of each electrified door hardware function, including location, sequence of operation, and interface with other building control systems.

j. Sequence of Operation: Include description of component functions that occur in the following situations: authorized person wants to enter; authorized person wants to exit; unauthorized person wants to enter; unauthorized person wants to exit.
k. List of related door devices specified in other Sections for each door and frame.

3. Submittal Sequence: Submit the final door hardware sets at earliest possible date, particularly where approval of the door hardware sets must precede fabrication of other work that is critical in Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the door hardware sets.

I. Keying Schedule: Prepared by or under the supervision of Architectural Hardware Consultant, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by lock manufacturer.

1. Installer's responsibilities include supplying and installing door hardware and providing a qualified Architectural Hardware Consultant available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.
2. Installer shall have warehousing facilities in Project's vicinity.
3. Scheduling Responsibility: Preparation of door hardware and keying schedules.
4. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Architectural Hardware Consultant Qualifications: A person who is currently certified by DHI as an Architectural Hardware Consultant and who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project.
C. Source Limitations: Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.

1. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering

analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
B. Tag each item or package separately with identification related to the final door hardware sets, and include basic installation instructions, templates, and necessary fasteners with each item or package.
C. Deliver keys to Owner’s Representative by registered mail or overnight package service.

1.7 COORDINATION

A. Coordinate layout and installation of recessed hardware with floor construction. Cast anchoring inserts into concrete. Concrete, reinforcement, and formwork requirements are specified in Division 03.
B. Templates: Distribute door hardware templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
C. Coordinate with aluminum entrance door supplier for door hardware installation.
D. Electrical System Roughing-in: Coordinate layout and installation of electrified door hardware with connections to power supplies, fire alarm system and detection devices, access control system, security system, and building control system.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.

    1. Failures include, but are not limited to, the following:

        a. Structural failures including excessive deflection, cracking, or breakage.
        b. Faulty operation of operators and door hardware.
        c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period: Three (3) years from date of Substantial Completion, except as follows:

    a. Continuous Hinges: Lifetime of Building
    b. Mortise Locks: Five (5) years from date of Substantial Completion.
    c. Grade 1 Cylindrical Locks: Ten (10) years from date of Substantial Completion.
    d. Exit Devices: Three (3) years from date of Substantial Completion.
    e. Manual Closers: Thirty (30) years from date of Substantial Completion.
    f. Automatic Operators: Two (2) years from date of Substantial Completion.
    g. Electrified Hardware Items: One (1) year from date of Substantial Completion.

1.9 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.
B. Maintenance Service: Beginning at Substantial Completion, provide six (6) months' full maintenance by skilled employees of door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door hardware operation. Provide parts and supplies same as those used in the manufacture and installation of original products.

1.10 EXTRA MATERIALS

A. Furnish full-size units of door hardware described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
B. Door Hardware:

    1. 2 each Von Duprin 98-L x 626 Exit Devices
    2. 2 each Schlage ND96PD x 626 Locksets
    3. 2 each LCN 4040XP EDA x 689 Closers

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1.	Hinges:	Ives, Hager, Stanley, McKinney, Bommer
2.	Continuous Hinges:	Ives, Stanley, Hager, Select, McKinney, Pemko
3.	Operating Door Trim:	Ives, Rockwood, Hager, Trimco
4.	Electric Strikes:	Von Duprin, HES
5.	Locks and Latches:	Schlage, Owner’s Standard
6.	Cylinders and Cores:	Schlage F, Owner’s Standard
7.	Exit Devices:	Von Duprin, Corbin Russwin,
8.	Mechanical Door Closers:	LCN, Owner’s Standard
9.	Closer Release Devices:	LCN , Rixson, ABH, Sargent
10.	Automatic Operators:	LCN, Owner’s Standard
11.	Accessories and Trim:	Ives, Rockwood, Hager, Trimco
12.	Overhead Stops and Holders:	Glynn Johnson, Rixson, ABH, Sargent
13.	Saddle and Panic Thresholds:	Zero, National Guard, Pemko
14.	Weather Strip and Gasket:	Zero, National Guard, Pemko
15.	Miscellaneous Hardware:	Ives, Rockwood, Hager, Trimco
16.	Electronic Accessories	Schlage Electronics / Von Duprin, Securitron, Security Door Controls
17.	Emergency Access Key Box:	Knox, Inc
18.	Key Cabinet:	Lund Equipment

B. Substitutions submitted in compliance with Division 01 Section “Substitutions” requirements will be reviewed for conformance to basis of design.

2.2 SCHEDULED HARDWARE

A. Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of finish hardware are indicated in the "Hardware Schedule" at the end of this Section. Products are identified by using hardware designation numbers of the following:

1. Manufacturer's Product Designations: The product designation and name of one manufacturer are listed for each hardware type required for the purpose of establishing minimum requirements. Provide either the product designated or, where more than one manufacturer is specified under the Article "Manufacturers" in Part 2 for each hardware type, the comparable product of one of the other manufacturers that complies with requirements.

2.3 MATERIALS AND FABRICATION

A. General
   1. Manufacturer's Name Plate: Do not use manufacturers' products that have manufacturer's name or trade name displayed in a visible location (omit removable nameplates) except in conjunction with required fire-rated labels and as otherwise acceptable to Architect.

      a. Manufacturer's identification will be permitted on rim of lock cylinders only.

   2. Base Metals: Produce hardware units of basic metal and forming method indicated using manufacturer's standard metal alloy, composition, temper, and hardness, but in no case of lesser (commercially recognized) quality than specified for applicable hardware units for finish designations indicated.
   3. Provide hardware manufactured to conform to published templates generally prepared for machine screw installation. Do not provide hardware that has been prepared for self-tapping sheet metal screws, except as specifically indicated.

B. Fasteners
   1. Furnish screws for installation with each hardware item. Provide Phillips flat-head screws except as otherwise indicated. Furnish stainless steel (exposed under any condition) screws to match hardware finish or, if exposed in surfaces of other work, to match finish of this other work as closely as possible including "prepared for paint" surfaces to receive painted finish.
   2. Provide concealed fasteners for hardware units that are exposed when door is closed except to the extent no standard units of type specified are available with concealed fasteners. Use through bolts only as indicated in this section unless their use is the only means of reinforcing the work adequately to fasten the hardware securely. Where thru-bolts are used as a means of reinforcing the work, provide sleeves for each thru-bolt or use sex screw fasteners.

2.4 HINGES

A. Acceptable Products:

1.	Ives:	5BB1	5BB1HW
2.	Hager:	BB1279	BB1168
3.	Stanley:	FBB179	FBB168
4.	McKinney	TB2714	T4B3386
5.	Bommer:	BB5000	BB5004

B. Requirements:

   1. Quantity: Provide the following, unless otherwise indicated:

a. Two Hinges: For doors with heights up to 60 inches.
b. Three Hinges: For doors with heights 61 to 90 inches.

2. Template Requirements: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.
3. Hinge Weight: As indicated in hardware sets.
4. Hinge Base Metal: Unless otherwise indicated, provide the following:

a. Exterior Hinges: Stainless steel with stainless-steel pin.
b. Interior Hinges: Steel with steel pin.
c. Hinges for Fire-Rated Assemblies: Steel with steel pin.

5. Hinge Options: Where indicated in door hardware sets or on Drawings:

a. Safety Stud: Designed for stud in one leaf to engage hole in opposing leaf.
b. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for out-swinging doors.
c. Corners: Square.

6. Fasteners: Comply with the following:

a. Machine Screws: For metal doors and frames. Install into drilled and tapped holes.
b. Wood Screws: For wood doors and frames.
c. Threaded-to-the-Head Wood Screws: For fire-rated wood doors.

2.5 CONTINUOUS HINGES

A. Acceptable Products:

1.	Ives:	112HD	224HD
2.	Stanley:	661HD	662HD
3.	Hager:	780-112HD	780-224HD
4.	Select:	SL11HD	SL24HD
5.	McKinney:	MCK-12HD	MCK-25HD
6.	Pemko:	FMSLFHD	FMHD

B. Requirements:

1. Geared Continuous Hinges: Shall utilize a single gear section for the door leaf and a separate gear section for the frame side of the door. Provide full mortise or surface applied hinge as scheduled in each set. Geared hinges are to be UL 10C tested and approved for 90 minutes.

2.6 OPERATING DOOR TRIM

A. Door Bolts

1. Acceptable Products:

a.	Ives:	FB358/FB458	DP1/DP2
b.	Rockwood:	557/555	570
c.	Hager:	283D/282D	280X
d.	Trimco:	3915/3917	3910/3911

2. Requirements:

   a. Provide bolt model recommended by manufacturer for door material type.
   b. Provide 1 inch throw stainless steel bolt with 12 inch length unless otherwise scheduled in the sets.
   c. Provide a dust proof strike for bottom bolt at all locations where there is not a threshold.

B. Push Plates, Pull Plates, and Pulls

1. Acceptable Products:

a.	Ives:	8200	8305	8111-5
b.	Rockwood:	70C	111x70C	130
c.	Hager:	30S	31J	7N
d.	Trimco:	1001	1018	1102T

2. Requirements:

   a. Push Plate: Provide 6 inch by 16 inch by .050 inch push plate constructed of stainless steel. Bevel all four edges.
   b. Pull Plate: Provide 4 inch by 16 inch by .050 inch push plate constructed of stainless steel, bevel all four edges. Provide 10 inch center to center (CTC) pull constructed of stainless steel with a diameter of 1 inch.

2.7 ELECTRIC STRIKES

A. Acceptable Products:

1.	Von Duprin:	6300 Series	6000 Series
2.	HES:	9000 Series	8000 Series

B. Requirements:

1. Provide electric strikes that are continuous duty rated without the use of external rectifiers.

2. Provide electric strikes with function (fail safe, fail secure) and power requirements as scheduled.
3. Where scheduled, provide electric strikes with monitor switches.

2.8 LOCKS AND LATCHES

A. General:

1. Lock Chassis: Shall be made from steel, with locking spindles of stainless steel.
2. Latch Bolt: Shall be constructed of stainless steel with 3/4 inch throw on mortise locks and 1/2 inch throw otherwise. Latch to be deadlocking on keyed functions.
3. Lever Trim: Shall be pressure cast brass, bronze, zinc, or steel with wrought rose design. Levers are to be solid with no voids or plastic inserts.
4. Fire Rating: Lock shall be listed for up to 3 hours.
5. Strike Plates: Provide ANSI 4-7/8 inch strike plates. At pairs of doors, provide strike with 7/8 inch flat lip. At single doors, provide round-lipped strike with lip length as required to minimally clear jamb and trim. Provide dust box at each strike location.

B. Mortise Locks

1. Acceptable Products:

   a. Schlage: L Series, 06B Trim Design

2. Requirements:

   a. ANSI Grade: BHMA/ANSI A156.13, Series 1000, Grade 1.
   b. Deadbolt: Shall be constructed of stainless steel and include security roller pins. Shall have a minimum 1 inch throw.
   c. Spring Cages: Lock shall have individual external spring cages for each lever.
   d. Lever Spindles: Provide lockset with independent, breakaway type lever spindles. Spindles that are continuous through the lock case are not acceptable.
   e. Hub Blocking: Provide lockset with a hub blocking plate to resist unauthorized entry.
   f. Vandal Resistant Lever: Where scheduled, provide lockset with lever that freely rotates even when locked to resist vandalism and abuse.
   g. Thumbturns: Provide thumbturns as enlarged, ADA designated style thumbturns.
   h. Visual Indicator: Where scheduled, provide visual indicator showing “Vacant” or “Occupied”.

C. Grade 1 Bored Locks

1. Acceptable Products:

   a. Schlage: ND Series, Rhodes Lever

2. Provide cylindrical locks exceeding the ANSI/BHMA A156.2 Grade 1 performance standards for strength, security & durability in the categories below:

   a. Abusive locked lever torque – minimum 3,100 inch-pounds without gaining access
   b. Offset lever pull - minimum 1,600 foot pounds without gaining access Simulates pry-bar attacks
   c. Vertical lever impact - minimum 100 impacts without gaining access Simulates sledgehammer-blows to trim, very aggressive abuse
   d. Cycle life - minimum 16 million cycles Cycle life speaks to robustness of lock, ensuring operation after 10M cycles (BHMA requirement is 1M).
      1) With no visible lever sag Working after 15M cycles is not the same as working well. No droop and wobble means the lock still works like new after the test.
      2) Without the use of performance aids (i.e. set screws, spacers, etc.) Set screws and spacers are a poor fix for droop and wobble. Both add to installation complexity, and set screws can be tamper targets.
   e. Door Prep: Provide lockset to install using a standard ANSI 161 door preparation.
   f. Anti-Rotation Plate: Provide lockset with a mechanically interlocked anti-rotation plate. Anti-Rotation teeth or “bite tabs” are not acceptable. Locks without any rotation prevention devices are not acceptable.
   g. Lever Return Springs: Provide each lever with two compression type return springs that are easily accessible without dismantling the lock chassis. Locks utilizing tension or torsion lever return springs are unacceptable. Locks with internal springs that require dismantling the lock chassis are unacceptable.
   h. Lever Spindles: Provide lock with either milled or 1-piece deep drawn spindles. 2-piece interlocking stamped spindles are not acceptable.
   i. Multi-Functionality: Provide modular lockset with capability to convert to a new lock function by changing key cams.
   j. Vandal Resistant Lever: Where scheduled, provide lockset with lever that freely rotates even when locked to resist vandalism and abuse.

D. Deadbolts

1. Requirements:

a. Provide deadbolts by same manufacturer as the provided locksets.
b. Provide chassis type, function, and grade as scheduled.

2.9 CYLINDERS AND CORES

A. Acceptable Products:

1. Schlage: FG Keyway

B. Requirements:

1. Full Size Interchangeable Cylinders: Provide cylinders of quantity and type and with the appropriate cam/tailpiece to be compatible with the locking hardware provided. Provide cylinder housings ready to accept 6-pin, Full-Size Interchangeable Cores (FSIC) where scheduled in FG Keyway compatible with Owner's existing key system.

   a. Temporary Construction Keying: Provide each cylinder housing and/or lock lever with keyed construction core during the construction period. Cores will remain property of the contractor and will be returned upon installation of owner's permanent key system.
   b. Permanent Cores: Provide factory keyed cores. Ship cores directly to owner's representative. At substantial completion, accompany the owner's representative while replacing temporary construction cores with the owner's permanent key system.

2. Conventional Cylinders: Provide cylinders of quantity and type and with the appropriate cam/tailpiece to be compatible with the locking hardware provided. Provide factory keyed 6-Pin conventional cylinders in FG Keyway compatible with Owner's existing key system.

   a. Temporary Construction Keying: Provide each cylinder with "Split Key" type temporary keying during the construction period. At substantial completion, accompany the owner's representative while voiding construction keying.

3. Keys: Provide cylinder manufacturer's standard keys. Keys shall be shipped separate from cores directly to owner's representative. For estimating purposes, provide keys in the following quantities:

a.	Construction Control Keys:	2	each
b.	Construction Change Keys:	12	each
c.	Permanent Control Keys:	2	each
d.	Split Key Voiding Keys:	2	each
e.	Permanent Master Keys:	2	each
f.	Permanent Change Keys:	4	per core

2.10 EXIT DEVICES

A. Acceptable Products:

1.	Von Duprin:	XP98 Series	98/35A Series
2.	Corbin Russwin:	ED5200S Series	--

B. Requirements:

1. ANSI Grade: BHMA/ANSI A156.3, Grade 1.
2. Device Construction:

    a. Exit device(s) shall have a mechanism case constructed of extruded aluminum or wrought stainless steel, base plates constructed of cold rolled or cast steel, push pad of extruded aluminum with stainless steel covering or wrought stainless steel, and end caps with flush mounted, sloped design. At full-glass doors, provide exit devices with no exposed fasteners or rivets visible through glass. Where required by stile width, provide narrow-stile type device.
    b. Latchbolt: Provide Pullman-type deadlocking latch bolts constructed of stainless steel. Where specified provide high security Pullman-type latchbolt that collapses to be square faced under high pull forces. Latch return springs shall be compression type. Tension and Torsion latch return springs are not acceptable.
    c. Dogging Mechanism: where dogging or latch-retraction options are not specifically scheduled for non-fire rated doors, provide device with a hex-key activated hook-type dogging mechanism constructed of steel.
    d. Plastic or nylon used for the push pad, or parts in the dogging mechanism or latchbolt mechanism are unacceptable.
    e. Sound Dampening: Device shall be provided with factory-installed sound dampening materials.
    f. Provide device type, function, and trim style as indicated in hardware schedules.

3. Where exit device(s) are provided for fire rated door, provide with fire listing and label indicating “Fire Exit Hardware”. If device is mounted on wood doors, provide sex nuts and bolts.
4. Provide shim kits, filler plates, and other accessories as required for each opening.
5. Unless otherwise indicated in the sets, provide device with roller-type strike.
6. Where scheduled, provide removable mullions by same manufacturer as provided exit devices. Provide mullion stabilizers, key removable option, strike preps, and fire rating as indicated in sets.

7. Concealed vertical exit devices shall be a cable-actuated concealed vertical latch system available in two-point and less bottom latch (LBL) configurations. Vertical rods are not acceptable.

    a. Cable shall include color-coded stainless steel with polytetrafluoroethylene (Teflon®) liner and stainless steel core wire. Latches and center slides are color coded to aid in installation. Conduit and core wire ends snap into latch and center slides without the use of tools. Latchbolts and blocking cams shall be manufactured from sintered metal low carbon copper- infiltrated steel, with a molybdenum disulfide coating for low friction and consistent performance.
    b. Top latchbolt shall have a minimum 0.382 inch and greater than 90 degree engagement with strike to prevent door and frame separation under high static load. Bottom latchbolt, when used, shall have a minimum of 0.44 inch engagement with strike.
    c. Product cycle life shall exceed 1,000,000 cycles.
    d. Latch release does not require separate trigger mechanism.
    e. Top and bottom latch must operate independently of each other. Top latch will fully engage top strike even when bottom latch is compromised.
    f. Cable and latching system shall have the ability to:
        1) Be assembled as a complete assembly and function prior to being installed in the door.
        2) Install into the door as a one-piece single assembly
        3) Be installed independently of device installation and function on door even prior to device and trim installation.
        4) Connect to the exit device at a single attachment point.
        5) Adjust bottom latch height from a single point, after the system is installed and connected to exit device, while the door is hanging
        6) Alter latch position up and down within two-inches without additional adjustment.
        7) Ability to remove the system while door is hanging.
        8) Configure latchbolt mounting: double or single tab mount for steel doors, and wood doors, face mount for aluminum doors, eliminating requirement of tabs.
        9) Provide adjustable exit device to latch center line adjustment. Ensures double tab mounting option for top latch, regardless of exit device centerline.

2.11 MECHANICAL DOOR CLOSERS

A. General:

1. Valves: Closers shall have separate valves for latch speed, main speed, and back check. Valves shall be staked to prevent accidental removal. Internal Pressure Relief Valves (PRVs) are prohibited
2. Provide the appropriate closer body, handing, and brackets to mount closer inside the building on the least-public side of the door.

    a. Where closers are to be mounted parallel arm, provide with heavy duty, fully forged arms.
    b. Where closers are to be mounted regular arm and the opening can otherwise be opened to 180 degrees, provide closer with the appropriate special templating to allow 180 degree door swing. Where a special template is not available for 180 degree swing, provide closer arm with integrated stop.

3. Integrated Stop Closer Arms: Where a closer with integrated stop is required, provide the appropriate closer and arm as follows:

    a. Parallel arm with spring-cushioned stop arm: Provide where door is otherwise able to open to 95 degrees and requires a parallel arm mount closer.
    b. Parallel arm with dead stop arm: Provide where door is obstructed from opening to 95 degrees and requires a parallel arm mount closer.
    c. Regular arm with push side surface-mounted overhead stop: Provide where door closer should mount on pull side of door.

4. Hold Open Arms: Provide closer arms with mechanical hold-opens as scheduled.
5. Provide closers with any special templates, brackets, plates, or other accessories required for interface with header, door, wall, and other hardware. Provide closers with screw packs containing thru-bolts, machine screws, and wood screws.
6. Closers shall be provided with all-weather fluid and shall not require readjustment from 120 degrees F to -30 degrees F. Fluid shall be non-flaming and shall not fuel door or floor covering fires. Upon request, provide data indicating thermal properties of fluid.
7. Closers shall close and latch door when adjusted to meet accessibility requirements for door opening force: 8.5 lbs at exterior doors, 5 lbs at interior doors, and 15 lbs at labeled fire doors.

B. Heavy Duty Door Closers:

1. Acceptable Products:

    a. LCN: 4040XP

2. Requirements:

a. ANSI Grade: BHMA/ANSI A156.4, Grade 1.
b. Closer Construction: Closer shall have cast iron or aluminum alloy body with 1-1/2 inch steel piston, double heat treated pinion, 5/8 inch bearing journals, and full complement needle or caged ball bearings. Closer shall be adjustable from sizes 1 through 6.
c. Provide closers with spring size adjustment dial for ease of adjusting.

C. Closer Release Devices

1. Acceptable Products:

a. LCN: SEM7800 Series
b. Rixson: 900 Series
c. ABH: 2000 Series
d. Sargent: 1500 Series

D. Requirements:

1. Provide 35 pound electro-magnetic hold open device constructed of die cast metal or plastic. Electromagnet shall accept 120VAC, 24VDC, and/or 12VDC power from fire alarm. Provide mounting style as scheduled.

2.12 AUTOMATIC OPERATORS

A. Acceptable Products:

1. LCN: 4600 Series

B. Requirements:

1. Provide low energy automatic operator units with hydraulic closer complying with ANSI A156.19.
2. Provide units with conventional door closer opening and closing forces unless power operator motor is activated. Provide door closer assembly with adjustable spring size, back-check, and opening and closing speed adjustment valves to control door.

a. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.

3. Provide units with on/off switch for manual operation, motor start up delay, vestibule interface delay, electric lock delay, and door hold open delay.
4. Provide drop plates, brackets, or adapters for arms as required for details.
5. Provide actuator switches for operation as specified. Provide weather-resistant actuators at exterior applications.

6. Provide complete assemblies of controls, switches, power supplies, relays, and parts/material recommended and approved by manufacturer of automatic operator for each individual leaf.
7. Provide units with vestibule inputs that allow sequencing operation of two units, and SPDT relay for interfacing with latching or locking devices.

2.13 ARCHITECTURAL DOOR TRIM

A. Protection Plates and Edge Guards

1. Acceptable Products:

a.	Ives:	8400 Series
b.	Rockwood:	K1050
c.	Hager:	194S
d.	Trimco:	K Series

2. Requirements:

a. Provide .050 inch thick stainless steel protection plates with height as scheduled. Plate shall have four beveled edges and countersunk screws. Provide plate with width as follows:
   1) Pairs of Doors: Provide plate to be 1 inch less door width.
   2) Single Doors: Provide plate to be 2 inches less door width on push side, pull side mounted plates to be 1 inch less door width.

B. Door Stops and Holders

1. Acceptable Products:

a.	Ives:	WS407	FS18S
b.	Rockwood:	405/406	466
c.	Hager:	236W	269F
d.	Trimco:	1270	1209

2. Requirements:

a. Provide stops and holders as indicated in the HW sets.
b. Where wall bumpers are scheduled, provide concave rubber bumper where the adjacent lever trim incorporates a push-button. Otherwise, provide convex rubber bumpers.

2.14 OVERHEAD STOPS AND HOLDERS

A. Acceptable Products:

1.	Glynn Johnson:	100 Series	90 Series

2.	Rixson-Firemark:	6 Series	9 Series
3.	ABH:	1000 Series	9000 Series
4.	Sargent:	100 Series	90 Series

B. Requirements:

1. Provide overhead stops and holders as scheduled, sized per manufacturer's recommendations based on door width.
2. Provide concealed overhead stops with adjustable jamb bracket.
3. Where possible without conflicting with other hardware, mount surface overhead stops on least public side of door.
4. Provide stops with any special templates, brackets, plates, or other accessories required for interface with header, door, wall, and other hardware.

2.15 SADDLE AND PANIC THRESHOLDS

A. Acceptable Products:

1.	Zero International:	655A
2.	National Guard:	425HD
3.	Pemko:	1715A

B. Requirements:

1. Saddle thresholds: Provide with length equal to the width of the opening.
2. Panic thresholds: Provide with length equal to the overall frame width. Provide with mitered and welded ends.
3. Where floor closers are scheduled with thresholds, provide threshold with factory cut outs to be compatible with the provided floor closer.
4. Provide stainless steel machine screws and lead anchors for each threshold.

2.16 WEATHERSTRIP AND GASKET

A. General:

1. Provide weather strip and gasketing as scheduled.
2. Size weather strip and gasket to provide a continuous seal around opening and at meeting stiles.

B. Perimeter Seals

1. Acceptable Products:

a.	Zero:	429A	488S-BK
b.	National Guard:	700SA	5050B
c.	Pemko:	2891AS	S88D

C. Astragals, Meeting Stiles, and Mullion Seals

1. Acceptable Products:

a.	Zero:	43SP
b.	National Guard:	139A
c.	Pemko:	357C

2. Requirements

a. Where overlapping astragals are scheduled on exterior doors, provide with thru-bolts.
b. Where overlapping astragals are scheduled on out-swinging doors, provide for mounting on the pull-side of the active leaf. Otherwise, provide for mounting on the push-side of the inactive leaf.

D. Door Bottoms

1. Acceptable Products:

a.	Zero:	8198AA	39A
b.	National Guard:	C627A	200NA
c.	Pemko:	3452CNB	3452CNB

2.17 MISCELLANEOUS HARDWARE

A. Silencers

1. Acceptable Products:

a.	Ives:	SR64
b.	Rockwood:	608
c.	Hager:	307D
d.	Trimco:	1229A

2. Requirements:

a. Where indicated on single openings, provide 3 each rubber silencers on lock jamb.
b. Where indicated on paired openings, provide 2 each rubber silencers on header.
c. Where indicated on dutch door openings, provide 4 each rubber silencers on lock jamb.

B. Lock Guards

1. Acceptable Products:

a.	Ives:	LG14

b. Rockwood: 322
c. Trimco: 5002

2. Requirements:

a. Provide lock guards as scheduled.
b. Provide through bolt fasteners at all lock guards.

2.18 ELECTRONIC ACCESSORIES

A. Electric Power Transfers

1. Acceptable Products:

a. Von Duprin: EPT-10
b. Falcon: EPT-10
c. Securitron: CEPT

2. Requirements:

a. Provide edge-mounted electric power transfer with either two 18 gauge wires or ten 24 gauge wires as scheduled.
b. Provide transfer capable of carrying a 16 Amp current for a minimum of .3 seconds.

B. Door Contacts

1. Acceptable Products:

a.	Schlage Electronics:	679-05	7764
b.	Securitron:	DPS Series	--
c.	Security Door Controls:	MC-4	MC-4M

2. Requirements:

a. Provide concealed, edge-mounted door contacts as appropriate for door/frame material.
b. Provide 7764 door contacts where scheduled on fire rated openings, otherwise provide 679-05 switches.

2.19 HIGH SECURITY EMERGENCY KEY BOX

A. Acceptable Products:

1. Knox, Inc. 3200 Series x RMK

B. Requirements:

1. Provide recess-mounted emergency key box as approved by the local fire jurisdiction. Key box to be master-keyed as dictated by local fire jurisdiction.

2.20 KEY CONTROL CABINET

A. Acceptable Products:

1. Lund, Inc. 1200 Series

B. Requirements:

1. Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet.
2. Provide complete cross-index system set up by Owner, and place keys on markers and hooks in the cabinet as determined by the final key schedule.
3. Provide hinged-panel type cabinet for wall mounting with capacity for 250 unique keys.

2.21 FINISHES

A. Match items to the manufacturer's standard color and texture finish for the latch and locksets (or push-pull units if no latch or locksets).
B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.
C. The designations used in schedules and elsewhere to indicate hardware finishes are those listed in ANSI/BHMA A156.18, "Materials and Finishes," including coordination with the traditional U.S. finishes shown by certain manufacturers for their products.
D. The designations used in schedules and elsewhere to indicate hardware finishes are the industry-recognized standard commercial finishes, except as otherwise noted.

1. Brushed Chrome and/or Stainless Steel Appearance

a. Brushed Stainless Steel, no coating: ANSI 630.
b. Satin Chrome, Clear Coated: ANSI 626, ANSI 652.
c. Powder Coated Aluminum finish: ANSI 689.
d. Saddle and Panic Thresholds: Mill Aluminum finish.
e. Weatherstrip and Gasket: Clear Anodized Aluminum finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Steel Doors and Frames: Comply with DHI A115 Series.

    1. Surface-Applied Door Hardware: Drill and tap doors and frames according to ANSI A250.6.

B. Wood Doors: Comply with DHI A115-W Series.

3.3 INSTALLATION

A. Pre-installation conference shall be conducted prior to installation of hardware at Project site. Meet with the, Owner, Contractor, installer, and manufacturer's representatives. A separate pre-installation conference shall be conducted prior to the installation of electronic security hardware with the electrical contractor Review catalogs, brochures, templates, installation instructions, and the approved hardware schedule. Survey installation procedures and workmanship, with special emphasis on unusual conditions, as to ensure correct technique of installation, and coordination with other work. Notify participants at least ten, 10 working days before conference.
B. Hardware Installers must have a minimum of five (5) years' experience in installation of hardware. Provide verification of installer's qualification to Consultant for approval. All installers to attend review meetings with the hardware distributor.
C. Install hardware using only manufacturer supplied and approved fasteners in strict adherence with manufacturers published installation instructions.
D. Install head seal prior to installation of "PA"-parallel arm mounted door closers and push side mounted door stops/holders. Trim, cut and notch thresholds and saddles neatly to minimally fit the profile of the door frame. Install thresholds

and saddles in a bed of caulking completely sealing the underside from water and air penetration.

E. Counter sink through bolt of door pull under push plate during installation.

F. Mounting Heights: Mount door hardware units at heights indicated, as follows, unless otherwise indicated or required to comply with governing regulations.

1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
2. Custom Steel Doors and Frames: DHI's "Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames."
3. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."

G. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 09 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

H. Furnish wiring diagrams to electrical contractor for use in installing electrical hardware products.

1. Electrical contractor to run all wiring and make all final connections for electrified hardware. Hardware supplier shall be responsible to furnish all wiring diagrams to operate electrified hardware. Access control material and electrified hardware to interface at junction boxes.

I. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."

3.4 FIELD QUALITY CONTROL

A. Architectural Hardware Consultant: Architect shall engage a qualified Architectural Hardware Consultant to perform inspections and to prepare inspection reports.

B. Architectural Hardware Consultant shall inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

3.5 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
2. Door Closers: Unless otherwise required by authorities having jurisdiction, adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches (75 mm) from the latch, measured to the leading edge of the door.

B. Occupancy Adjustment: Approximately six months after date of Substantial Completion, Installer's Architectural Hardware Consultant shall examine and readjust, including adjusting operating forces, each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.6 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.
B. Clean operating items as necessary to restore proper function and finish.
C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes. Refer to Division 01 Section "Demonstration and Training."

3.8 DOOR HARDWARE SETS

A. The following schedule of hardware sets shall be considered a guide and the supplier is cautioned to refer to general conditions, special conditions, and the

full requirements of this section. It shall be the hardware supplier's responsibility to furnish all required hardware.

B. Where items of hardware are not definitely or correctly specified and are required for completion of the Work, a written statement of such omission, error, conflict, or other discrepancy shall be sent to the Architect, prior to date specified for receipt of bids, for clarification by addendum.

C. Adjustments to the Contract Sum will not be allowed for omissions or items of hardware not clarified prior to bid opening.

HARDWARE SET NO: 01
DOOR NUMBER: A101B, A101C

Provide each door(s) with the following:

1	EA	CONT. HINGE	224HD		628	IVE
1	EA	VANDL STOREROOM LOCK	ND96TD RHO		626	SCH
1	EA	FSIC CORE	23-030		626	SCH
1	EA	ELECTRIC STRIKE	6223 FSE DS 12/16/24/28 VAC/VDC	↯	630	VON
1	EA	LOCK GUARD	LG14		630	IVE
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS		689	LCN
1	EA	CUSH SHOE SUPPORT	4040XP-30		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
1	EA	RAIN DRIP	142AA		AA	ZER
1	EA	GASKETING	429AA-S		AA	ZER
1	EA	DOOR SWEEP	39A		A	ZER
1	EA	THRESHOLD	547 MSLA-10		AL	ZER
1	EA	MULTITECH READER	BY SECURITY CONTRACTOR BY SECURITY CONTRACTOR	↯	BLK	SCE
1	EA	DOOR CONTACT	679-05	↯	WHT	SCE
1	EA	POWER SUPPLY	BY SECURITY CONTRACTOR BY SECURITY CONTRACTOR	↯		VON

HARDWARE SET NO: 02
DOOR NUMBER: A102

Provide each door(s) with the following:

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	VANDL ENTRANCE LOCK	ND92TD RHO	626	SCH
1	EA	FSIC CORE	23-030	626	SCH
1	EA	WALL STOP	WS406/407CCV	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE SET NO: 03
DOOR NUMBER: A103

Provide each door(s) with the following:

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	VANDL STOREROOM LOCK	ND96TD RHO	626	SCH
1	EA	FSIC CORE	23-030	626	SCH
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ TBWMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE SET NO: 04
DOOR NUMBER: A101A

All door hardware by door manufacturer.

END OF SECTION 08710

SECTION 08800 - GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
   1. Windows.
   2. Doors.

1.3 DEFINITIONS

A. Manufacturers of Glass Products: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Interspace: Space between lites of an insulating-glass unit that contains dehydrated air or a specified gas.

C. Deterioration of Coated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in metallic coating.

D. Deterioration of Insulating Glass: Failure of hermetic seal under normal use that is attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

1.4 PERFORMANCE REQUIREMENTS

A. General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Glass Design: Glass thickness designations indicated are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites in the thickness designations indicated for various size openings, but not less than thicknesses and in strengths (annealed or heat treated) required to meet or exceed the following criteria:
   1. Glass Thicknesses: Select minimum glass thicknesses to comply with ASTM E 1300, according to the following requirements:
      a. Specified Design Wind Loads: As indicated.
      b. Design Wind Loads: Determine design wind loads applicable to Project from basic wind speed indicated in miles per hour at 33 feet above grade, according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 6.5, "Method 2-Analytical Procedure," based on mean roof heights above grade indicated on Drawings.
      c. Specified Design Snow Loads: As indicated, but not less than snow loads applicable to Project as required by ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 7.0, "Snow Loads."

C. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

1.5 SUBMITTALS

A. Product Data: For each glass product and glazing material indicated.
B. Samples: For the following products, in the form of 12-inch-square Samples for glass and of 12-inch-long Samples for sealants. Install sealant Samples between two strips of material representative in color of the adjoining framing system.
   1. Each color of tinted float glass.
   2. Ceramic-coated spandrel glass.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in glass installations with a record of successful in-service performance.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

B. For insulating-glass units that will be exposed to substantial altitude changes, comply with insulating-glass manufacturer's written recommendations for venting and sealing to avoid hermetic seal ruptures.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
   1. Do not install liquid glazing sealants when ambient and substrate temperature conditions are outside limits permitted by glazing sealant manufacturer or below 40 deg F.

1.9 WARRANTY

A. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form, made out to Owner and signed by insulating-glass manufacturer agreeing to replace insulating-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
   1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Product: Subject to compliance with requirements, provide product specified.

2.2 GLASS PRODUCTS

A. Float Glass: ASTM C 1036, Type I (transparent flat glass), Quality-Q3; of class indicated.

B. Heat-Treated Float Glass: ASTM C 1048; Type I (transparent flat glass); Quality-Q3; of class, kind, and condition indicated.
   1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed, unless otherwise indicated.

2. Provide Kind HS (heat-strengthened) float glass in place of annealed float glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in Part 1 "Performance Requirements" Article.
3. Provide Kind FT (fully tempered) designated as tempered, float glass in place of annealed or Kind HS (heat-strengthened) float glass where safety glass is indicated.

C. Insulating-Glass Units, General: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, and complying with ASTM E 774 for Class CBA units and with requirements specified in this Article and in Part 2 "Insulating-Glass Units" Article.
1. Provide Kind HS (heat-strengthened) float glass in place of annealed glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in Part 1 "Performance Requirements" Article.
2. Provide Kind FT (fully tempered) designated as tempered, glass lites where safety glass is indicated.
3. Overall Unit Thickness and Thickness of Each Lite: Dimensions indicated for insulating-glass units are nominal and the overall thicknesses of units are measured perpendicularly from outer surfaces of glass lites at unit's edge.
4. Sealing System: Dual seal, with primary and secondary sealants as follows:
   a. Manufacturer's standard sealants.
5. Spacer Specifications: Manufacturer's standard spacer material and construction.

2.3 GLAZING GASKETS

A. Lock-Strip Gaskets: Neoprene extrusions in size and shape indicated, fabricated into frames with molded corner units and zipper lock-strips, complying with ASTM C 542, black.

2.4 GLAZING SEALANTS

A. General: Provide products of type indicated, complying with the following requirements:
1. Compatibility: Select glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.

B. Elastomeric Glazing Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
   1. Single-Component Neutral- and Basic-Curing Silicone Glazing:
      a. Available Products:
         1) GE Silicones; SilPruf SCS2000.
         2) Polymeric Systems Inc.; PSI-641.
         3) Sonneborn, Div. of ChemRex, Inc.; Omniseal.
         4) Tremco; Spectrem 3.
      b. Type and Grade: S (single component) and NS (non-sag).
      c. Class: 50.
      d. Use Related to Exposure: NT (non-traffic).

2.5 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based elastomeric tape with a solids content of 100 percent; non-staining and non-migrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; packaged on rolls with a release paper backing; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
   1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.

2.6 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
D. Spacers: Elastomeric blocks or continuous extrusions with a Shore, Type A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

2.7 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites in a manner that produces square edges with slight kerfs at junctions with outdoor and indoor faces.

C. Grind smooth and polish exposed glass edges and corners.

2.8 MONOLITHIC FLOAT-GLASS UNITS

A. Uncoated Clear Float-Glass Units: Class 1 (clear) Kind HS (heat-strengthened) float glass, Kind FT (fully tempered) float glass.
   1. Thickness: 6.0 mm.

B. Uncoated Clear Float-Glass Units: Class 1, Kind HS (heat-strengthened), Kind FT (fully tempered) float glass.
   1. Basis-of-Design Product: PPG Industries, Inc.
   2. Thickness: 6.0 mm.
   3. Tint Color: "Clear”.

2.9 INSULATED GLASS UNITS

A. Clear Insulating-Glass Units with Low-E coating:
   1. Basis-of-Design Product: “Solarban 60 Double-IGU” by Vitro (Formerly PPG Industries)
   2. Overall Unit Thickness and Thickness of Each Lite: 25 and 6.0 mm.
   3. Interspace Content: Air or Argon gas.
   4. Outdoor Lite: Class 1 (clear) float glass.
      a. Tint Color: "Clear”.
      b. Kind HS (heat strengthened), Kind FT (fully tempered).
   5. Indoor Lite: Class 1 (clear) float glass.
      a. Annealed, Kind HS (heat strengthened), Kind FT (fully tempered).
   6. Low-E coating Location: Second surface.
   7. Acid-Etching location (as occurs): See above
   8. Visible Light Transmittance: 72%
   9. SHGC: 0.40
   10. U-Value: 0.25

2.10 LAMINATED GLASS

A. Laminated Glass: ASTM C 1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

1. Construction: Laminate glass with polyvinyl butyral interlayer to comply with interlayer manufacturer's written instructions.
2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
3. Interlayer Color: Clear unless otherwise indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing glazing, with Installer present, for compliance with the following:
1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
2. Presence and functioning of weep system.
3. Minimum required face or edge clearances.
4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Glazing channel dimensions, as indicated on Drawings, provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.

C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.
E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
G. Provide spacers for glass lites where length plus width is larger than 50 inches as follows:
    1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
    2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

3.4 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
C. Do not remove release paper from tape until just before each glazing unit is installed.

3.5 GASKET GLAZING (DRY)

A. Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
D. Install gaskets so they protrude past face of glazing stops.

3.6 CLEANING AND PROTECTION

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.
B. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended by glass manufacturer.
C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.
D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

END OF SECTION 08800

SECTION 09221 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Non-load-bearing steel framing systems for interior gypsum board assemblies.
   2. Suspension systems for interior gypsum ceilings, soffits, and grid systems.

PART 2 - PRODUCTS

2.1 FRAMING SYSTEMS

A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
B. Studs and Runners: ASTM C 645.Use steel studs and runners

C. Slip-Type Head Joints: At top of wall, provide the following:
   1. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length:
   1. Minimum Base-Metal Thickness: 0.027 inch (0.68 mm)

E. Resilient Furring Channels: 1/2-inch- (13-mm-) deep, steel sheet members designed to reduce sound transmission.

2.2 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.

B. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch (4.12 mm) in diameter.
C. Carrying Channels: Cold-rolled, commercial-steel sheet with a minimum base-metal thickness of 0.053 inch (1.34 mm) and minimum 1/2-inch- (13-mm-) wide flanges.

D. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Armstrong World Industries, Inc.; Drywall Grid Systems.
      b. Chicago Metallic Corporation; Drywall Grid System.
      c. USG Corporation; Drywall Suspension System.

2.3 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.
   1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Isolation Strip at Exterior Walls: Provide the following:
   1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), nonperforated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at

spacing required to support the Work and that hangers will develop their full strength.

1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

3.3 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754.
   1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C 841 that apply to framing installation.
   2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.
   3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
   4. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

C. Install bracing at terminations in assemblies.

D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
   1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.

2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
   a. Install two studs at each jamb unless otherwise indicated.
   b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (13-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.
   c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
   a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.

E. Direct Furring:
   1. Screw to wood framing.
   2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.

F. Z-Furring Members:
   1. Erect insulation, specified in Division 07 Section "Thermal Insulation," vertically and hold in place with Z-furring members spaced [24 inches (610 mm)] [600 mm] o.c.
   2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.
   3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches (305 mm) from corner and cut insulation to fit.

G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

3.5 INSTALLING SUSPENSION SYSTEMS

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:
   1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
   2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
   3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
   4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
   5. Do not attach hangers to steel roof deck.
   6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
   7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
   8. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

F. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 09221

SECTION 09290 - GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Interior gypsum board.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 DELIVERY, STORAGE AND HANDLING

A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.5 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.
B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
C. Do not install panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

A. Gypsum Board, Type X: ASTM C 1396/C 1396M.

1. Thickness: 5/8 inch.
2. Long Edges: Tapered.

2.4 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet.
2. Shapes:

    a. Cornerbead.
    b. Bullnose bead.
    c. LC-Bead: J-shaped; exposed long flange receives joint compound.
    d. L-Bead: L-shaped; exposed long flange receives joint compound.
    e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
    f. Expansion (control) joint.
    g. Curved-Edge Cornerbead: With notched or flexible flanges.

2.5 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:

1. Interior Gypsum Board: Paper.

C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.

    a. Use setting-type compound for installing paper-faced metal trim accessories.

3. Fill Coat: For second coat, use setting-type, sandable topping compound.
4. Finish Coat: For third coat, use setting-type, sandable topping compound.
5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping.

2.6 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
C. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.

1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

D. Sound-Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

E. Acoustical Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

F. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL

A. Comply with ASTM C 840.
B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
E. Form control and expansion joints with space between edges of adjoining gypsum panels.
F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

    1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
    2. Fit gypsum panels around ducts, pipes, and conduits.

3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.

G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

I. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members or provide control joints to counteract wood shrinkage.

J. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

K. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install control joints at locations indicated on Drawings.

C. Interior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners.
2. LC-Bead: Use at exposed panel edges.

3.4 FINISHING GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints and damaged surface areas.
C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.

2. Level 5: All exposed locations including walls, soffits, headers, etc.

E. Special Gypsum board finish is required at specialty light fixtures specified to have “Flangeless” appearance. Coordinate with light fixture schedule and electrician. At these locations. linear light fixtures are recessed into gypsum board. Drywall contractor is required to mud over raw aluminum flange up to the lens of the light fixture. Drywall contractor must coordinate with fixture manufacturer’s details for the desired finish.

3.5 PROTECTION

A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
C. Remove and replace panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

3.6 PARTITION IDENTIFICATION

A. Identify partitions indicated on drawings as having a required fire or smoke rating.

1. Follow guidelines set in Chapter 7 of International Building Code or as locally amended.
2. Permanently identify with stenciling:

a. Mininum 6 inches high letters with minimum ½ inch stroke.

b. Bottom of lettering to start at 6 inches above ceiling.
c. Stenciling to be 10 feet on center max.
d. Color: Red for 1-hr rated walls, Blue for 2-hr rated walls, Green for smoke partition walls.
e. Provide in a manner acceptable to authority having jurisdiction.

END OF SECTION 09290

SECTION 09651 - RESILIENT WALL BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Resilient wall base.
   2. Resilient floor transitions and accessories.

1.3 SUBMITTALS

A. Product Data: For each type of product specified.
B. Samples for Initial Selection: Manufacturer's standard sample sets consisting of sections of units showing the full range of colors and patterns available for each type of product indicated.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer to perform work of this Section who has specialized in installing resilient products similar to those required for this Project and with a record of successful in-service performance.
B. Source Limitations: Obtain each type and color of product specified from one source with resources to provide products of consistent quality in appearance and physical properties without delaying the Work.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to Project site in manufacturer's original, unopened cartons and containers, each bearing names of product and manufacturer, Project identification, and shipping and handling instructions.

1.6 PROJECT CONDITIONS

A. Maintain a temperature of not less than 70 deg F or more than 95 deg F in spaces to receive resilient products for at least 48 hours before installation, during installation, and for at least 48 hours after installation, unless manufacturer's written recommendations specify longer time periods. After post

installation period, maintain a temperature of not less than 55 deg F or more than 95 deg F.

B. Do not install products until they are at the same temperature as the space where they are to be installed.

C. For resilient products installed on traffic surfaces, close spaces to traffic during installation and for time period after installation recommended in writing by manufacturer.

D. Coordinate resilient product installation with other construction to minimize possibility of damage and soiling during remainder of construction period. Install resilient products after other finishing operations, including painting, have been completed.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
   1. Furnish not less than 10 linear feet for each 500 linear feet or fraction thereof, of each different type, color, pattern, and size of resilient product installed.
   2. Deliver extra materials to Owner.

PART 2 - PRODUCTS

2.1 RESILIENT WALL BASE

A. Product Standard: ASTM F 1861, Type TP (rubber, thermoplastic), Group I (solid, homogeneous).

B. Rubber Wall Base: Provide rubber wall base complying with the following and as indicated on the Drawings:
   1. Products: As follows:
      a. Burke Flooring Products Division – Burke Industries, Inc.
      b. Flexco Div. – Textile Rubber Co.
      c. Johnson Rubber Co., Inc.
      d. R.C. Musson Rubber Co, Inc.
      e. Roppe Rubber Corp.
   2. Color and Pattern: See Finish Schedule.
   3. Style: Traditional Base with Toe
   4. Minimum Thickness: 1/8 inch.
   5. Height: 4 inches.

6. Lengths: Coils in lengths standard with manufacturer, but not less than 96 feet.
7. Surface: Smooth.

2.2 RESILIENT ACCESSORIES

A. Rubber Accessory: Provide rubber accessory molding complying with the following:
   1. Products: As follows:
      a. Burke Flooring Products Division – Burke Industries, Inc.
      b. Flexco Div. – Textile Rubber Co.
      c. Johnson Rubber Co., Inc.
      d. R.C. Musson Rubber Co, Inc.
      e. Roppe Rubber Corp.
      f. RCA Rubber Company
   2. Color and Pattern: Match rubber base.
   3. Product Description: Carpet edge for glue-down applications. Reducer strip for resilient flooring. Tile and carpet joiner.

2.3 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based formulation provided or approved by resilient product manufacturer for applications indicated.
B. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where installation of resilient products will occur, with Installer present, for compliance with manufacturer's requirements, including those for maximum moisture content. Verify that substrates and conditions are satisfactory for resilient product installation and comply with requirements specified. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Comply with manufacturer's written installation instructions for preparing substrates indicated to receive resilient products.

B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, and depressions in substrates.
C. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
D. Broom and vacuum clean substrates to be covered immediately before installing resilient products. After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. General: Install resilient products according to manufacturer's written installation instructions.
B. Apply resilient wall base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
    1. Install wall base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.
    2. Tightly adhere wall base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
    3. Do not stretch base during installation.
    4. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient wall base with manufacturer's recommended adhesive filler material.
    5. Form outside corners on job, from straight pieces of maximum lengths possible, without whitening at bends. Shave back of base at points where bends occur and remove strips perpendicular to length of base that are only deep enough to produce a snug fit without removing more than half the wall base thickness.
    6. Form inside corners on job, from straight pieces of maximum lengths possible, by cutting an inverted V-shaped notch in toe of wall base at the point where corner is formed. Shave back of base where necessary to produce a snug fit to substrate.

C. Place resilient products so they are butted to adjacent materials and bond to substrates with adhesive. Install reducer strips at edges of flooring that would otherwise be exposed.
D. Apply resilient products to stairs as indicated and according to manufacturer's written installation instructions.

3.4 CLEANING AND PROTECTING

A. Perform the following operations immediately after installing resilient products:
   1. Remove adhesive and other surface blemishes using cleaner recommended by resilient product manufacturers.
   2. Sweep or vacuum horizontal surfaces thoroughly.
   3. Do not wash resilient products until after time period recommended by resilient product manufacturer.
   4. Damp-mop or sponge resilient products to remove marks and soil.

B. Protect resilient products against mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by resilient product manufacturer.

END OF SECTION 09651

SECTION 09900
HIGH-PERFORMANCE COATINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Furnishing and applying protective coatings of paint to all surfaces indicated on the Drawings or specified herein, including all surface preparation and related work.

B. Architectural coatings are specified in Section 09910 and as shown on the Architectural Finish Schedules.

1.2 EXCLUSIONS

A. Painting is not required for the following surfaces or items unless otherwise shown on the Drawings, specified in other sections, or specified herein:

1. Stainless steel, aluminum (except where in contact with concrete), chrome, fiberglass, copper instruments, pressure gauge tubing, and structural FRP. (unless noted on plans or finish schedules.)
2. Electrical panels, motor control centers, pumps, and motors having a factory finish. The factory finish shall be approved by the Engineer. Non-approved factory finishes shall be painted as specified hereinafter.
3. Surfaces hidden from view such as piping, ducts, structural wood, and insulation.

1.3 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American National Standards Institute (ANSI)
   a. Standard Colors for Color Identification and Coding
   b. A13.1, Scheme for the Identification of Piping Systems
2. American Water Works Association (AWWA)
   a. C203, Coal-Tar Protective Coatings and Linings for Steel Water Pipelines-Enamel and Tape-Hot-Applied
   b. C210, Liquid Epoxy Coating System for the Interior and Exterior of Steel Water Pipelines
   c. C214, Tape Coating Systems for the Exterior of Steel Water Pipelines
3. NSF International (NSF): 61 Drinking Water System Components-Health Effects
4. National Association of Corrosion Engineers (NACE): Manual for Painter Safety

5. Occupational Safety and Health Act (OSHA)

6. Steel Structures Painting Council (SSPC)

    a. QP1, Standard Procedure for Evaluating Qualifications of Painting Contractors
    b. QP2, Standard Procedure for Evaluating the Qualifications of Painting Contractors to Remove Hazardous Paint
    c. SP 1, Surface Preparation Specification No. 1, Solvent Cleaning
    d. SP 2, Hand Tool Cleaning
    e. SP 3, Power Tool Cleaning
    f. SP 5, White Metal Blast Cleaning
    g. SP 6, Commercial Blast Cleaning
    h. SP 7, Brush-Off Blast Cleaning
    i. SP 8, Pickling
    j. SP 10, Near-White Blast Cleaning
    k. SP 11, Power Tool Cleaning to Bare Metal
    l. SP 12, High Pressure Water Jetting
    m. SP 13, Surface Preparation of Concrete
    n. SP 16, Brush off Blast Cleaning of Non-Ferrous Metals.
    o. PA1, Best Practices for Paints and Coatings Application
    p. PA2, Measurement of Dry Coating Thickness with Magnetic Gauges
    q. PA17, Determining Conformance to Steel Profile/Surface Roughness
    r. Guide No. 3, PA, Guide to Safety in Paint Applications

7. National Association of Pipe Fabricators (NAPF)
    a. 500-03-01, Solvent Cleaning
    b. 500-03-02, Hand Tool Cleaning
    c. 500-03-03, Power Tool Cleaning
    d. 500-03-04, Abrasive Blast Cleaning for Ductile Iron Pipe
    e. 500-03-05, Abrasive Blast Cleaning for Ductile Iron Fittings

8. International Concrete Repair Institute (ICRI)
    a. 310.2, Surface Preparation of Concrete
    b. CSP, Concrete Surface Profile

9. NACE International (NACE)
    a. SP-0188-06, Discontinuity (Holiday) Testing of Protective Coatings

10. ASTM International (ASTM)
    a. ASTM D 16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications.
    b. ASTM D 4258, Standard Practice for Surface Cleaning Concrete for Coating.
    c. ASTM D 4259, Standard Practice for Abrading Concrete.
    d. ASTM D 4261, Standard Practice for Surface Cleaning Concrete Unit Masonry for Coating.
    e. ASTM D 4262, Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces.

f. ASTM D 4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
g. ASTM D 4417 Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel.
h. ASTM D 4541, Standard Test Method for Pull-off Strength of Coatings Using Portable Adhesion Testers.
i. ASTM D 7091 - Standard Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals.
j. ASTM D 3359 Standard Test Methods for Rating Adhesion by Tape Test

1.4 SUBMITTALS

A. Shop Drawings

1. Data Sheets, including catalog cuts and color charts.

a. Material Safety Data Sheets (MSDS), the manufacturer's Technical Data Sheets, and paint colors available (where applicable) for each product used in the paint system.

b. Submit required information on a system-by-system basis.

c. Furnish copies of paint system submittals to the coating applicator.

d. Indiscriminate submittal of manufacturer's literature only is not acceptable.

2. Detailed chemical and gradation analysis for each proposed abrasive material.

3. System Application Process (for each coating system):

a. Contractor shall indicate surface preparation, primer, stripe coat, finish coat, and quality control parameters as indicated in Section 3.7.

b. Submittal shall include a detailed pre-installation packet with on-site photographs of each edge and transition termination around pipes, gates, frames, edge of coating etc. Drawings on the photographs shall indicate the termination method to be used, in conformance with the coating system manufacturer's recommendations.

c. Submittals shall be approved by the coating manufacturer, the applicator and the General Contractor that is specific to each application system.

B. Quality Control Submittals

1. Applicator's Qualification: List of references substantiating experience.

2. Factory-Applied Coatings: Manufacturer's certification stating factory-applied coating system meets or exceeds requirements specified.

3. If the manufacturer of finish coating differs from that of shop primer, provide both manufacturers' written confirmations that materials are compatible.

4. Manufacturer's written instructions and special details for applying each type of paint.

5. Manufacturer's written verification that submitted material is suitable for the intended use.

C. Extended Warranty Certificates

D. Contract Closeout Submittals: Extended Warranty Certificate

1.5 QUALITY CONTROL

A. Qualifications of Applicator: Minimum 5 years' experience in application of specified products.

B. Contractor's Responsibilities

1. The Contractor shall perform first-line, in-process QC inspections and testing in accordance with the level of quality control specified for each coating system.

2. The Contractor shall use the "Daily Coating Inspection Report" found at the end of this specification to record the results of quality control inspections and tests. The completed reports shall be turned in to the Engineer before work resumes the following day.

3. The Contractor shall supply all necessary equipment to perform the QC tests. The instruments shall be calibrated by the Contractor's personnel according to the equipment manufacturer's recommendations and the Contractor's QC Program. All inspection equipment shall be made available to the Engineer for QA observations on an as-needed basis.

4. Equipment shall include the following at a minimum:

   a. Recording thermometer.

   b. Hygrometer.

   c. Recording or comparable equipment for the recording of dew point and continuous recording of relative humidity.

   d. Surface temperature thermometer.

   e. Hypodermic Needle Pressure Gage for determining blasting pressure at the nozzle.

   f. Visual Standard for abrasive blast cleaning.

   g. Testex Press-O-Film Replica Tape and Spring Micrometer.

h. Wet Film Thickness Gage.

i. Blotter paper and plate glass for compressed air cleanliness checks.

j. Magnetic Dry Film Thickness Gage with calibration standards.

k. Holiday Detector: Non-destructive wet sponge-type detector. Operating test voltage shall be per NACE RO-02-74 or as recommended by the Coating Manufacturer's representative.

l. A non-sudsing-type wetting agent such as Kodak Photo-Flo, or equal, shall be added to the water prior to wetting the detector sponge.

C. Quality Assurance (QA) Observations by Engineer

1. The Engineer will conduct QA observations of any or all phases of the work. The presence or activity of Engineer observations in no way relieves the Contractor of the responsibility to provide all necessary daily QC inspections of his/her own and to comply with all requirements of this Specification.

2. Hold Points: Work that requires a specific inspection upon completion is designated as a Hold Point. The Contractor shall provide the Engineer with a minimum one-day notification before a Hold Point inspection will be reached. Permission to proceed beyond a Hold Point without a QA inspection will be granted solely at the discretion of the Engineer, and only on a case-by-case basis.

3. The Engineer has the right to reject any work that was performed without adequate provision for QA observations.

4. The Engineer will issue a Non-Conformance Report when work is found to be in violation of the specification requirements and is not corrected to bring it into compliance before proceeding with the next phase of work.

5. Inspection Access and Lighting

a. The Contractor shall facilitate the Engineer's observations as required, including allowing ample time to view the work. The Contractor shall furnish, erect, and move scaffolding or other mechanical equipment to permit close observation of all surfaces to be cleaned and painted. This equipment shall be provided during all phases of the work.

b. When the surface to be inspected is more than 1.8 m (6 ft) above the ground or water surface, the Contractor shall provide the Engineer with a safety harness and a lifeline according to OSHA regulations.

c. The Contractor shall provide artificial lighting in areas where natural light is inadequate, as determined by the Engineer, to allow proper cleaning, inspection, and painting. Illumination for inspection shall be at least 325 LUX (30-foot candles). Illumination for cleaning and painting, including the working platforms, access, and entryways shall be at least 215 LUX (20-foot candles).

1.6 SUBSTITUTIONS

A. Products of manufacturers other than those specified, and equal in type and quality to those specified, may be considered acceptable if said products are offered by the Contractor with satisfactory data on past performance, composition and directions for use. No request for substitution will be approved which decreases the film thickness specified and/or number of coats to be applied, or which offers a change from the generic type of paint and coating system specified.

1.7 DELIVERY, STORAGE AND HANDLING

A. All paint shall be delivered to the job site in the manufacturer's original, sealed and labeled containers and shall be subject to inspection and approval by the Engineer prior to use.

B. Shipping

1. Where pre-coated items are to be shipped to the site, protect coating from damage. Batten coated items to prevent abrasion.

2. Use non-metallic or padded slings and straps in handling.

C. Storage

1. Store products in a protected area that is heated or cooled to maintain temperatures within the range recommended by paint manufacturer.

2. Primed surfaces shall not be exposed to weather for more than two months before being topcoated, or less time if recommended by coating manufacturer.

1.8 SERVICES OF MANUFACTURER

A. For submerged and severe service coating systems, the Contractor shall require the paint manufacturer to furnish the following services:

1. The manufacturer's representative shall provide technical support to resolve field problems associated with the surface preparation requirements and application and curing of the manufacturer's products.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Provide tenting, dehumidification, heating, and other environmental controls necessary to meet the preparation, application, and curing requirements of the coatings used.

1.10 EXTENDED WARRANTIES

A. When specified, provide manufacturer's and contractor's extended warranty for materials and workmanship with Owner named as beneficiary, and shall commence at the time of Substantial Completion.

1.11 PROTECTION OF EXISTING PAINTED STRUCTURES

A. The painting on existing structures and equipment shall be protected. Any damage caused by the Contractor's operation shall be repaired or restored to a condition equal to or better than before it was damaged.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer used as the basis of design: Product names used herein refer to materials manufactured and/or supplied by Tnemec Co. and are used as the basis of quality for design and bidding.

1. Approved Manufacturers – Paint
   a. Tnemec
   b. or pre-approved "or-equals" in accordance with Instructions to Bidders Article 11 and listed below:
      i. N/A

B. All paint materials selected for each system for each type of surface shall be the product of a single manufacturer. The type of paint material to be used and the number of coats to be applied are listed in the coating systems specified below.

C. All paint materials and equipment shall be compatible in use. Finish coats shall be compatible with prime coats. Prime coats shall be compatible with the surface to be coated. All tools and equipment shall be compatible with the coating to be applied.

D. Coal tar epoxy and products containing coal tar pitch will not be allowed.

E. Special systems as specified for surface conditions by the manufacturer specified; substitution only upon affidavit of alternate manufacturer that product will meet conditions and label for surface use.

2.2 COLORS

A. Alternating coats shall be contrasting but complimentary to finish coating.

B. All colors and glosses shall be as selected by the Owner.

C. Colors and painting schemes shall match existing colors at project for similar surfaces.

2.3 ABRASIVE MATERIALS

A. Select abrasive type and size to produce a surface profile that meets coating manufacturer's recommendations.

B. Abrasive blast cleaning shall be performed using either expendable abrasives (other than silica sand) or recyclable steel grit abrasives. Expendable abrasive shall be used one time and disposed of. Abrasive suppliers shall certify that the expendable abrasives meet the requirements of SSPC-AB1 and that recyclable steel grit abrasives meet AB3. The Contractor shall verify that recycled abrasives meet the requirements of SSPC-AB2 during use. All surfaces prepared with abrasives not meeting the SSPC-AB1, AB2, or AB3 requirements, as applicable, shall be solvent cleaned or low pressure water cleaned as directed by the Engineer, and re-blast cleaned at the Contractor's expense.

2.4 THINNERS, CLEANERS, DRIERS, AND OTHER ADDITIVES

A. As recommended by manufacturer of the particular coating.

2.5 VISUAL STANDARD

A. When specified and to facilitate inspection, Contractor shall, on the first day of sandblasting operations, sandblast metal plates to the surface preparation standards specified. Plates shall measure 8½ inches by 6 inches. Plates shall be approved by the Engineer. Plates shall be coated with a clear, non-yellowing finish. One of these plates shall be prepared for each type of sandblasting and shall be used as the comparison standard throughout the project.

PART 3 EXECUTION

3.1 SURFACE PREPARATION, GENERAL

A. Prior to all surface preparation and painting operations, completely mask, remove or otherwise adequately protect all hardware, accessories, machined surfaces, plates, lighting fixtures, equipment, and similar items in contact with painted surfaces but not scheduled to receive paint.

B. All surfaces to be painted shall be in the proper condition to receive the specified paint before said paint is applied. Surface preparation shall be done in a workmanlike manner with the objective of obtaining a clean and dry surface. No more surface preparation

than can be coated in a normal working day shall be permitted. No coating shall be applied before the prepared surfaces are approved by the Engineer.

C. Schedule all cleaning and painting so that dust and other contaminants from the cleaning process will not fall on wet, newly-painted surfaces.

D. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.

E. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process. For process piping, mask bolt threads to allow nuts to be removed for maintenance.

F. Mask openings in motors to prevent paint and other materials from entering the motors.

G. Protect all surfaces adjacent to or downward of work area from overspray. Contractor shall be responsible for any damage resulting from overspray.

3.2 SURFACE PREPARATION DESIGNATIONS

A. General:

1. The following designations for surface preparation shall be utilized in the coating systems specified. In no case shall the surface preparation be less than that specified by the Paint Manufacturer. In case of conflict, the more restrictive requirement shall apply.

2. Inspect and provide substrate surfaces prepared in accordance with these Specifications and the printed directions and recommendations of paint manufacturer whose product is to be applied. The more stringent requirements shall apply.

3. Position diesel- or gasoline-powered equipment in a manner to prevent deposition of combustion contaminants on any part of the structure.

4. Do not perform abrasive blast cleaning whenever relative humidity exceeds 85 percent or whenever surface temperature is less than 5° F above dew point of ambient air.

5. Schedule all cleaning and painting so that dust and other contaminants from the cleaning process will not fall on wet, newly-painted surfaces.

6. No more surface preparation than can be coated in a normal working day shall be permitted.

7. No coating shall be applied before the prepared surfaces are approved by the Engineer.

B. Concrete and Masonry*:* All surfaces shall be cleaned of all dust, mortar splatter, curing compounds, grease and other foreign matter. Prepare concrete surfaces per SSPC-

SP13, ICRI 310.2 with the appropriate concrete surface profile (CSP) as suggested by the coatings manufacturer. Surface preparation shall conform to the following table:

CONCRETE AND MASONRY SURFACE PREPARATION	
Designation	**Description**
CM-1/CSP-1	**Solvent Cleaning**: Solvent cleaning is a method for removing all visible oil, grease, soil, and other soluble contaminants. Low pressure (1500 – 4000 psi) high volume (3-5 gal/min) water washing with appropriate cleaning chemicals.
CM-2/CSP-2	**Acid Etch**: Clean and etch with 10% muriatic acid solution, scrub thoroughly, neutralize acid, rinse thoroughly, and allow to dry. If curing compound has been used on concrete, clean curing compound off with solenoid prior to acid etching.
CM-3/CSP-3	**Abrasive Blasting**

C. Metal: All surfaces shall be cleaned of all rust, scale, dust and other foreign matter. Sharp edges, burrs and weld spatter shall be removed. Surface preparation shall conform to the following table and shall be in accordance with the Steel Structures Painting Council (SSPC). Ductile Iron Pipe surface preparation requirements are detailed elsewhere.

METAL SURFACE PREPARATION	
Designation	**Description**
SSPC-SP1	**Solvent Cleaning**: Solvent cleaning is a method for removing all visible oil, grease, soil, drawing and cutting compounds and other soluble contaminants. Solvent cleaning does not remove rust or mill scale. Change rags and cleaning solution frequently so that deposits of oil and grease are not spread over additional areas in the cleaning process. Low-pressure (1500 - 4000 psi) high volume (3 - 5 gal/min.) water washing with appropriate cleaning chemicals is a recognized "solvent cleaning" method. All surfaces should be cleaned per this specification prior to using hand tools or blast equipment.
SSPC-SP2	**Hand Tool Cleaning**: Hand Tool Cleaning removes all loose mill scale, loose rust and other detrimental foreign matter. It is not intended that this process remove adherent mill scale, rust and paint. Mil scale, rust and paint are considered adherent if they cannot be removed by lifting with a dull putty knife. Before hand-tool cleaning, remove visible oil, grease, soluble welding residues and salts by the methods outlined in SSPC-SP1.
SSPC-SP3	**Power Tool Cleaning**: Power Tool Cleaning removes all loose mill scale, loose rust and other detrimental foreign matter. It is not intended that this process remove adherent mill scale, rust and paint. Mil scale, rust and paint are considered adherent if they cannot be removed by lifting with a dull putty knife. Before power tool cleaning, remove visible oil, grease, soluble welding residues and salts by the methods outlined in SSPC-SP1.

METAL SURFACE PREPARATION	
Designation	**Description**
SSPC-SP5	**White Metal Blast Cleaning**: A White Metal Blast Cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products and other foreign matter. Before blast cleaning, visible deposits of oil or grease shall be removed by any of the methods specified in SSPC-SP1 or other agreed upon methods.
SSPC-SP6	**Commercial Blast Cleaning**: A Commercial Blast Cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products and other foreign matter, except for staining. Staining shall be limited to no more than 33% of each square inch of surface area and may consist of light shadows, slight streaks or minor discoloration caused by stains of rust, stains of mill scale or stains of previously applied paint. Before blast cleaning, visible deposits of oil or grease shall be removed by any of the methods specified in SSPC-SP1 or other agreed upon methods.
SSPC-SP7	**Brush-Off Blast Cleaning**: A Brush-Off Blast Cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, loose mill scale, loose rust and loose paint. Tightly adherent mill scale, rust and paint may remain on the surface. Mil scale, rust and coating are considered adherent if they cannot be removed by lifting with a dull putty knife after abrasive blast cleaning has been performed. Before blast cleaning, visible deposits of oil or grease shall be removed by any of the methods specified in SSPC-SP1 or other agreed upon methods.
SSPC-SP10	**Near-White Blast Cleaning**: A Near-White Blast Cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products and other foreign matter, except for staining. Staining shall be limited to no more than 5 percent of each square inch of surface area and may consist of light shadows, slight streaks or minor discoloration caused by stains of rust, stains of mill scale or stains of previously applied paint. Before blast cleaning, visible deposits of oil or grease shall be removed by any of the methods specified in SSPC-SP1 or other agreed upon methods.
SSPC-SP11	**Power Tool Cleaning to Bare Metal**: Metallic surfaces that are prepared according to this specification, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxide corrosion products and other foreign matter. Slight residues of rust and paint may be left in the lower portions of pits if the original surface is pitted. Prior to power tool surface preparation, remove visible deposits of oil or grease by any of the methods specified in SSPC-SP1, Solvent Cleaning, or other agreed upon methods.
SSPC-SP13	Surface preparation of concrete by mechanical, chemical, or thermal methods prior to the application of bonded protective coating or lining systems. An acceptable prepared concrete surface should be free of contaminants, laitance, loosely adhering concrete, and dust, and should provide a sound, uniform substrate suitable for the application of protective coating or lining systems.
SSPC-SP16	**Brush-Off Blast Cleaning of Non-Ferrous Metals** SP 16 is intended for brush-off blast cleaning of coated or uncoated metal surfaces other than carbon steel prior to the application of a protective coating system. Surface preparation using this standard is intended to roughen and clean coated and uncoated non-ferrous metal substrates, including, but not limited to, galvanized surfaces, stainless steel, copper, aluminum, and brass. SP 16 requires the cleaned surface to be free of loose contaminants and loose coating as determined by visual inspection. A minimum surface profile of 19 micrometers (0.75 mil) on the bare metal surface is required.

METAL SURFACE PREPARATION	
Designation	**Description**
	Intact coatings are required to be roughened to the degree specified in the project specification.

D. Wood: Wood surfaces shall be thoroughly cleaned and free of all foreign matter. Surface preparation shall conform to the following table:

WOOD SURFACE PREPARATION	
Designation	**Description**
W-1	Clean with mineral spirits, scraping or wire-brushing. Properly fill cracks, nail holes and other defects. Wipe clean of dust.

E. PVC Pipe: PVC pipe shall be clean and dry. Surface preparation shall conform to the following table:

PVC PIPE SURFACE PREPARATION	
Designation	**Description**
P-1	Sand lightly and wipe clean with xylol or toluol solvent. Allow to dry completely.

F. Ductile Iron Pipe and Fittings: Prepare per Prepare per NAPF 500-03.

A. Per 500-03-01:

a. Solvent cleansing is a method which shall result in the surface being free of all oil, small deposits of asphalt paint, grease, soil, drawing and cutting compounds and other soluble contaminants from iron surfaces. It is intended that solvent cleaning, when necessary, be used prior to the application of special coating/lining and in conjunction with surface preparation methods specified for the removal of rust, annealing oxide, or mold coating.

B. Per 500-03-02:

a. Hand tool cleaning is a method of preparing iron surfaces by the use of non-power hand tools which shall result in the surface being free of all loose annealing oxide, loose rust, loose mold coating and other loose detrimental foreign matter. It is not intended that adherent annealing oxide, mold coating and rust be removed by this process. Annealing oxide, mold coating, and rust are considered adherent if they cannot be removed by lifting with a dull putty knife. All asphalt paint must be removed prior to hand tool cleaning.

C. Per 500-03-03:

a. Power tool cleaning is a method of preparing iron surfaces by the use of power assisted hand tools which shall result in the surface being free of all loose annealing oxide, loose rust, loose mold coating and other loose

detrimental foreign matter. It is not intended that adherent annealing oxide, mold coating and rust be removed by this process. Annealing oxide, mold coating, and rust are considered adherent if they cannot be removed by lifting with a dull putty knife. All asphalt paint must be removed prior to power tool cleaning.

D. Per 500-03-04:
    a. Abrasive Blast Cleaning – **External** Pipe Surfaces is a method of preparing the exterior of ductile iron pipe surfaces which, when viewed without magnification, shall result in the surface being free of all visible dirt, dust, loose annealing oxide, loose rust, loose mold coating and other foreign matter. All oils, small deposits of asphalt paint and grease shall have been removed by solvent cleaning (see NAPF 500-03-01). After the entire surface to be coated is struck by the blast media, tightly adherent annealing oxide, mold coating and rust staining may remain on the surface provided they cannot be removed by lifting with a dull putty knife.

    b. Abrasive Blast Cleaning - **Internal** Pipe Surfaces is a method of preparing the interior of ductile iron pipe surfaces which, when viewed without magnification, shall result in the surface being free of all visible dirt, dust, loose annealing oxide, loose rust, loose mold coating and other foreign matter. Internal pipe surface preparation requirements shall be specified by the pipe manufacturer or pipe fabricator as well as the lining manufacturer and shall be based upon testing of a specific lining applied to ductile iron pipe exposed to a specific environment.

E. Per 500-03-05:
    a. Abrasive Blast Cleaning - Cast Ductile Iron Fittings. Internal and External Surfaces is a method of repairing the interior and exterior of cast ductile iron fittings surfaces which, when viewed without magnification, shall result in the surface being free of all visible dirt, dust, loose annealing oxide, loose rust, loose mold coating and other foreign matter. All oils, small deposits of asphalt paint and grease shall have been removed by solvent cleaning (see NAPF 500-03-01). Four degrees of abrasive blast cleaning for fittings are available, depending on the type of service for which the fitting is intended and upon the type of coating/lining specified.

3.3 APPLICATION

A. General

1. The application of all coatings shall be in strict accordance with the Manufacturer's Instructions and shall be performed in a manner satisfactory to the Engineer. Painting shall be done at such times as the Contractor and Engineer may agree upon in order that dust-free and neat work be obtained.

2. On metal surfaces, each coat shall be applied at the rate specified by the Manufacturer to achieve the dry mil thickness specified herein. If material has thickened or must be diluted for application by spray gun, the coating shall be built up to the same film thickness achieved with undiluted material. Deficiencies in film thickness shall be corrected by the application of additional coats of paint.

3. On masonry or wood, application rates will vary according to surface texture; however, in no case shall the Manufacturer's stated coverage rate be exceeded. On porous surfaces, it shall be the Contractor's responsibility to achieve a protective and decorative finish, either by decreasing the coverage rate or by applying additional coats of paint.

4. Additional coats of paint shall not be applied until the preceding coat has dried as evidenced by tests with a moisture meter. Drying time shall be construed to mean an interval under normal conditions and shall be increased to allow for adverse weather or drying conditions.

5. Thinning, when required, shall be done in strict accordance with the Manufacturer's recommendations using the Manufacturer's thinner, or that recommended by the Manufacturer, with knowledge and approval of the Engineer.

6. Use skilled craftsmen and experienced supervision.

7. Apply coating to produce an even film of uniform thickness. Give special attention to edges, corners, crevices, and joints. Ensure thorough cleaning and an adequate thickness of coating material. Apply coatings to produce finished surfaces free from runs, drips, ridges, waves, laps, brush marks, and variations in color, texture, and finish. Effect complete hiding so that the addition of another coat would not increase the hiding. Give special attention to ensure that edges, corners, crevices, welds, and similar areas receive a film thickness equivalent to adjacent areas. Apply a brushed stripe coat to all edges and welds after priming submerged or severe service areas.

8. Coordinate cleaning and coating so that dust and other contaminants from the cleaning process will not fall on wet, newly-coated surfaces.

9. Prime surfaces within 12 hours after they are blasted. Re-blast surfaces that have started to rust before they are painted.

10. No paint shall be applied in fog, snow, rain, or to wet or damp surfaces or when air temperatures are below 40° F.

11. Surface temperature shall be at least 5° F above the dew point during final surface preparation and painting.

12. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.

13. Coat units or surfaces to be bolted together or joined closely to structures or to one another prior to assembly or installation.

14. On pipelines, terminate coatings along pipe runs to 1 inch inside pipe penetrations.

15. Keep paint materials sealed when not in use.

16. Where more than one coat of a material is applied within a given system, alternate color to provide a visual reference that the required number of coats have been applied.

17. The Contractor shall be responsible for ensuring that the shop prime coating is compatible with the finish coating. Materials and application as specified herein shall govern regardless of whether coatings are factory-applied or field-applied. After installation, any damaged areas in prime or finish coatings shall be repaired as directed by the Engineer.

B. Stripe Coating

1. Stripe coat all field welds, edges, angles, fasteners, and other irregular surfaces.

2. Stripe coat shall consist of one coat, brush applied, to the coating thickness specified.

3. Apply stripe coat between primer and intermediate coats.

4. Stripe coat color shall contract with prime coat to allow visual verification of application.

3.4 FACTORY-APPLIED COATINGS AND TOUCH-UP

A. Except where factory or shop application of finish coatings is permitted elsewhere in these Specifications, or by the Engineer in writing, all items shall be finish-painted after installation with the color selected or approved by the Engineer. Shop priming shall be permitted in all cases. The Contractor shall be responsible for insuring that the shop prime coating is compatible with the finish coating. Materials and application as specified herein shall govern regardless of whether coatings are factory-applied or field-applied. After installation, any damaged areas in prime or finish coatings shall be repaired as directed by the Engineer.

3.5 INSPECTION

A. Do not apply additional coats until completed coat has been inspected and approved by the Engineer. Only inspected and approved coats of paint shall be considered in determining the number of coats applied.

3.6 CLEANUP

A. Prevent accidental spilling of paint materials and, in the event of such a spill, immediately remove all spilled material and the waste or other equipment used to clean up the spill, and wash the surfaces to their original, undamaged condition.

B. Upon completion of painting, visually inspect all surfaces and remove all paint and traces of paint from surfaces not specified to be painted.

3.7 QUALITY CONTROL TESTING

A. Contractor shall perform and document quality control testing as specified for each coating system.

1. Level 1 – Minimum required QC test requirements for all painting and coating:
    a. Weather conditions – every 4 hours
    b. Ambient temperatures – every 4 hours
    c. Surface temperature – every 4 hours
    d. Wet film thickness – every ½ hour
    e. Verify DFT of each coat and total DFT of each coating system are as specified using wet film and dry film gauges. DFT's shall be measured in accordance with SSPC-PA2.
2. Level 2 – Testing requirements in addition to Level 1 requirements:
    a. Continuous ambient temperature (recording thermometer)
    b. Relative humidity – every 4 hours
    c. Dew point – every 4 hours
    d. Compressed air cleanliness – prior to using compressed air for abrasive blast cleaning, blowing down the surfaces, and painting with conventional spray, the Contractor shall verify that the compressed air is free of moisture and oil contamination according to the requirements of ASTM D4285. The tests shall be conducted at least one time each shirt for each compressor system in operation. If air contamination is evident, the Contractor shall change filters, clean traps, add moisture separators or filters, or make other adjustments as necessary to achieve clean, dry air. The Contractor shall also examine the work performed since the last acceptable test for evidence of defects or contamination caused by the compressed air. Affected work shall be repaired at the Contractor's expense.

e. Blast pressure at nozzle – every 4 hours
f. Visual standard for abrasive blast cleaning
g. Surface profile – every 4 hours
h. Surface pH of concrete surfaces
i. Dry film thickness with magnetic dry film thickness gauge
j. Holiday testing by high voltage discontinuity (spark) testing – entire surface

B. Where specifically noted, Contractor shall perform adhesion testing per ASTM D4541 – 17. Pass/fail test pressure, curing conditions required prior to testing, and test location(s) shall be per the coating system manufacturer.

C. Where specifically noted, contractor to perform adhesion testing per ASTM D 3359-17. Curing conditions required prior to testing hall be per coating system manufacturer. Engineer shall witness adhesion testing and contractor shall submit testing report. For Test Method A-X – cut Tape Test of ASTM D 3359-17, only tests resulting in a SA rating are acceptable, and considered as passing. For Test Method B – Cross-cut Tape Test of ASTM D 3359-17, only tests resulting in a 5B rating are acceptable, and considered as passing.

3.8 PIPING COLOR CODE AND IDENTIFICATION

A. General:
1. Unless required otherwise by the Engineer, all exposed process and building piping and accessories shall be identified and painted as specified herein and in conformance with this specification.
2. The following piping materials need not be painted with the basic identification color except for colored bands.
   a. Stainless steel
   b. chrome-plated piping
   c. Interior HDPE Chemical Piping
   d. Interior PVC/CPVC Chemical Piping
3. Where piping is to be identified with colored bands, a three-band system shall be used. The background color, as identified on the pipe schedule, shall appear in the left and right-most bands, with the secondary color located in the center.
4. PVC Piping that extends to the exterior of buildings/structures (i.e., exposed to UV/sunlight) shall be painted completely. Submit to coordinate color with process identification and architectural elements.
5. The entire exposed surface of all other piping and accessories shall be painted according to the color codes indicated in the pipe schedule.

B. Identification Labels:
1. Identify all exposed piping and all piping on each side of each valve; on each side of a branch; on both sides and adjacent to each wall and floor penetrations and not more than 15 feet on center.
2. All chemical piping shall be identified a minimum of two (2) times in each interior room.

3. Identification Tag Requirements:
   a. Name of service as shown on Plans
   b. Flow direction arrows
   c. Position identification so that it is readily visible from eye level.
   d. Block letters on adhesive labels on the finished insulation or pipe with flat black or white enamel contrasting the background pipe color. Label/Text size shall be as noted below. In some instances, as an alternative to painting of identification, an adhesive decal pipe identification system may be approved upon review by the Engineer. Contractor shall submit product information for review by Owner and Engineer as an alternative to painted identification.

SIZE OF LETTERS / ARROWS	
Outside Diameter of Pipe or Covering	**Height of Adhesive Letter**
¾" to 1¼"	½"
1½" to 2"	¾"
2½" to 6"	1¼"
8" to 10"	2½"
Over 10"	3½"

3.9 COATING SYSTEMS

A. **Architectural Finishes Including:** (see Section 09910 Architectural Paints and Coatings):

1. Gypsum Wall Board
2. Siding and Trim (interior and exterior)
3. Concrete Masonry Units - CMU (interior and exterior)
4. Exterior and Interior Metal Doors, Frames and Vision Lite Frames
5. Exterior Overhead Entry Canopies and Sun Shades

B. **General:** Surface preparation, prime coatings and finish coatings for the various surfaces and items to be painted are specified below. Prime coatings shall be contrasting but complimentary to finish coat.

Table 1: Coating System Application Area Descriptions, includes general descriptions of a systems and a corresponding letter (for example: “A”) to be the designator throughout the rest of the document. Table 2: Applicable Manufacturer Products, includes approved manufacturers and materials for each system. The following pages each correspond to a single system (for example: “A”) and include some details that are necessary for installation. There is also a section labelled Notes at the bottom of each page. These notes can include requirements and reviews of how the systems have performed.

Table 1: Coating System Application Area Descriptions

COATING SYSTEM APPLICATION AREA DESCRIPTIONS	
System A-1	**Exterior Metal and Piping, Non-Submerged (unless specified elsewhere)** Includes, but not limited to, machinery, structural steel beams, columns, bracing, open web steel bar joists, and ancillary structural elements, pumps, pipe hangers, ductile iron pipe, cast iron pipe, galvanized steel pipe, copper pipe, fabrications, PVC pipe, and electrical conduit; *excludes others specifically noted or specified elsewhere*. "Non-submerged" is defined as those items located one (1) foot or more above the maximum water level.
System B-1	**Interior Metal and Piping (unless specified elsewhere)** Includes, but not limited to, machinery, pumps, pipe hangers, ductile iron pipe, cast iron pipe, galvanized steel pipe, steel pipe, copper pipe, fabrications, PVC pipe, and electrical conduit; *excludes others specifically noted or specified elsewhere.*
System B-2	**Interior Structural Components (unless specified elsewhere)** Includes, but not limited to, structural steel beams, columns, bracing, open web steel bar joists, and ancillary structural elements; *excludes others specifically noted or specified elsewhere. SEE NOTES 1, 2 and 3 in System B-2*
System C-1	**Submerged and Intermittently Submerged Metal (unless specified elsewhere)** "Submerged" is defined as all items below one (1) foot above the maximum water level, including submerged elements. Also includes all metal surfaces, structural steel, and metal fabrications in proximity noted above.
System D-1	**Metal, Concrete Encased (unless specified elsewhere)** All metal surfaces, encased in concrete, such as pipes, wall pipes, thimbles, pipe sleeves, gate guides. Excludes reinforcing steel, stainless steel, and galvanized metals.
System D-2	**Aluminum in Contact with Concrete (unless specified elsewhere)**
System E-1	**Epoxy coated floors, interior walls and secondary containment (as called-out on the drawings)** **Provide sand-grit floors in secondary chemical containment areas and equipment/pump areas**
System F-1	**Concrete process tank interior floor and walls and sumps (unless specified elsewhere)**
System G-1	**Dry fall for interior ceilings**
System H-1	**Fluoride collection box**

Table 2: Applicable Manufacturer Products

System Designation	Manufacturer	Filler	Primer Coat(s)	Stripe Coat(s)	Intermediate Coat(s)	Finish Coat(s)
A-1	Tnemec	N/A	Series 1 Omnithane	Series 66	N/A	Series 73
B-1	Tnemec	N/A	Series 1 Omnithane	Series 66	N/A	Series 66
B-2	Tnemec	N/A	115 Unibond	Series 1029	N/A	Series 1029
C-1	Tnemec	N/A	Series 1 Omnithane	Series 66	N/A	Series 69
D-1	Tnemec	N/A	N/A	N/A	N/A	Series 69
D-2	Tnemec	N/A	Series 66	N/A	N/A	Series N69
E-1	Tnemec	Series 218	Series 201 Epoxoprime	N/A	Int. Coat: Series 280 Tneme-Glaze (includes sand grit for horizontal surfaces) Grout Coat: 280 Tneme-Glaze	Series 290 CRU-Urethane; Color light gray with flecks
F-1	Tnemec	Series 218	N/A	N/A	N/A	Series 141
G-1	Tnemec	N/A	115 Unibond	Series 1029	N/A	Series 1029
H-1	Tnemec	(If needed) Series 218 MortarClad	Series 201 Epoxoprime	N/A	Series 282 Tneme-Glaze	Series 282 Tneme-Glaze

The following pages include the System Application Data Sheets and their corresponding details.

System: A-1

	TNEMEC
Surface Preparation:	1. Bare Metal (Steel). SSPC-SP6 or as approved by the Engineer 2. Primed Metal (Ductile or Cast Iron). SSPC-SP1 and SSPC-SP7 (or SP3) 3. PVC per this specification
Generic Type Primer:	• Modified Aromatic Polyurethane
Generic Type Intermediate Coat:	• N/A
Generic Type Finish:	• Acrylic Polyurethane
Generic Type Stripe Coat:	• Per Manufacturer recommendations
Generic Type Surface/Filler:	• N/A
Primer Thickness:	• 3.0 to 4.0 MDFT
Intermediate Coat Thickness:	• N/A
Finish Coat Thickness:	• 2.0 to 5.0 MDFT
Stripe Coat Thickness:	• Stripe coat shall be used as necessary to insure proper dry film thickness and a pin-hole free surface.
Surface/Filler Thickness:	• N/A
Quality Control:	• Level 1 and 2
Extended Warranty:	• Three (3) Years. At the completion of the work, stencil the date on the structure/machine in 2-inch-high capital letters containing the following wording: “PAINTED (insert month and year in which painting was completed)”.

Notes:

System: B-1

	TNEMEC
Surface Preparation:	1. Bare Metal (Steel). SSPC-SP6 2. Primed Metal (Ductile or Cast Iron). SSPC-SP1 and SSPC-SP7 (or SP3) 3. Galvanized Metal. SSPC-SP1 and SSPC-SP3 4. PVC. P-1
Generic Type Primer:	• Modified Aromatic Polyurethane
Generic Type Intermediate Coat:	• N/A
Generic Type Finish Coat:	• Polyamide epoxy
Generic Type Stripe Coat:	• Polyamide epoxy
Generic Type Surface/Filler:	• N/A
Primer Thickness: **Intermediate Coat Thickness:**	• 3.0 to 4.0 MDFT • N/A
Finish Coat Thickness:	• 3.0 to 4.0 MDFT
Stripe Coat Thickness:	• 3.0 to 4.0 MDFT. Stripe coat shall be used as necessary to insure proper dry film thickness and a pin-hole free surface.
Surface/Filler Thickness:	• N/A
Quality Control:	• Level 1 and 2
Extended Warranty:	• Three (3) Years. At the completion of the work, stencil the date on the structure/machine in 2-inch-high capital letters containing the following wording: “PAINTED (insert month and year in which painting was completed)”.

Notes:

1. All bituminous coated metals shall be sealed prior to the application of the prime coat to prevent bleeding. Sealer shall be compatible with other coatings.
2. Fabrications and elements that are not Factory Shop-Coated in conformance with this specification with Primer, Stripe and Finish Coats shall be prepared and field coated (or shop coated) per this specification prior to erection on-site. Following erection of structural steel elements, coatings shall be touched-up in the field to repair damaged areas per this specification.

System: B-2

	TNEMEC
Surface Preparation:	1. Bare Metal: SSPC-SP6 2. Primed Metal SSPC-SP7
Generic Type Primer:	• Self-crosslinking Hydrophobic Acrylic
Generic Type Finish Coat:	• HDP Acrylic Polymer
Generic Type Stripe Coat:	• HDP Acrylic Polymer
Primer Thickness:	• 2 to 4 MDFT
Finish Coat Thickness:	• 2 to 4 MDFT
Stripe Coat Thickness:	• 2 to 4 MDFT Stripe coat shall be used to ensure proper coverage on all edges.
Quality Control:	• Level 1 and Level 2
Extended Warranty:	• Three (3) Years. At the completion of the work, stencil the date on the structure/machine in 2-inch-high capital letters containing the following wording: "PAINTED (insert month and year in which painting was completed)".

Notes:

1. All bituminous coated metals shall be sealed prior to the application of the prime coat to prevent bleeding. Sealer shall be compatible with other coatings.
2. STRUCTURAL STEEL fabrications and elements that are not Factory Shop-Coated in conformance with this specification with Primer, Stripe and Finish Coats shall be prepared and field coated (or shop coated) per this specification prior to erection on-site. Following erection of structural steel elements, coatings shall be touched-up in the field to repair damaged areas per this specification.
3. Bar joist factory hold priming and dip priming shall not be considered in conformance with this specification and shall be removed and re-coated per these specifications on-site or at Contractors facility.

System: C-1

	TNEMEC
Surface Preparation:	1. Bare Metal. SSPC-SP10 2. Primed Metal. SSPC-SP1 and SSPC-SP3, scarify the surface
Generic Type Primer:	• Modified Aromatic Polyurethane
Generic Type Finish Coat:	• Polyamidoamine Epoxy
Generic Type Stripe Coat:	• Polyamide Epoxy
Generic Type Surface/Filler:	• N/A
Primer Thickness:	• 3.0 to 5.0 MDFT
Finish Coat Thickness:	• Two (2) coats, 8.0 to 10.0 MDFT/coat
Stripe Coat Thickness:	• Stripe coat shall be used as necessary to insure proper dry film thickness and a pin-hole free surface.
Surface/Filler Thickness:	• N/A
Quality Control:	• Level 1 and 2
Extended Warranty:	• Three (3) Years. At the completion of the work, stencil the date on the structure/machine in 2-inch-high capital letters containing the following wording: “PAINTED (insert month and year in which painting was completed)”.

System: D-1

	TNEMEC
Surface Preparation:	• Bare Metal (Steel). SSPC-SP6
Generic Type Primer:	• N/A
Generic Type Intermediate Coat:	• N/A
Generic Type Finish Coat:	• Polyamidoamine Epoxy
Generic Type Stripe Coat:	• Polyamidoamine Epoxy
Generic Type Surface/Filler:	• N/A
Primer Thickness:	• N/A
Intermediate Coat Thickness:	• N/A
Finish Coat Thickness:	• Two (2) coats, 8.0 to 10.0 MDFT/coat
Stripe Coat Thickness:	• Stripe coat shall be used as necessary to insure proper dry film thickness and a pin-hole free surface.
Surface/Filler Thickness:	• N/A
Quality Control:	• Level 1 and 2
Extended Warranty:	• None

System: D-2

	TNEMEC
Surface Preparation:	• SSPC-SP1 and SSPC-SP16 (Scarify, degloss and provide 1 mil profile)
Generic Type Primer:	• Polyamide Epoxy
Generic Type Intermediate Coat:	• N/A
Generic Type Finish Coat:	• Polyamidoamine Epoxy
Generic Type Stripe Coat:	• Polyamide Epoxy
Generic Type Surface/Filler:	• N/A
Primer Thickness:	• 3-5 MDFT
Intermediate Coat Thickness:	• N/A
Finish Coat Thickness:	• 6 to 8 MDFT
Stripe Coat Thickness:	• Stripe coat shall be used to insure proper coverage on all sharp edges.
Surface/Filler Thickness:	• N/A
Quality Control:	• Level 1
Extended Warranty:	• None

System: E-1

	TNEMEC
Surface Preparation:	• Surface Preparation: CM3, prepare in accordance with SSPC-13/NACE 6 and ICRI Technical Guidelines. Abrasive Blast, shot- blast or mechanically abrade concrete surfaces to provide a minimum ICRI-CSP 3 or greater surface profile.
Generic Type Surface/Filler:	• Epoxy Modified Cementitious Mortar
Generic Type Primer Coat:	• Moisture tolerant epoxy primer
Generic Type Intermediate Coat:	• Modified Polyamine Epoxy
Grout Coat:	• Modified Polyamine Epoxy
Generic Type Finish (top) Coat:	• Aliphatic Polyester Polyurethane
Surface/Filter Thickness:	• Fill flush to plane all bug holes and surface voids as a result of the abrasive blasting process.
Primer Coat Thickness:	• 6 to 12 mils DFT; Coverage at 160 - 200 square feet per gallon
Intermediate Coat Thickness:	• 6 to 10 mils DFT; Coverage at 160-200 square feet per gallon • For texture/tread on horizontal walking surfaces - randomly broadcast 30/50 mesh aggregate into the wet Intermediate Coat to refusal
Grout Coat Thickness:	• 8 to 10 mils DFT
Finish (top) Coat and Thickness:	• 2 to 3 mils DFT; Coverage at 390-425 square feet per gallon • The finished appearance and texture will depend on the film thickness and number of coats applied. 4'x 4' Mock-ups shall be applied to determine the desired finish appearance and texture. • Light gray color with added flecks
Quality Control:	• Level 1 and 2
Extended Warranty:	• None

Notes:

1. Coordinate the amount of sand grit to apply with the Owner. Provide 4'x 4' mock-ups for the Owner to approve to determine the desired finish appearance and texture.
2. Reference manufacturer's application guide for termination details (edge of coating terminations).
3. Reference manufacturer's application guide for termination details (edge of coating terminations). Upon full cure, the installed lining system shall be checked by high voltage spark detection in accordance with NACE RP0188-90 to verify a pinhole-free surface.

System: F-1

	TNEMEC
Surface Preparation:	• SSPC SP 13 to meet ICRI CSP5 surface profile all surfaces to be coated. Surface shall be clean, dry, and free of contaminants. CSP-3 minimum.
Generic Type Primer:	• Modified Polyamine Epoxy
Generic Type Intermediate Coat:	• N/A
Generic Type Finish Coat:	• Modified Polyamine Epoxy
Generic Type Stripe Coat:	• Modified Polyamine Epoxy
Generic Type Surface/Filler:	• Epoxy Modified Cementitious Mortar
Primer Thickness:	• N/A
Intermediate Coat Thickness:	• N/A
Finish Coat Thickness:	• 14 to 16 MDFT in one-coat application
Stripe Coat Thickness:	• Per Manufacturer Recommendations.
Surface/Filler Thickness:	• 1/32" minimum thickness. Fill surface voids flush to plane to ensure finish is monolithic and pinhole free.
Quality Control:	• Level 1 and 2 and as specified below
Extended Warranty:	• Three (3) Years. At the completion of the work, stencil the date on the structure/machine in 2-inch-high capital letters containing the following wording: “PAINTED (insert month and year in which painting was completed)”.

Notes:

1. Coating system shall be applied only by coating-system certified contractor. Applicator must be trained and certified as an installer by the manufacturer of the product which they are applying.
2. Alternative coating systems submitted for substitution approval for this system shall be reviewed for approval by the Engineer.

3. Reference manufacturer's application guide for termination details (edge of coating terminations). Upon full cure, the installed lining system shall be checked by high voltage spark detection in accordance with NACE RP0188-90 to verify a pinhole-free surface.

System: G-1

	TNEMEC
Surface Preparation:	1. Bare Metal: SSPC-SP6 2. Primed Metal SSPC-SP7 3. Galvanized Metal Composite Deck: SSPC-SP1 and SSPC-SP3. Clean galvanized metal deck with Clean n' Etch (Mfr. Great Lakes Laboratories) per manufacturers recommendations for passivated galvanized surfaces.
Generic Type Primer:	• Self-crosslinking Hydrophobic Acrylic
Generic Type Finish Coat:	• HDP Acrylic Polymer
Generic Type Stripe Coat:	• HDP Acrylic Polymer
Primer Thickness:	• 2 to 4 MDFT
Finish Coat Thickness:	• 2 to 4 MDFT
Stripe Coat Thickness:	• As required.
Quality Control:	• Level 1 and Level 2
Extended Warranty:	• Three (3) Years. At the completion of the work, stencil the date on the structure/machine in 2-inch-high capital letters containing the following wording: "PAINTED (insert month and year in which painting was completed)".

Notes:

1. Specifications for Open Web Steel Bar-Joists and structural steel are specified elsewhere.

System: H-1

	TNEMEC
Surface Preparation:	• SSPC SP 13 to meet ICRI CSP3 surface profile all surfaces to be coated. Surface shall be clean, dry, and free of contaminants. CSP-3 minimum.
Generic Type Surface/Filler:	• If needed, Epoxy Modified Cementitious Mortar
Generic Type Primer:	• Modified Polyamine Epoxy
Generic Type Intermediate Coat:	• Polyamine Novolac Epoxy
Generic Type Finish Coat:	• Polyamine Novolac Epoxy
Generic Type Stripe Coat:	• N/A
Surface/Filler Thickness	• If needed, 1/16" minimum thickness. Fill surface voids flush to plane to ensure finish is monolithic and pinhole free. 1/16” to 1/2" thickness per coat.
Primer Thickness:	• 6-8 MDFT (200-250 SF/GAL) per coat
Intermediate Coat Thickness:	• 8-10 MDFT (160-200 SF/GAL) per coat
Finish Coat Thickness:	• 8-10 MDFT (160-200 SF/GAL) per coat
Stripe Coat Thickness:	• N/A
Quality Control:	• Level 1 and 2 and as specified below
Extended Warranty:	• Three (3) Years. At the completion of the work, stencil the date on the structure/machine in 2-inch-high capital letters containing the following wording: “PAINTED (insert month and year in which painting was completed)”.

Notes:

1. Coating system shall be applied only by coating-system certified contractor. Applicator must be trained and certified as an installer by the manufacturer of the product which they are applying.
2. Alternative coating systems submitted for substitution approval for this system shall be reviewed for approval by the Engineer.

3. Reference manufacturer's application guide for termination details (edge of coating terminations). Upon full cure, the installed lining system shall be checked by high voltage spark detection in accordance with NACE RP0188-90 to verify a pinhole-free surface.

END OF SECTION

Paint Inspection:

Daily Coating Inspection Report

Date: / / M T W Th F S Su | Pg. Of

Project #: | COPY To: ☐ QC Mgr ☐ Owner

Inspector: | ☐ Contr ☐ _____

Attachments: ☐ DFT Sheet ☐ NCR/CAR ☐ _____

Project/Client:

Location:

Description:

Requirements:

Contractor: | Spec # | Revision #

Description of Areas & Work Performed

Hold Point Inspections Performed

- ☐ 1 Pre Surface Pep/Condition & Cleanliness
- ☐ 2 Surface Preparation Monitoring
- ☐ 3 Post Surface Preparation/Cleanliness & Profile
- ☐ 4 Pre Application Prep/Surface Cleanliness
- ☐ 5 Application Monitoring/Wet Film Thickness (WFT)
- ☐ 6 Post Application/Application Defects
- ☐ 7 Post Cure/Dry Film Thickness (DFT)
- ☐ 8 Nonconformance/Corrective Actions Follow-up
- ☐ 9 Final Inspection

Approved By: _____

Surface Conditions

☐ New ☐ Maint ☐ Primer/Paint ☐ Age/Dry/Cure_____

☐ Steel ☐ Galvanize ☐ Concrete ☐ Other_____

☐ Hazard _____ ☐ Sample Report # _____

☐ Degree of contamination: _____

Test: ☐ Cl_____ µg/cm² / ppm ☐ Fe ____ppm ☐ pH _____

☐ Degree of Corrosion: _____

☐ Scale ☐ Pitting/Holes ☐ Crevices ☐ Sharp Edges

☐ Weld _____ ☐ Moisture ☐ Oils ☐ Other_____

☐ Painted Surface Condition: _____

Dry to: ☐ Touch ☐ Handle ☐ Recoat

☐ Dry/Over Spray ☐ Runs/Sags ☐ Pinholes ☐ Holidays

☐ Abrasion ☐ Fall Out ☐ Other _____

Surface Preparation

Start Time: Finish Time: Est Sq/ft:

☐ Solvent Clean ☐ Hand Tool ☐ Power Tool

☐ HP Wash PSI_____ ☐ Other _____

☐ Abrasive Blast ☐ Abrasive Type _____ ☐ Sample

☐ Blast Hose Size _____ ☐ Nozzle Size / PSI _____

☐ Air Supply CFM _____ ☐ Air Supply Cleanliness

☐ Water/Oil Trap Check ☐ Equipment Condition Check

Surface Cleanliness & Profile Measurement

☐ Job Specification ☐ SSPC/NACE - SP- _____

☐ SSPC/NACE Spec / Visual Stds ☐ _____

Profile Check: _____ ☐ Disc ☐ Tape ☐ Gauge

☐ Specified _____ mils avg. / Achieved _____ mils

☐ Surface effect on DFT Gauge/BMR _____ mils

Dry Film Thickness

Gage Type / Model	Gage Serial #	Gage Calib. Verified	Spec Avg. DFT	Total Avg DFT	DFT Last Coat	DFT This Coat

Ambient Conditions

Time (Indicate AM or PM)	:	:	:	:
Dry Bulb Temp° (C/F)	°	°	°	°
Wet Bulb Temp° (C/F)	°	°	°	°
% Relative Humidity	%	%	%	%
Surface Temp° (C/F) Min/Max	/ °	/ °	/ °	/ °
Dew Point Temp° (C/F)	°	°	°	°
Wind Direction/Speed				
Weather Conditions:				

Application

Start Time : Finish Time : Est. Sq/ft.

☐ Primer ☐ Intermediate ☐ Topcoat ☐ Touch-up

Generic Type: | Qty Mixed:

Manuf.: | Mix Ratio:

Prod Name: | Mix Method:

Prod #: | Strain/Screen:

Color: | Material Temp: °F

Kit Sz/Cond.: | Sweat-in Time: Min/Hrs

Shelf Life: | Pot Life: Min/Hrs

Batch #'s

(A) | Reducer #:

(B) | Qty Added: Pt/Qt/Gal

(C) | % by Vol: %

Reducer: | Specified WFT Avg: Mils

Achieved WFT Avg: Mils

☐ Airless/Conv. Spray ☐ Brush ☐ Roller ☐ Other _____

Pump Pot	Hose Dia.	Air Check
Ratio/Size	Hose Lng.	SEP/Trap
GPM/CFM	Spray Gun	Filter
PSI	Tip Sz.	Agitator

Inspector's Signature Date

SSPC the society for protective coatings Created03/03 by

SECTION 09910 – ARCHITECTURAL PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes surface preparation and field painting of the following:
   1. Exposed interior items and surfaces.

B. Paint exposed surfaces, except where the paint schedules indicate that a surface or material is not to be painted or is to remain natural. If the paint schedules do not specifically mention an item or a surface, paint the item or surface the same as similar adjacent materials or surfaces whether or not schedules indicate colors. If the schedules do not indicate color or finish, the Architect will select from standard colors and finishes available.

C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.
   1. Prefinished items include the following factory-finished components:
      a. Architectural woodwork and casework.
      b. Metal toilet enclosures.
      c. Metal lockers.
      d. Elevator entrance doors and frames.
      e. Elevator equipment.
      f. Light fixtures.
   2. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:
      a. Furred areas.
      b. Ceiling plenums.
      c. Pipe spaces.
      d. Duct shafts.
      e. Elevator shafts.
   3. Labels: Do not paint over Underwriters Laboratories (UL), Factory Mutual (FM), or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

1.3 SUBMITTALS

A. Product Data: For each paint system specified. Include block fillers and primers.
   1. Manufacturer's Information: Provide manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material proposed for use.

B. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for each type of finish-coat material indicated.

1.4 QUALITY ASSURANCE

A. Applicator Qualifications: Engage an experienced applicator who has completed painting system applications similar in material and extent to that indicated for this Project with a record of successful in-service performance.
B. Source Limitations: Obtain block fillers, primers, and undercoat materials for each coating system from the same manufacturer as the finish coats.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the Project Site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label, and the following information:
   1. Product name or title of material.
   2. Application instructions.
   3. Color name and number.

B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F. Maintain containers used in storage in a clean condition, free of foreign materials and residue.
   1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and application.

1.6 PROJECT CONDITIONS

A. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50 and 90 deg F.
B. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 45 and 95 deg F.
C. Do not apply paint in snow, rain, fog, or mist; or when the relative humidity exceeds 85 percent; or at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.

1.7 EXTRA MATERIALS

A. Furnish extra paint materials from the same production run as the materials applied in the quantities described below. Package paint materials in unopened, factory-sealed containers for storage and identify with labels describing contents. Deliver extra materials to the Owner.
   1. Quantity: Furnish the Owner with an additional 1 gal. of each material and color applied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in the paint schedules.
   1. Benjamin Moore & Co. (Moore).
   2. Glidden Co. (The) (Glidden).
   3. ICI Dulux Paint Centers (ICI Dulux Paints).
   4. PPG Industries, Inc. (PPG).
   5. Pratt & Lambert, Inc. (P & L).
   6. Sherwin-Williams Co. (S-W).

2.2 PAINT MATERIALS, GENERAL

A. Material Compatibility: Provide block fillers, primers, undercoats, and finish-coat materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified. Paint-material containers not displaying manufacturer's product identification will not be acceptable.
C. Colors: Provide color selections shown on the Finish Schedule. Architect will provide supplemental instruction prior to painting showing locations of field and accent paint colors – notify architect prior to ordering painting materials that the project is ready for this instruction.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with the Applicator present, under which painting will be performed for compliance with paint application requirements.
   1. Do not begin to apply paint until unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
   2. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.

3.2 PREPARATION

A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of the size or weight of the item, provide surface-applied protection before surface preparation and painting.
   1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.

B. Cleaning: Before applying paint or other surface treatments, clean the substrates of substances that could impair the bond of the various coatings. Remove oil and grease before cleaning.
   1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

C. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.
   1. Cementitious Materials: Prepare concrete, concrete masonry block, cement plaster, and mineral-fiber-reinforced cement panel surfaces to be painted. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.
   2. Wood: Clean surfaces of dirt, oil, and other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sand surfaces exposed to view smooth and dust off.
   3. Ferrous Metals: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with the Steel Structures Painting Council's (SSPC) recommendations.

D. Materials Preparation: Mix and prepare paint materials according to manufacturer's written instructions.
   1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.

2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
3. Use only thinners approved by paint manufacturer and only within recommended limits.

E. Tinting: Tint each undercoat a lighter shade to simplify identification of each coat when multiple coats of the same material are applied. Tint undercoats to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

3.3 APPLICATION

A. General: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.
1. Paint colors, surface treatments, and finishes are indicated in the schedules.
2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
3. Provide finish coats that are compatible with primers used.
4. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, convector covers, covers for finned-tube radiation, grilles, and similar components are in place. Extend coatings in these areas, as required, to maintain the system integrity and provide desired protection.
5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before the final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
6. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.
7. Sand lightly between each succeeding enamel or varnish coat.

B. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
1. The number of coats and the film thickness required are the same regardless of application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
2. Omit primer on metal surfaces that have been shop primed and touchup painted.
3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure edges, corners, crevices,

welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.

4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and where application of another coat of paint does not cause the undercoat to lift or lose adhesion.

C. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.

D. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer.

E. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to items exposed in equipment rooms and in occupied spaces.

F. Block Fillers: Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled.

3.4 CLEANING

A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from the site.

1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping. Be careful not to scratch or damage adjacent finished surfaces.

3.5 PROTECTION

A. Protect work of other trades, whether being painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Architect.

B. Provide "Wet Paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.

1. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in PDCA P1.

3.6 INTERIOR PAINT SCHEDULE

A. Gypsum Board: Provide the following finish systems over interior gypsum board surfaces or a comparable one from one of the approved manufacturers:

1. Satin Finish — Low Odor Zero VOC System

Primer: ProMar 200 Zero VOC Interior Latex Primer, B28W2600 0 g/L VOC
1st coat: ProMar 200 Zero VOC Eg-Shel B26-2600 series, 0 g/L VOC
2nd coat: ProMar 200 Zero VOC Eg-Shel B26-2600 series, 0 g/L VOC

2. Semi-Gloss Finish - Water-Based Epoxy System
Primer: ProMar 200 Zero VOC Primer, B28W2600, 0 g/L VOC
1st coat: Pro Industrial Pre-Catalyzed Water-Based Epoxy Semi-Gloss, K46 series, <150 g/L VOC
2nd coat: Pro Industrial Pre-Catalyzed Water-Based Epoxy Semi-Gloss, K46 series, <150 g/L VOC

B. Non-Ferrous Metal & Ferrous Metal (Doors, Frames and Miscellaneous Metals): Provide the following finish systems over new, interior wood surfaces or a comparable one from one of the approved manufacturers:
1. Semi-Gloss Finish
Primer: Pro Industrial Pro-Cryl Universal Primer, B66-310 series, <100 g/L VOC
1st coat: Pro Industrial Zero VOC Acrylic Semi-Gloss, B66-650 series, 0 g/L VOC
2nd coat: Pro Industrial Zero VOC Acrylic Semi-Gloss, B66-650 series, 0 g/L VOC

C. Non-Ferrous Metal & Ferrous Metal (High Performance System for Handrails): Provide the following finish systems over new, interior wood surfaces or a comparable one from one of the approved manufacturers:
1. Egg-Shell or Semi-Gloss Finish
Primer: Pro Industrial Pro-Cryl Universal Primer, B66-310 series, <100 g/L VOC
1st coat: Pro Industrial Zero VOC Water-Based Epoxy Eg-Shel, B73-360 series or Gloss, B73-300 series, 0 g/L VOC
2nd coat: Pro Industrial Zero VOC Water-Based Epoxy Eg-Shel, B73-360 series or Gloss, B73-300 series, 0 g/L VOC

D. Galvanized Metal Decking & Ferrous Decking — Including Bar Joists: Provide the following finish systems over new, interior wood surfaces or a comparable one from one of the approved manufacturers:
1. Flat, Egg-Shell
Primer: Pro Industrial Pro-Cryl Universal Primer, B66-310 series, <100 g/L VOC
1st coat: Low VOC Waterborne Acrylic Dryfall, Flat B42W81, Eg-Shel B42W82, Semi-Gloss, B42W83,
All sheens <50 g/L VOC

2nd coat: Low VOC Waterborne Acrylic Dryfall, Flat B42W81, Eg-Shel B42W82, Semi-Gloss, B42W83,
All sheens <50 g/L VOC

E. Concrete Slabs with Opaque Sealers
1st and 2nd Coat: Benjamin Moore Floor Enamel C112 or Sherwin Williams – Porch and Floor Enamel.

END OF SECTION 09910

SECTION 10140 - SIGNAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following types of signs:
   1. Panel signs.
      a. Interior room identification signs.
      b. Handicap accessibility signage.
      c. Exterior directional and parking signs
      d. Handicap entry signs.
      e. Maximum occupancy load signs.
   2. Dimensional letters and numbers.
   3. Building address.
   4. Metal Plaques

1.3 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product data for each type of sign specified, including details of construction relative to materials, dimensions of individual components, profiles, and finishes.

C. Shop drawings showing fabrication and erection of signs. Include plans, elevations, and large-scale sections of typical members and other components. Show anchors, grounds, layout, reinforcement, accessories, and installation details.
   1. Provide message list for each sign required, including large-scale details of wording and lettering layout.
   2. For signs supported by or anchored to permanent construction, provide setting drawings, templates, and directions for installation of anchor bolts and other anchors to be installed as a unit of Work in other Sections.
   3. Templates: Furnish full-size spacing templates for individually mounted dimensional letters and numbers.

D. Samples: Provide the following samples of each sign component for initial selection of color, pattern and surface texture as required and for verification of compliance with requirements indicated.
   1. Samples for initial selection of color, pattern, and texture:
      a. Cast Acrylic Sheet and Plastic Laminate: Manufacturer's color charts consisting of actual sections of material including the full range of colors available for each material required.
      b. Aluminum: Samples of each finish type and color, on 6-inch-long sections of extrusions and not less than 4-inch squares of sheet or plate, showing the full range of colors available.
      c. Cast Acrylic Sheet and Plastic Laminate: Provide a sample panel not less than 8-1/2 inches by 11 inches for each material, color, texture, and pattern required. On each panel include a representative sample of the graphic image process required, showing graphic style, and colors and finishes of letters, numbers, and other graphic devices.

1.4 QUALITY ASSURANCE

A. Sign Fabricator Qualifications: Firm experienced in producing signs similar to those indicated for this Project, with a record of successful in-service performance, and sufficient production capacity to produce sign units required without causing delay in the Work.
B. Single-Source Responsibility: For each separate sign type required, obtain signs from one source of a single manufacturer.
C. Handicapped Accessibility: Provide signs which are in conformance with the requirements of ANSI A117.1-1992 and the Americans with Disability Act of 1990 (ADA).

1.5 PROJECT CONDITIONS

A. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication to ensure proper fitting. Show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. Manufacturers of Panel Signs:
   a. ABC Architectural Signing System.
   b. ASI Sign Systems, Inc.
   c. Best Manufacturing Company.
   d. Spanjer Brothers, Inc.
   e. Vomar Products, Inc.
2. Manufacturers of Dimensional Letters:
   a. ASI Sign Systems, Inc.
   b. Metal Arts.
   c. Metallic Arts, Inc.
   d. Spanjer Brothers, Inc.
   e. Vomar Products, Inc.

2.2 MATERIALS

A. Cast Acrylic Sheet: Provide cast (not extruded or continuous cast) methyl methacrylate monomer plastic sheet, in sizes and thicknesses indicated, with a minimum flexural strength of 16,000 psi when tested according to ASTM D 790, with a minimum allowable continuous service temperature of 176 deg F and of the following general types:
   1. Opaque Sheet: Where sheet material is indicated as "opaque," provide colored opaque acrylic sheet in colors and finishes as selected from the manufacturer's standards.

B. Aluminum Castings: Provide aluminum castings of alloy and temper recommended by the sign manufacturer for the casting process used and for the use and finish indicated.

C. Fasteners: Use concealed fasteners fabricated from metals that are not corrosive to the sign material and mounting surface.

D. Anchors and Inserts: Use nonferrous metal or hot-dipped galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or lead expansion bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

2.3 PANEL SIGNS

A. Panel Signs: Comply with requirements indicated for materials, thicknesses, finishes, colors, designs, shapes, sizes, and details of construction.
   1. Produce smooth, even, level sign panel surfaces, constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16 inch measured diagonally.

B. Unframed Panel Signs: Fabricate signs with edges mechanically and smoothly finished to conform with the following requirements:
   1. Edge Condition: Square cut.

2. Corner Condition: Corners rounded.

C. Brackets: Fabricate brackets and fittings for bracket-mounted signs from extruded aluminum to suit sign panel construction and mounting conditions. Factory-paint brackets in a color matching the background color of the sign panel.

D. Raised Copy: Machine-cut copy characters from matte-finished opaque acrylic sheet and chemically weld onto the acrylic sheet forming sign panel face. Produce precisely formed characters with square cut edges free from burrs and cut marks.
   1. Panel Material: Matte-finished opaque acrylic sheet.
   2. Raised Copy Thickness: Not less than 1/32 inch.

E. Graphic Content and Style: Provide sign copy that complies with the requirements indicated for size, style, spacing, content, position, material, finishes, and colors of letters, numbers and other graphic devices.
   1. Provide signage indicating handicap entry at each set of entry doors into facility.
   2. Provide one wall mounted sign per door or set of doors throughout building.
      a. Provide signs with cutouts and removable inserts (maximum of two (2) per sign) with permanent ADA text.
   3. Provide maximum occupancy load signs in assembly rooms as required by code.

2.4 DIMENSIONAL LETTERS AND NUMBERS

A. Cast Letters and Numbers: Form individual letters and numbers by casting. Produce characters with smooth, flat faces, sharp corners, and precisely formed lines and profiles, free from pits, scale, sand holes, or other defects. Cast lugs into the back of characters and tap to receive threaded mounting studs. Comply with requirements indicated for finish, style, and size.
   1. Metal: Aluminum.
   2. Provide letters of size and style indicated attached to exterior surface of building.
   3. Building Address: Adhere flat metal numbers above main entrance to facility. Coordinate location with architect. If numbers are to be mounted on glass, provide back-up shapes on inside of glass matching numbers.

B. Aluminum Castings: Provide aluminum castings of alloy and temper recommended by sign manufacturer for casting process used and for type of use and finish indicated.

C. Aluminum Finishes - Clear Anodic Finish: Manufacturer's standard clear anodic coating, 0.018 mm or thicker, over a satin (directionally textured mechanical finish).

2.5 EXTERIOR DIRECTIONAL AND PARKING SIGNS

A. Panel Signs: Comply with requirements indicated for materials, thickness, finishes, colors, designs, shapes, sizes, and details and construction.
   1. Produce smooth, even, level sign panel surfaces, constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16 inch measured diagonally.

B. Steel Posts: 0.120-inch, galvanized, seamless, square steel posts in length adequate for mounting method specified. Include post caps, fillers, spacers, junction boxes, access panels, and related accessories required for a complete installation. Comply with the following requirements for post shape, finish, and mounting method indicated.
   1. Post Size: 2 by 2 inches square.
   2. Post Mounting Method: Provide sign posts of length required for permanent installation by direct-burial mounting method.

C. Sign Panels: Provide smooth, even, level sign panel surfaces constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16 inch measured diagonally from corner to corner.
   1. Unframed Single-Sheet Panels: Provide unframed single-sheet sign panels with edges mechanically and smoothly finished to conform to the following:
      a. Panel Material: 0.125 inch thick fiberglass sheet.
         1. Panel Finish: Manufacturer’s standard semigloss finish with UV inhibitors.
      b. Edge Condition: Square cut.
      c. Corner Condition: Square corners.

D. Graphic Content and Style: Provide sign copy that complies with the requirements indicated for size, style, spacing, content, position, material, finishes, and colors of letters, numbers, and other graphic devices.
   1. Copy Embedded in Fiberglass Panels: Apply computer-generated adhesive graphics to panel as a masking material. Apply acrylic polyurethane background-color flood coats, 0.015-inch minimum thickness. Include UV inhibitors. Remove masking materials.
      a. Provide signage indicating handicap parking at all handicap parking spaces.
      b. Provide directional signage on site for bus, automobile, and pedestrian access.

E. Fabrication:
   1. General: Provide manufacturer’s standard single-post, single-panel-type post and panel sign. The completed sign assembly shall consist of a message panel supported on 1 post. Comply with requirements indicated for materials, thicknesses, finishes, colors, designs, shapes, sizes and details of construction.

a. Allow for thermal movement resulting from a maximum ambient temperature change (range) of 100 deg F. Design, fabricate, and install post and panel sign assemblies to prevent buckling, opening up of joints, and overstressing of welds and fasteners.
   1. Base design on actual surface temperatures of metals due to both solar heat gain and nighttime-sky heat loss.
b. Welded Connections: Comply with AWS standards for recommended practices in shop welding. Provide welds behind finished surfaces without distortion or discoloration of exposed side. Clean exposed welded surfaces of welding flux and dress on exposed and contact surfaces.
c. Mill joints to a tight, hairline fit. Form joints exposed to the weather to exclude water penetration.
d. Preassemble signs in the shop to the greatest extent possible to minimize field assembly. Disassembly sign only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation, in a location not exposed to view after final assembly.
e. Conceal fasteners if possibly; otherwise, locate fasteners where they will be inconspicuous.

2. Posts: Fabricate posts to lengths required for mounting method indicated.
   a. Direct Burial: For permanent sign installation, provide post 36 inches longer than height of sign to permit direct embedment in concrete foundations.

3. Panels: Form panels to required size and shape. Comply with requirements indicated for design, dimensions, finish, color and details of construction.
   a. Coordinate dimensions and attachment methods to produce message panels with closely fitting joints. Align edges and surfaces with one another in the relationship indicated.
   b. Increase metal thickness or reinforce with concealed stiffeners or backing materials as required to produce surfaces without distortion, buckles, warp, or other surface deformations.
   c. Continuously weld joints and seams, unless other methods are indicated; grind, fill and dress welds to produce smooth, flush, exposed surfaces with welds invisible after final finishing.

2.6 CAST METAL PLAQUES

A. Plaques: Castings shall be free from pits, scale, sand holes, or other defects. Comply with requirements specified for metal, border style, background texture, and finish and with requirements shown for thickness, size, shape, and copy. Hand-tool and buff borders and raised copy to produce the manufacturer's standard satin polished finish. Refer to the "Finishes" Article for other finish requirements.

1. Plaque Material: Cast aluminum.
2. Border Style: Raised flat band, clear anodized finish
3. Background Texture: Manufacturer's standard pebble texture.
4. Mounting: Concealed studs.
5. Text and Typeface: Typeface matching Architect's sample

B. Provide cast metal plaque as indicated in drawings.

2.7 FINISHES

A. Colors and Surface Textures: For exposed sign material that requires selection of materials with integral or applied colors, surface textures or other characteristics related to appearance, provide color matches indicated, or if not indicated, as selected by the Architect from the manufacturer's standards.

B. Metal Finishes: Comply with NAAMM "Metal Finishes Manual" for finish designations and applications recommendations.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Locate sign units and accessories where indicated, using mounting methods of the type described and in compliance with the manufacturer's instructions.
   1. Install signs level, plumb, and at the height indicated, with sign surfaces free from distortion or other defects in appearance.

B. Wall-Mounted Panel Signs: Attach panel signs to wall surfaces using the methods indicated below:
   1. Shim Plate Mounting: Provide 1/8-inch-thick concealed aluminum shim plates with predrilled and countersunk holes, at locations indicated, and where other mounting methods are not practicable. Attach the plate with fasteners and anchors suitable for secure attachment to the substrate. Attach panel sign units to the plate using the method specified above.

C. Dimensional Letters and Numbers: Mount letters and numbers using standard fastening methods recommended by the manufacturer for letter form, type of mounting, wall construction, and condition of exposure indicated. Provide heavy paper template to establish letter spacing and to locate holes for fasteners.
   1. Projected Mounting: Mount letters at the projection distance from the wall surface indicated.

3.2 CLEANING AND PROTECTION

A. After installation, clean soiled sign surfaces according to the manufacturer's instructions. Protect units from damage until acceptance by the Owner.

END OF SECTION 10140

SECTION 10280 – TOILET & BATHROOM ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Toilet and bath accessories.

1.3 SUBMITTALS

A. Product Data: Include construction details, material descriptions and thicknesses, dimensions, profiles, fastening and mounting methods, specified options, and finishes for each type of accessory specified.

1.4 QUALITY ASSURANCE

A. Product Options: Accessory requirements, including those for materials, finishes, dimensions, capacities, and performance, are established by specific products indicated in the Toilet and Bath Accessory Schedule.
   1. Products of other manufacturers listed in Part 2 with equal characteristics, as judged solely by Architect, may be provided.

1.5 COORDINATION

A. Coordinate accessory locations with other work to prevent interference with clearances required for access by disabled persons, proper installation, adjustment, operation, cleaning, and servicing of accessories.
B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide accessories by one of the following:

1. Toilet and Bath Accessories:
   a. A & J Washroom Accessories, Inc.
   b. American Specialties, Inc.
   c. Bobrick Washroom Equipment, Inc.
   d. Bradley Corporation.
   e. Gamco.
   f. McKinney/Parker Washroom Accessories Corp.

2.2 MATERIALS

A. Stainless Steel: ASTM A 666, Type 304, with No. 4 finish (satin), in 0.0312-inch minimum nominal thickness, unless otherwise indicated.
B. Brass: ASTM B 19, leaded and unleaded flat products; ASTM B 16, rods, shapes, forgings, and flat products with finished edges; ASTM B 30, castings.
C. Chromium Plating: ASTM B 456, Service Condition Number SC 2 (moderate service), nickel plus chromium electrodeposited on base metal.
D. Mirror Glass: ASTM C 1036, Type I, Class 1, Quality q2, nominal 6.0 mm thick, with silvering, electroplated copper coating, and protective organic coating complying with FS DD-M-411.
E. Galvanized Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
F. Fasteners: Screws, bolts, and other devices of same material as accessory unit, tamper and theft resistant when exposed, and of galvanized steel when concealed.

2.3 FABRICATION

A. General: One, maximum 1-1/2-inch-diameter, unobtrusive stamped manufacturer logo, as approved by Architect, is permitted on exposed face of accessories. On interior surface not exposed to view or back surface of each accessory, provide printed, waterproof label or stamped nameplate indicating manufacturer's name and product model number.
B. General: Names or labels are not permitted on exposed faces of accessories. On interior surface not exposed to view or on back surface of each accessory, provide printed, waterproof label or stamped nameplate indicating manufacturer's name and product model number.
C. Surface-Mounted Toilet Accessories: Unless otherwise indicated, fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with continuous stainless-steel hinge. Provide concealed anchorage where possible.

D. Framed Glass-Mirror Units: Fabricate frames for glass-mirror units to accommodate glass edge protection material. Provide mirror backing and support system that permits rigid, tamper-resistant glass installation and prevents moisture accumulation.
E. Mirror-Unit Hangers: Provide mirror-unit mounting system that permits rigid, tamper- and theft-resistant installation, as follows:

1. One-piece, galvanized steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.

F. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
B. Secure mirrors to walls in concealed, tamper-resistant manner with special hangers, toggle bolts, or screws. Set units level, plumb, and square at locations indicated, according to manufacturer's written instructions for substrate indicated.
C. Install grab bars to withstand a downward load of at least 250 lbf, when tested according to method in ASTM F 446.

3.2 ADJUSTING AND CLEANING

A. Adjust accessories for unencumbered, smooth operation and verify that mechanisms function properly. Replace damaged or defective items.
B. Remove temporary labels and protective coatings.
C. Clean and polish exposed surfaces according to manufacturer's written recommendations.

3.3 TOILET AND BATH ACCESSORY SCHEDULE

A. Accessory items are based on Bobrick product numbers unless otherwise noted.
B. Paper Towel Dispenser: Owner furnished, contractor installed.

C. Toilet Tissue Dispenser: Owner furnished, contractor installed.
D. Grab Bar: Provide stainless-steel grab bar complying with the following:
   1. Products: Bobrick; B-5806, 18", 36" & 42" & shower grab bar.
   2. Stainless-Steel Nominal Thickness: Minimum 0.05 inch. Mounting: Concealed with manufacturer's standard flanges and anchors.
   3. Gripping Surfaces: Smooth, satin finish.
   4. Outside Diameter: 1-1/4 inches for medium-duty applications.

E. Mirror Unit: Provide mirror unit complying with the following:
   1. Products: Bobrick; B-165, 24"X48" and other size as indicated on drawings.
   2. Stainless-Steel, Channel-Framed Mirror: Fabricate frame from stainless-steel channels in manufacturer's standard satin or bright finish with square corners mitered to hairline joints and mechanically interlocked.

F. Soap Dispenser: Owner furnished, contractor installed.
G. Mop Rack:
   1. Products: Bobrick; B-223, 36" surface mounted.

H. Sanitary Napkin Disposal: Owner furnished, contractor installed.

END OF SECTION 10280

SECTION 10441 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes portable, hand-carried fire extinguishers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher.
B. Product Schedule: For fire extinguishers. Coordinate final fire-extinguisher schedule with fire-protection cabinet schedule to ensure proper fit and function.

1.4 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.6 COORDINATION

A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure of hydrostatic test according to NFPA 10 when testing interval required by NFPA 10 is within the warranty period.
b. Faulty operation of valves or release levers.

2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

1. Provide fire extinguishers approved, listed, and labeled by FM Global.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Amerex Corporation.
b. Ansul by Johnson Controls Company.
c. Babcock-Davis.
d. Badger Fire Protection.
e. Buckeye Fire Equipment Company.
f. Fire End & Croker Corporation.
g. Guardian Fire Equipment, Inc.
h. JL Industries, Inc.; a division of the Activar Construction Products Group.
i. Kidde Residential and Commercial Division.
j. Larsens Manufacturing Company.
k. MOON American.

l. Nystrom.
m. Potter Roemer LLC; a Division of Morris Group International.
n. Pyro-Chem; Tyco Fire Suppression & Building Products.
o. Strike First Corporation of America (The).

2. Source Limitations: Obtain fire extinguishers, fire-protection cabinets, and accessories, from single source from single manufacturer.
3. Valves: Manufacturer's standard.
4. Handles and Levers: Manufacturer's standard.
5. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging.

B. Multipurpose Dry-Chemical Type in Steel Container : UL-rated 4-A:60-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install fire extinguishers in locations indicated and in compliance with requirements of authorities having jurisdiction.

1. Mounting Brackets: Top of fire extinguisher to be at 42 inches above finished floor.

B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION 10441

SECTION 11000
GENERAL REQUIREMENTS FOR EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Scope: This section specifies general requirements which are applicable to all mechanical equipment. Division 15 - Mechanical and Division 16 - Electrical, (electrical equipment provided with mechanical equipment) also specify general requirements for mechanical equipment. The Contractor is responsible for ensuring that all mechanical equipment meets the requirements of those sections in addition to the specific requirements of the individual equipment specification section. In the event of a discrepancy between the minimum requirements of this section and the individual equipment specification, the more stringent requirements shall take precedence.

B. This specification applies to all equipment specified in Divisions 11 through 15.

C. Equipment Lists: Equipment lists presented in these Specifications are included for the convenience of the Contractor and may not represent a complete and precise listing of all equipment, devices, and material to be provided under this Contract. The Contractor agrees to rely upon his own material and equipment takeoff lists as necessary to meet the requirements of the Contract Documents.

D. All equipment and appurtenances shall be rated for the area classification assigned to the location in which they will be installed.

1.2 RELATED SECTIONS

Section 01025 – Measurement and Payment
Section 01300 – Submittals
Section 01400 – Quality Control
Section 01650 – Starting of Systems
Section 01730 – Operation and Maintenance Data
Section 03300 – Cast-in-place Concrete
Section 09900 – High Performance Coatings
Section 11000 – General Requirements for Equipment
Section 15060 – Process Pipe and Pipe Fittings
Section 15100 – Hydraulic Process Valves
Division 16 – Electrical

1.3 QUALITY ASSURANCE

A. Arrangement: The arrangement of equipment on the Drawings is based upon information available to the Owner at the time of design and is not intended to show exact dimensions peculiar to a specific manufacturer. The Drawings are, in part, diagrammatic, and some features of the illustrated equipment installation may require revision to meet actual

equipment installation requirements. Structural supports, foundations, connected piping and valves, electrical and instrument equipment connections shown may have to be altered to accommodate the equipment provided. No additional payment will be made for such revisions and alterations. Substantiating calculations and drawings shall be submitted prior to beginning the work.

B. References: This section contains references to the following documents (the most current version shall apply). They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the most restrictive requirements shall prevail.

Reference	Title
ABMA Std 9	Load Ratings and Fatigue Life for Ball Bearings
ABMA Std 11-78	Load Ratings and Fatigue Life for Roller Bearings
ANSI B1.1	Unified Inch Screw Threads
ASME B1.20.1	Pipe Threads, General Purpose (Inch)
ASME B16.1	Grey Iron Pipe Flanges and Flanged Fittings, Classes 25, 125 and 250
ASME B18.2.1	Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.2.2	Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B31.3	Process Piping Guide
NFPA 70	National Electrical Code (NEC)
NFPA 820	Standard for Fire Protection in Wastewater Treatment and Collection Facilities
IBC	International Building Code
UPC	Uniform Plumbing Code
UMC	Uniform Mechanical Code

1. All applicable Federal, State, and local codes shall apply.

C. Unit Responsibility: Equipment systems made up of two or more components shall be provided as a unit by the responsible manufacturer. The responsible manufacturer shall select all components of the system to assure compatibility, ease of construction and efficient maintenance. The responsible manufacturer shall coordinate selection and design of all system components such that all equipment furnished and/or provided under the specification for the equipment system, including equipment specified elsewhere but referenced in the specification, is compatible and operates properly to achieve the performance requirements specified. Unless otherwise specified, the responsible manufacturer shall be the manufacturer of the driven equipment. Agents, representatives or other entities who are not a direct component of the manufacturing corporation will not be acceptable as a substitute for the manufacturer's corporation in meeting this requirement. This requirement for unit responsibility shall in no way relieve the Contractor of his responsibility to the Engineer for performance of all systems. Contractor is responsible to the Owner for testing and guarantee of all systems.

D. Identification of Listed Products: Electrical equipment and materials shall be listed for the purpose for which they are to serve, by an independent testing laboratory. Three such organizations are Underwriters Laboratories (UL), Canadian Standards Association (CSA), and Electrical Testing Laboratories (ETL). Independent testing laboratory shall be acceptable to the inspection authority having jurisdiction. When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority to undergo a special inspection at the manufacturer's place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price.

E. Factory Tests: Where specified in the individual product specification section, factory tests shall be performed at the place of fabrication and performed upon completion of manufacture or assembly. Factory tests shall be included in the original contract price.

1.4 FIELD TESTING

A. Equipment testing and plant startup in accordance with Section 01650 are requisite to satisfactory completion of the Contract and, therefore, shall be completed within the Contract time. Except where otherwise provided, all work specified in this section shall be performed at no additional cost to the Owner.

B. Where specified in the individual product specification section, the Contractor shall provide the services of an experienced and authorized representative of the manufacturer or supplier who shall visit the site of the work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall inspect and verify location of anchor bolts, placement, leveling, alignment, field erection of equipment, and controls operation. The representative shall make all necessary adjustments and settings to the controls to achieve proper sequence of operation as intended by the design. In each case, the Contractor shall arrange to have the equipment supplier's representative re-visit the job site as often as necessary until any and all trouble is corrected, and the equipment installation and operation are satisfactory to the Engineer.

C. The Contractor shall require that each equipment supplier's representative furnish/provide to the Engineer a written report addressed to the Owner certifying that the equipment has been properly installed and lubricated, is in accurate alignment, is free from any undue stress imposed by connecting piping or anchor bolts, and has been operated satisfactorily under full-load conditions.

D. The Contractor shall be responsible for scheduling all operations testing. The Contractor is advised that the Engineer and the Owner's operating personnel will witness operations testing and that the equipment supplier's representative shall be required to instruct the Owner's operating personnel in correct operation and maintenance procedures. Such instruction shall be scheduled at a time arranged with the Owner at least two (2) weeks in advance, and shall be provided while the respective representative's equipment is fully operational. On-site instruction shall be given by qualified persons who have been made familiar in advance with the equipment and systems in the plant. The Contractor shall have previously furnished/provided the technical manuals required under Section 01300 and

01730. The Contractor shall notify the Engineer at least three (3) days in advance of each equipment test.

E. The Contractor shall furnish/provide all personnel, chemicals, fuel, oil, grease and all other necessary equipment, facilities and services required for conducting the tests.

F. Perform the following field-testing services for all pump systems.

1. The manufacturer's representative shall analyze the complete pump and piping system and recommend such supports and modifications as necessary to eliminate harmonics and vibration in the system when operated over the operational speed range. Pump bases and foundations, as well as piping and supports as shown on the plans shall be modified and enlarged as necessary to provide adequate support and vibration control.

2. The installed pumping units shall operate without excessive vibration. Balance of rotating parts shall be maintained throughout the pumps rated performance curve, which will include shut-off points. Vibration amplitude shall not exceed Hydraulic Institute limits, at any operating point along pump curve. If requested by Engineer, Contractor shall provide for an independent vibration analysis at no cost to the Owner to verify vibration requirements are met. Contractor shall be responsible to make required adjustments to ensure vibration is less than the maximum allowable amount. Excessive vibration will be defined as that which exceeds the limits outlined by the Hydraulic Institute for this type of pump.

3. Perform hydraulic testing for each pump verifying performance on the pump curve. Data shall include flow measurement and discharge pressure at 3 different operation points for each pump. Data shall also include voltage, amperage, and motor speed for each pump taken at each of the recorded operating points.

1.5 SUBMITTALS

A. Submittals shall be made as described in this section and as may be supplemented for each equipment item or group of related equipment items. Submittals shall be in accordance with Section 01300 and shall identify the equipment by the number listed in the specification section, manufacturer and type designation.

B. Product data submittals including the following:

1. Descriptive literature, brochures, and/or catalogs of the equipment.
2. Motor characteristics and performance information.
3. Gear reducer data, including service factor, efficiency, torque rating, and materials, as applicable
4. Parts list, including a list of recommended spare parts.
5. Control philosophy provided in both written and schematic form.
6. Compliance with electrical area classification requirements for all equipment and appurtenances.

7. Anchor bolt sizing and seismic restraint calculations per this Specification; and as required in individual equipment submittals.

C. Shop drawing submittals, including the following:

1. Manufacturer's installation drawings showing equipment dimensions, weights, materials of construction and assembly, and lifting points.
2. Elevation of main operator control station showing panel mounted devices. Provide details of power distribution and full load current draw of panel. Provide list of all terminations required to receive inputs or transmit inputs to the main control panel.
3. Marked-up specification and Contract Document P&IDs indicating conformance or exception.
4. Wiring and schematic diagrams.
5. Nameplate data of each electric motor.
6. Failure to include all drawings applicable to the equipment specified in this section will result in rejection of the entire submittal with no further review.

D. Quality Assurance/Control Submittals

1. Submit a copy of the equipment specification section, with addendum updates included, with each paragraph clearly-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. If deviations from the specifications are indicated and, therefore requested by the Contractor, the submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification for any requested deviations to the specification requirements, with the submittal shall be cause for rejection of the entire submittal with no further consideration. The Owner retains the right to reject any proposed deviations in favor of this specification, as written.
2. Design Data, Test Reports: Submit equipment testing reports, per this section. Submit proposed testing procedures and protocol.
3. Submit manufacturer's shop test reports of electrical and control panels prior to shipment of equipment.
4. Qualification statements
5. Installation reference list
6. Manufacturer's installation instructions
7. Recommendations for short- and long-term storage
8. A copy of manufacturer's field reports

E. Closeout Submittals

1. Operations and Maintenance Manual per Section 01730.
2. Provide written copies of manufacturer's warranties on products described in this specification section.

1.6 PROTECTION DURING SHIPMENT

A. Shipping: Equipment shall be shipped in sealed, weathertight, enclosed conveyances and protected against damaging stresses during transport.

Bearing housings shall be wrapped or otherwise sealed to prevent contamination by grit and dirt; and ventilation and other types of openings shall be taped closed.

Damage shall be corrected to conform to the requirements of the Contract before the assembly is incorporated into the work. The Contractor shall bear the costs arising out of dismantling, inspection, repair and reassembly.

B. Factory Applied Coatings: Each item of equipment shall be shipped to the site of the work with either the manufacturer's shop-applied prime coating or shop-applied finish coating. Manufacturer's shop-applied prime coating shall be compatible with the field-applied finish coating. The prime coating shall be applied over clean dry surfaces in accordance with the paint manufacturer's recommendations. The prime coating will serve as a base for field-applied finish coats. All factory finishes shall be approved by the Engineer. Non-approved finishes shall be painted as specified in Section 09900.

PART 2 PRODUCTS

2.1 FLANGES AND PIPE THREADS

A. Flanges on equipment and appurtenances provided under this section shall conform in dimensions and drilling to ANSI B16.1, Class 125. Pipe threads shall conform in dimension and limits of size to ANSI B1.1, coarse thread series, Class 2 fit. Threaded flanges shall have a standard taper pipe thread conforming to ANSI B1.20.1. Unless otherwise specified, flanges shall be flat faced. Flange assembly bolts shall be heavy pattern, hexagonal head, carbon steel machine bolts with heavy pattern, hot pressed, hexagonal nuts conforming to ANSI B18.2.1 and B18.2.2. Threads shall be Unified Screw Threads, Standard Coarse Thread Series, Class 2A and 2B, ANSI B1.1.

2.2 BEARINGS

A. Unless otherwise specified, equipment bearings shall be oil or grease lubricated, ball- or roller-type, designed to withstand the stresses of the service specified. Each bearing shall be rated in accordance with the latest revisions of AFBMA Methods of Evaluating Load Ratings of Ball and Roller Bearings. Unless otherwise specified, equipment bearings shall have a minimum L-10 rating life of 50,000 hours. The rating life shall be determined using the maximum equipment operating speed.

B. Grease lubricated bearings, except those specified to be factory sealed and lubricated, shall be fitted with easily accessible grease supply, flush, drain and relief fittings. Extension tubes shall be used when necessary. Grease supply fittings shall be standard hydraulic alemite-type.

C. Oil lubricated bearings shall be equipped with either a pressure lubricating system or a separate oil reservoir-type system. Each oil lubrication system shall be of sufficient size to safely absorb the heat energy normally generated in the bearing under a maximum ambient temperature of 60° C and shall be equipped with a filler pipe and an external level indicator gauge.

2.3 V-BELT ASSEMBLIES

A. V-belt assemblies shall be Dodge Dyna-V belts with matching Dyna-V sheaves and Dodge Taper-lock bushings, Wood's Ultra V-belts with matching Ultra-V sheaves and Wood's Sure-Grip bushings, or equal. Where stationary control variable pitch sheaves are specified, they shall be dry lubricated, and shall have locking collars to clamp all movable parts securely in place to eliminate relative motion between sheave parts. The sheaves shall be adjustable only when the unit is stopped and the sheaves are unloaded.

Sheaves and bushings shall be statically balanced. Additionally, sheaves and bushings which operate at a peripheral speed of more than 5500 feet per minute shall be dynamically balanced. Sheaves shall be separately mounted on their bushings by means of three pull-up grab or cap tightening screws. Bushings shall be key seated to the drive shaft.

Belts shall be selected for not less than 150% of rated driver horsepower and, where two sheaves sized are specified, shall be capable of operating with either set of sheaves. Belts shall be of the antistatic-type where explosion-proof equipment is specified.

2.4 SEALS

A. Mechanical: Unless otherwise specified, rotating shafts shall be provided with mechanical seals and stuffing boxes tapped for flushing seal faces. Seals shall be factory installed. Seals shall be internal, single or double as specified, and unbalanced, except balanced seals shall be provided when shaft speed is greater than 3600 rpm for variable speed pumps, or when pressures are greater than shown in the following. Mechanical seals for variable speed pump applications shall be specifically designed to accommodate shaft deflection incurred under specified operating conditions.

Limits for Unbalanced Seals

Seal Inside Diameter (in)	Shaft Speed (rpm)	Sealing Pressure (psig)
<2 to 2	Up to 1800	100
	1801 to 3600	50
Over 2 to 4	Up to 1800	50
	1801 to 3600	25

Single unbalanced seals shall be Crane 8-1, Durametallic RO, or equal. Single balanced seals shall be Chesterton 880, Crane 8B-1, or equal. Double seals shall be Chesterton 241, Durametallic RO/RD, or equal.

To maintain the necessary minimum or maximum pressure across the seal faces, spring pressure shall be uniformly distributed to the sealing faces by a coil spring or multiple springs. The rotating seal element shall be clamped to the shaft and provided with an O-ring seal. The stationary seal element shall be sealed with O-ring or gasket material.

Seal faces shall be either tungsten carbide, carbon, silicon carbide or ceramic. Elastomeric materials shall be Viton. Metal parts shall be Type 316 stainless steel.

B. Shaft Packing: Where shaft packing is specified, stuffing boxes shall be tapped to permit introduction of seal liquid and shall hold a minimum of five rows of packing. Unless otherwise specified, lantern rings shall be bronze, packing shall be die-molded packing rings of non-asbestos material suitable for the intended service and as recommended by the manufacturer, and glands shall be bronze, two-piece split construction. Lantern rings shall be of two-piece construction and shall be provided with tapped holes to facilitate removal. Lantern rings shall be drilled and tapped 3 NC-20. Threaded lantern ring removal tools shall be provided with spare parts for each pump.

2.5 COUPLINGS

A. Unless otherwise specified in the particular equipment sections, equipment with a driver greater than 2 HP, and where the input shaft of a driven unit is directly connected to the output shaft of the driver, shall have its two shafts connected by a flexible coupling which can accommodate angular misalignment, parallel misalignment and end float, and which cushions shock loads and dampens torsional vibrations. The flexible member shall consist of a tire with synthetic tension members bonded together in rubber. The flexible member shall be attached to flanges by means of clamping rings and cap screws, and the flanges shall be attached to the stub shaft by means of taperlock bushings which shall give the equivalent of a shrunk-on fit. There shall be no metal-to-metal contact between the driver and the driven unit. Each coupling shall be sized and provided as recommended by the coupling manufacturer for the specific application, considering horsepower, speed of rotation and type of service. Contractor shall provide a mill-wright for final alignment of equipment and couplings once installed on-site.

B. Where torque or horsepower capacities of couplings of the foregoing type is exceeded, Thomas-Rex, Falk Steel Flex, or equal, couplings will be acceptable, provided they are sized in accordance with the equipment manufacturer's recommendations and sizing data are submitted. They shall be installed in conformance to the coupling manufacturer's instructions. Contractor shall provide a mill-wright for final alignment of equipment and couplings once installed on-site.

2.6 GUARDS

A. Exposed moving parts shall be provided with guards which meet the requirements of OSHA. Guards shall be fabricated of 14-gauge steel, 1/2-13-15 expanded metal screen to provide visual inspection of moving parts without removal of the guard. Guards shall be

galvanized after fabrication and shall be designed to be readily removable to facilitate maintenance of moving parts. Reinforced holes shall be provided. Provisions shall be made to extend lube fittings through guards.

2.8 PRESSURE TAPS, TEST PLUGS AND GAUGES

A. Pressure taps shall be provided on the suction and discharge sides of pumps, blowers and compressors. Pressure and vacuum test plugs and gauges shall be provided where specified. Test plugs and gauges shall be as specified in Division 15.

2.9 EQUIPMENT SIGNAGE

A. Bridge Cranes, Jib Cranes and Hoists

1. Every bridge crane or jib crane shall be provided with a sign indicating the lifting capacity in pounds or tons with the words “Lifting Capacity”.

2. Every hoist shall have a lifting capacity painted on the hoist in 3-inch-high letters.

B. Equipment and Instrument Nametags

1. A stainless steel plate shall be attached to all equipment with lettering embossed into the plate. Lettering shall be the equipment number in the contract documents.
Method of attachment shall be as recommended by the signage supplier.

2. Large equipment may have lettering stenciled directly onto the equipment, in letter size and color determined by the ENGINEER. Furnish the proposed wording to the ENGINEER for approval.

3. All components within a packaged equipment system, including valves, instruments, and motors, shall be physically tagged with a 1½-inch- diameter minimum stainless steel tag. Each tag shall be keyed to a valve, instrument, or equipment schedule designating the function and location of the item. The number and letters shall be on block-type, ¼” high, and stamped thereon.

C. Valve and Gate Nametags: Each valve and gate shall be provided with a 1½-inch-diameter minimum stainless steel tag. Each tag shall be keyed to a valve schedule designating the function and location of the valve or gate. For exposed valves and gates, the tags shall be attached to the operator with key rings so that the tag cannot be removed. For buried valves, permanently attached SST valve designator to valve box interior with sheet metal screw, and 1/8” SST cable and crimp ferrules. Cable length shall allow tag to be pulled completely out of the valve box for reading. The number and letters shall be on block-type, ¼” high, and stamped thereon. The valve and gate numbers shall be provided by the Engineer during construction.

2.10 LUBRICANTS

A. The Contractor shall provide for each item of mechanical equipment a supply of the lubricant required for the commissioning period. Lubricants shall be of the type

recommended by the equipment manufacturer and shall be products of the Owner's current lubricant supplier. The Contractor shall limit the various types of lubricants by consolidating them, with the equipment manufacturer's approval, into the least number of different types. Not less than ninety (90) days before the date shown in his construction schedule for starting, testing and adjusting equipment, the Contractor shall provide the Owner with three (3) copies of a list showing the required lubricants, after consolidation, for each item of mechanical equipment. The list shall show estimated quantity of lubricant needed for a full year's operation, assuming the equipment will be operating continuously.

2.11 PRODUCT DATA

A. Information shall be provided for each item of equipment as specified under individual specification sections. This information shall be identified by the equipment number listed in the Specifications and Drawings.

2.12 SPARE PARTS

A. Spare parts, wherever required by detailed specification sections, shall be stored in accordance with the provisions of this paragraph. Spare parts shall be tagged by project equipment number and identified as to part number, equipment manufacturer and subassembly component (if appropriate). Spare parts subject to deterioration, such as ferrous metal items and electrical components, shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping. The quality of protection shall be equal to that required for shipment overseas and storage in humid, tropical climates. Spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, 18 inches high, and 3 feet in length shall be stored in a heavy wooden box with a hinged wooden cover. Hinges shall be heavy-duty strap type. The box shall be painted and identified with stenciled lettering stating the name of the equipment, equipment numbers, and the words "spare parts." A neatly typed inventory of spare parts shall be taped to the underside of the cover.

2.13 ANCHOR BOLTS

A. Anchor bolts shall be designed for lateral forces for both pullout and shear for all equipment items.

B. Manufacturer shall perform and submit calculations for anchor bolts and seismic restraint for their equipment and shall be signed and sealed by a Registered Structural Professional Engineer Licensed in the State of Utah. Calculations shall be based upon local American Society of Civil Engineers (ASCE) 7 (current edition) considerations for seismic design criteria.

C. Anchor Bolts: Provide stainless steel bolts complying with ASTM A 320, Type 316.

2.14 EQUIPMENT LIFTING PROVISIONS

A. All equipment shall be equipped with a single point lifting bale/eye to allow picking of the equipment and/or motor combination from a single lifting point.

PART 3 EXECUTION

3.1 GENERAL

A. Equipment shall be provided and tested within the tolerances recommended by the equipment manufacturer where indicated in the individual mechanical specification sections. Certain sections may also require that equipment additionally be installed and tested under the direction of installers who have been factory-trained by the equipment manufacturer. This requirement, however, shall not be construed as relieving the Contractor of his overall responsibility for this portion of the work.

END OF SECTION

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SECTION 11100
FILTER SYSTEM INSTALLATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Filter Tank and Accessories Installation

1.2 RELATED SECTIONS

A. Section 01300 - Submittals.

B. Section 01400 - Quality Control.

C. Section 01650 - Starting of Systems.

D. Section 15060 – Pipe and Pipe Fittings.

E. Section 15100 – Hydraulic Process Valves.

1.3 SCOPE

A. This work includes multiple groups of equipment and materials:

1. WesTech-Provided: equipment and materials that have been procured by the Owner under a separate contract with WesTech Engineering, Inc.. The Contractor shall be responsible for coordinating delivery and taking responsibility for storage and installation of all materials and equipment provided by WesTech. The equipment and materials procured under the separate contract are provided in the following section for informational purposes:

a) Volume III – Filter system procurement executed contract documents (to be assigned to contractor)

b) Volume III Attachment A – Filter System Shop Drawings

2. Contractor-Provided: equipment and materials not specified as WesTech-Provided within these contract specifications and plans.

1.4 PERFORMANCE REQUIREMENTS

Refer to Volume III for performance requirements and conditions.

1.5 SUBMITTALS

A. Submit shop drawings under provisions of Section 01300. Contractor shall provide shop drawings for equipment and materials needed to install WesTech-Provided or Reused items and Contractor Provided equipment and materials.

B. Submit manufacturer's installation instructions under provisions of Section 01300.

C. Submit manufacturer's field reports under provisions of Section 01400.

1.6 QUALITY ASSURANCE

A. Perform work in accordance with manufacturer’s recommendations.

B. Maintain one copy of document onsite.

1.7 WARRANTY

A. Warranty: Include one (1) year coverage on all supplied parts.

1.8 SYSTEM START-UP

A. Submit a start-up plan prior to start-up for Engineer and Owner approval.

1. Include a detailed list of steps to prepare all equipment for start-up and all steps that will be followed during start-up.

2. Coordinate with manufacturers to include manufacturer recommendations.

3. Include a plan for storing and disposing of water used during start-up and prior to the system being brought fully online when the Owner gives approval to connect to the District’s water system.

a) This includes any water used to pre-condition the filter media using sodium hypochlorite (supplied by Contractor) for use.

4. Include any plans for temporary piping or appurtenances needed during start-up.

B. The backwash effluent air gap box drains to the Central Valley Water Reclamation Facility sewer system. Any flow sent to this air gap box during start-up must be approved by the Owner prior to the discharge. Any flow discharged to the air gap and detention tanks must not exceed one thousand eight hundred seventy five (1,875) gallons per minute. Any flow discharged from the detention tanks to the sewer must now exceed one hundred (100) gallons per minutes due to downstream sewer capacity.

C. Perform system start-up in accordance with this section and Section 01650.

D. The equipment manufacturer shall furnish the services of a qualified field engineer to

check installation, start-up and instruct operating personnel in the proper operation and maintenance of the equipment.

1. WesTech is providing a field engineer under provisions of the contract with the Owner.

1.9 MAINTENANCE SERVICE

A. Provide operation and maintenance manual for the complete filter system, which includes WesTech-Provided and Contractor-Provided equipment and material, in accordance with Section 01730.

PART 2 PRODUCTS

2.1 HORIZONTAL PRESSURE FILTER SYSTEM

A. The complete filter system includes the following items, at a minimum.

B. WesTech-Provided

1. See the final WesTech submittal in Volume IV for a complete list of WesTech-Provided equipment and materials.

C. Contractor-Provided

1. Onsite Sodium Hypochlorite Generation Systems, see Specification 11400.

2. Chlorine and turbidity analyzers, see Division 16 specifications.

3. All other items necessary for a complete and properly operating filter system that is not listed in Parts 2.1.B and 2.1.C including pipe supports, coatings, and finish touch-up on coatings supplied by the manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify all equipment specified in this and other sections is present and meets the requirements of these specifications and is suitable for the function intended.

3.2 INSTALLATION

A. Install equipment in accordance with manufacturer's recommendations.

B. Install concrete in the underdrain in strict accordance with the filter manufacturer’s instructions.

C. Install all electrical components in accordance with these plans and manufacturer’s recommendations, instructions and local electrical codes.

D. Coordinate control system integration with the District, WesTech, and the District's control system integrator.

E. Connect piping as shown on the plans and pipe supports.

F. Manufacturer's representative shall visit and inspect the installation of each component prior to system startup.

a) Written documentation is required from the manufacturer's representative stating the components are properly installed and suitable for startup and operation.

3.3 START-UP

A. The filter manufacturer, under provisions of the separate contract, shall assist in the start-up and commissioning the overall water treatment system.

B. The filter manufacturer shall provide instructions on filter media placement.

C. The filter manufacturer, under provisions of the separate contract, shall be responsible for original startup of WesTech-Provided equipment.

D. Contractor shall coordinate start-up activities specified here and Section 01650.

E. Certificate of "operational readiness" shall be issued prior to owner operation.

F. Contractor shall conduct one day of operator training with hands-on operation, and with assistance from WesTech for the WesTech-Provided equipment.

END OF SECTION

SECTION 11400
ONSITE SODIUM HYPOCHLORITE GENERATION SYSTEM (OSHGS)

PART 1 - GENERAL

1.1 SCOPE

A. This Section covers the work necessary by the Contractor, On-site Sodium Hypochlorite Generation System (OSHGS) Supplier, Owner, and Engineer, to furnish, install, test, and make ready for operation a separate OSHGS in the following locations:
   1. OSHGS in the new Anderson Water Treatment Plant (WTP)

B. Each Generation System includes, but is not limited to the Sodium Hypochlorite Generator Skid with integral piping, valves, system control cabinet with PLC, Water Softener, bulk salt/brine tank, hypochlorite solution storage tank, commercial strength hypochlorite dilution panel, piping, valves, ancillary equipment as specified herein, related testing, start-up and training services.

C. A single OSHGS Supplier shall furnish each OSHGS consisting of the following major components and shall be responsible for making sure that all equipment is compatible with each other to ensure a simple installation:
   1. Sodium Hypochlorite Generation cells
   2. Control cabinet, PLC, VFD's, networking communication components, and associated equipment
   3. Hydrogen Dilution System
   4. Water Softeners & Cartridge Filters
   5. Brine Tank and accessories
   6. Sodium hypochlorite storage tank and accessories
   7. Sodium hypochlorite dilution panel
   8. Chemical metering pumps and accessories
   9. Acid cleaning Cart/System
   10. Hydrogen detector
   11. Spare parts

1.2 RELATED SECTIONS

A. Section 01025 - Measurement and Payment

B. Section 01300 – Submittals

C. Section 01400 – Quality Control

D. Section 01600 – Material and Equipment

E. Section 01650 – Starting of Systems

F. Section 01730 – Operation and Maintenance Data

G. Section 11000 – General Requirements for Equipment

H. Division 15 – Mechanical

I. Division 16 – Electrical

1.3 REFERENCES

A. The following references apply:

1. American National Standards Institute (ANSI).
2. American Society for Quality Control (ASQC).
3. American Society of Mechanical Engineers (ASME).
4. American Society for Testing Materials (ASTM).
5. American Water Works Association (AWWA).
6. British Standards Institute (BSI).
7. Canadian Standards Association (CSA).
8. The Chlorine Institute (CI).
9. Confinement of Substances Hazardous to Health (COSHH).
10. European National Standard (EN).
11. Institute of Electrical and Electronics Engineers (IEEE).
12. International Standards Organization (ISO).
13. Member States of the European Council (EC).
14. Mine Safety and Health Administration (MSHA).
15. National Electrical Code (NEC).
16. National Electrical Manufacturers Association (NEMA).
17. National Fire Code (NFC).
18. National Institute of Occupational Safety & Health (NIOSH).
19. Occupational Safety and Health Administration (OSHA).
20. Standard Fire Code (SFC).
21. Uniform Fire Code (UFC).
22. Water Environment Federation (WEF).

1.4 SYSTEM DESCRIPTION

A. Each On-site Sodium Hypochlorite Generation System (OSHGS) shall consist of rack-mounted sodium hypochlorite generation cells, solenoid control valves, an electrical control panel, a transformer rectifier, a water softener, brine tank, sodium hypochlorite storage tank, feed pump, and hydrogen dilution system. The OSHGS shall generate an aqueous solution of a minimum concentration of 0.8 percent (±0.05%) by weight sodium hypochlorite expressed as chlorine. The minimum capacity shall be demonstrated to be equal to the capacity specified for each installation while not exceeding the maximum aggregate raw material quantities specified below.

B. The system shall be designed for the following operating conditions:

SYSTEM I.D.	GENERATION CAPACITY (SEE NOTE 1)
WTP	200 PPD

Note 1: Expressed as pounds per day (PPD) free available chlorine (FAC)

C. The electrolytic cell shall consume 1.8-2.4 AC kilowatt-hours of electricity per pound of chlorine equivalent output.

D. Expected water consumption will be in the range of 14.0-17.0 gallons per pound of chlorine equivalent output. Water temperature must measure between 55 °F and 78 °F. Higher temperature water will result in lower system efficiency and higher total consumable units. A minimum of 50 psi water pressure is required at the inlet to the water softener. The raw water supply to the softener must be potable.

E. Generator performance is to be measured as a function of total consumption for salt and power. Expected ranges of consumption for salt will be 2.5-3.5 pounds of salt and 1.8-2.4 KWH per pound of equivalent chlorine (PE). Product concentrations will be in the range of 0.80% ± 0.05%.

1. Performance will be measured as the sum of the unit measurements for salt (PPE) and power (KWHPPE) and will not exceed 6.0 consumable units. Example: salt consumption at 3.0 PPE and 2.0 KWHPPE will measure 5.0 consumable units and will be considered proper performance.

2. Note that electrolytic cells require an initial acclimation period of approximately 300 operational hours. Performance measured before the cells have completed this exercise may not satisfy specification requirements. Water softener salt consumption and or chiller or heater power consumption shall be excluded from performance calculations.

F. The only liquid waste product allowed from the OSHGS will be the periodic backwash discharge from the water softener.

1.5 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Product Data: Furnish the following information:

1. Performance data that shall show compliance with specification requirements stated herein.

2. Suggested spare parts list. List of parts that need regular replacing, the estimated frequency and cost.

3. List of special tools required for checking, testing, parts replacement, and maintenance with current price information.

4. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

5. Special shipping, storage and protection, and handling instructions.

6. Routine maintenance requirements prior to plant startup.

7. Specifications for the recommended salt to be used and contact information for recommended manufacturers.

8. Manufacturer/Supplier's literature, illustrations, Specifications and bill of materials for each component of the system. Data shall include a complete description in sufficient detail to permit comparison with the technical Specifications.

9. Motor Data: For each motor furnish a certified motor data sheet for the actual motor.

10. Pump Data: For each pump furnish a performance certification indicating: head, capacity, efficiency and horsepower.

11. A list of all parameters, ratings or other characteristics where the proposed Sodium hypochlorite generator system deviates from the requirements set forth in these Specifications.

12. Affidavits of compliance with referenced standards and codes.

13. Manufacturer/supplier's standards for Sodium hypochlorite generator system equipment.

14. The acceptable range of water pressure for proper system operation. If a pressure or flow regulator is required, it shall be provided.

15. Design calculations for equipment and equipment supports specified to be designed.

C. Shop Drawings: The OSHGS Supplier shall submit the following to the Contractor, for approval by the Engineer, for each generation system in accordance with the following:

1. Dimensions (including anchor bolt layout), materials, size, weight and performance data.

2. Drawings showing fabrication, assembly, installation and wiring diagram. Wiring diagrams shall consist of, at a minimum, of control schematics, including coordination with other electrical control devices operating in conjunction with the Sodium hypochlorite generator feed system. Also include drawing for control panel and rectifier as well as P&ID for overall system.

3. Process flow diagrams.

4. Dimensioned inlet/outlet system connections.

D. Submit information on the Certified OSHGS installer including years of experience and the number of installs the installer has done of this type of equipment.

E. Submit a copy of this Specification Section, with addendum updates, with each paragraph clearly-marked to indicate specification compliance or to indicate requested deviations from specification requirements. If deviations from the specifications are indicated and, therefore requested by the Contractor, the submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up Specification Section, along with justification for any requested deviations to the specification requirements, with the submittal shall be cause for rejection of the entire submittal with no further consideration. The Owner retains the right to reject any proposed deviations in favor of this specification, as written.

1.6 QUALITY ASSURANCE

A. In order to assure uniform quality, ease of maintenance and minimal parts storage, it is the intent of these Specifications that all treatment equipment called for under this Section shall be supplied by a single supplier. The equipment manufacturer shall, in addition to the CONTRACTOR, assume the responsibility for proper installation and functioning of the equipment.

B. The Contract Documents represent the minimum acceptable standards for the equipment for this project. All equipment shall conform fully in every respect to the requirements of the respective parts and sections of the drawings and specifications.

C. OSHGS Suppliers Qualifications: The OSHGS Supplier shall have experience in furnishing equipment of similar capacity and service capability to the equipment described herein. As part of their submittal package, the system manufacturer shall submit the following:

1. Evidence that equipment of similar design has been in successful operation in at least twenty-five (25) separate installations within the continental United States.

2. Supplier has a minimum of five (5) years of experience.

3. Current NSF Standard 61 Certification for the system being offered.

D. OSHGS Installer Qualifications:

1. The OSHGS Installer must be certified by the OSHGS Supplier.

2. The installer shall have at least 5 years of experience in installing equipment of similar capacity and service capability to the equipment described herein.

3. The installer must have installed a minimum of five (5) OSHGS within the last five (5) years in Utah. This list must be provided as part of the submittal.

1.7 OPERATION AND MAINTENANCE MANUALS

A. Submit Equipment Operation and Maintenance Manuals in accordance with section 01730.

B. Operation and maintenance manuals and Maintenance Summary Forms shall be provided by the sodium hypochlorite generator manufacturer at least two weeks prior to shipment of all major equipment components. Each hardcopy manual shall be bound and indexed with drawings and parts lists. Also provide an electronic copy of the manual. The O&M Manual and Forms shall be reviewed by the Contractor and issued to the Engineer for review and approval.

C. As a minimum, the manual shall contain:

1. General arrangement drawings.

2. Installation electrical drawings.

3. Cut sheets for all items of equipment purchased from other manufacturers.

4. Required Operation Data:

a) Complete, detailed operating instructions for each piece of equipment.

b) Explanations for all safety considerations relating to operations. Include mention of required protective equipment and clothing.

c) Recommended spare parts lists, specifically denoting all items convenient for stocking as optional replacement items.

5. Required Maintenance Data:

a) Maintenance data shall include all information and instructions required by plant personnel to keep equipment properly cleaned, lubricated and adjusted so that it functions economically throughout its full design life.

b) Explanation with illustrations as necessary for each maintenance task.

c) Recommended schedule of maintenance tasks.

d) Lubrication charts and tables of alternate lubricants.

e) Troubleshooting instructions.

f) List of maintenance tools and equipment

g) Name, address and phone number of manufacturer and manufacturer's local service representative.

1.8 PERFORMANCE REQUIREMENTS

A. All of the sodium hypochlorite generation equipment shall be sized for and capable of injecting a minimum of 200 pounds per day of Free Available Chlorine (FAC). The installed startup and future FAC design demands are shown in the table below.

Flow Parameter	WTP Flow (gpm)
Design Flow	6,000
FAC Parameter	Size (FAC ppd)
FAC at Future Flow	144

B. The OSHGS Supplier must accept system design responsibility and guarantee functional performance as if it were its own design. The OSHGS Supplier shall be required to correct any design deficiencies at its own cost regardless of the design's origin.

1.9 PRODUCT DELIVERY, STORAGE AND HANDLING

A. The Contractor shall be responsible for the delivery, storage and handling of products in accordance with the manufacturer's recommendations.

B. The Sodium hypochlorite generation equipment shall be pre-assembled and factory tested to assure compliance with all operational requirements. No field assembly or wiring shall be permitted with the exception of external conduits.

C. The Factory tests shall include cell functionality, control panel functionality, and equipment hardware check. At a minimum, the following items must be addressed and confirmed on the checklist:

- Cell Voltage
- Cell Amperage Range
- Sodium hypochlorite Solution Flow Rate from Cell
- Free Available Chlorine Measurement of Sodium hypochlorite Solution
- Temperature Monitoring and Control System
- Standby Switch
- System Operational
- Proper Alarm and Safety Shutdown Function
- Functionality of Menu and Manual Buttons
- Proper Cell Purge Function

- Bill of Materials Verified
- Proper Labeling in Place

A copy of the test results shall be certified and shipped with the equipment.

D. Ancillary items shall be properly packaged to prevent damage and shipped for assembly in the field.

E. All components shall be installed immediately by Contractor upon receipt from the sodium hypochlorite generator manufacturer or stored in strict conformance with storage recommendations provided by the Manufacturer.

1.10 WARRANTY

A. Prior to acceptance of the Sodium hypochlorite generator system, Contractor to provide written warranty from the OSHGS Supplier that includes the following statements:

23. OSHGS Supplier has inspected the installation during and after completion and the Sodium hypochlorite generator system is free from faults and defects and is in conformance with the Contract Documents.

24. OSHGS Supplier must provide the following after sales services:

    a) Must provide a 24-hour 365-day toll free service hot line.
    b) Next day technician availability.
    c) Same day or overnight parts availability.
    d) Must provide evidence of spare parts availability on this system such as electrodes, rectifiers, control cabinets, metering pumps.

25. Sodium hypochlorite generator system and all ancillary equipment shall be warrantied for a minimum of three full years, including materials and workmanship, from the date of substantial completion. The OSHGS will remain free of defects for a period of three (3) years from the date of substantial completion. (Complete system, not just the generator skid including parts and labor.)

26. The electrolytic cells including cell body shall have a three (3) year full replacement warranty and a prorated straight-line replacement warranty for years 4-7 from the date of final acceptance.

27. If the equipment requires repair or replacement because of ordinary wear and tear under normal conditions, the OSHGS Supplier will repair or replace such equipment as required without cost (including shipping, handling and labor) to the Owner.

28. The warranty period shall start from the date of substantial completion of the system.

PART 2 - PRODUCTS

2.1 GENERAL

A. The sodium hypochlorite generator shall be designed to generate sodium hypochlorite by passing a dilute brine solution through electrolytic cells. The sodium hypochlorite shall be suitable for final disinfection of treated water. All necessary ancillary equipment needed to form a complete system shall be provided by the sodium hypochlorite generator manufacturer/supplier. This shall include equipment needed to accomplish brine generation, sodium hypochlorite storage, and sodium hypochlorite injection.

B. The electrolytic system shall generate an aqueous solution of a minimum concentration of 0.8 percent (±0.05%) by weight sodium hypochlorite expressed as chlorine. The minimum capacity shall be demonstrated to be equal to the capacity specified for each installation while not exceeding the maximum raw material quantities. Under normal operating conditions, site generated sodium hypochlorite solution will be injected into the process at locations shown on the drawings for disinfection.

C. The electrolytic cells shall consume a maximum of 2.5-3.5 pounds of salt per pound of chlorine equivalent output, using the same quality of solar salt provided by the District's salt provider to their other OSHGS installations. If provided by a different supplier then the solar salt shall also contain no organic binders, flow control agents or resin cleaning material, and shall meet the following specifications:

SALT ELEMENT	**TOLERANCE**
• NaCl:	
- dry basis	96.3% minimum
- wet	93.3% minimum
• Calcium Sulfate	0.30% maximum
• Magnesium Chloride	0.06% maximum
• Calcium Chloride	0.10% maximum
• Magnesium Sulfate	0.02% maximum
• Insolubles	0.1% maximum
• Moisture (as H_2O)	3.0% maximum
• Lead	0.0007% maximum
• Copper	0.0003% maximum
• Iron (as Fe)	0.002% maximum

D. The electrolytic cells shall consume a maximum of 1.8-2.4 AC kilowatt-hours of electricity per pound of chlorine equivalent output.

E. The electrolytic cells shall consume a maximum of 14-17 gallons of water per pound of chlorine equivalent output. The raw water supply to the softener shall be free of organics and suspended solids.

2.2 MANUFACTURERS

A. PSI Water Technologies Microclor® OSHGS (with associated equipment items specified herein) was used as basis of design for the project.

1. The manufacturer's representative is:

   Matt Wiest
   Waterford Systems
   (801) 463-9900
   Matt.waterford@gmail.com

2. The acceptable manufacturers must still conform to all elements of this specification. Approved equals must be presented to the Engineer for consideration during the bid phase per the General Conditions.

2.3 ON-SITE SODIUM HYPOCHLORITE GENERATION SYSTEM

A. A transformer rectifier, electrolytic cells, water solenoid valve, brine solenoid valve, brine pump, rectifier cabinet, hydrogen dilution blower, chemical storage tanks, chemical metering pumps, and a PLC-based control panel containing system controls, water softener with flow meter, sodium hypochlorite dilution panel, acid cleaning skid (bucket), hydrogen detector, and all necessary interconnecting wiring and hardware shall form a complete on-site sodium hypochlorite generation system. Components of the OSHGS shall comply with this specification. All components of the electrolytic cell skid shall be pre-assembled, piped, wired to input and output, flanged, threaded, etc. connections located at easily accessible points on the skid. The installation contractor shall provide all interconnecting piping and conduit, which shall be Sch 80 CPVC and as noted in the plans and process & instrumentation diagrams (P&ID's). The OSHGS shall be factory-tested prior to shipping as one self-contained unit.

2.4 HYDROGEN SAFETY MANAGEMENT

A. The generators shall have no waste products associated with its use other than hydrogen gas, which is to be vented to the atmosphere. Hydrogen Dilution blowers will be used to purge all residual hydrogen out of the system and storage tanks and dilute the hydrogen concentration 100 to 1 or below 25% of the LEL.

B. Any proposed system must meet every operational and material aspect of this specification. Hydrogen management shall be accomplished by the passive venting of each electrolytic cell without potential restrictions. This flow path should not have baffle plates, orifice plates or backpressure valves between the last point of product generation and atmospheric evacuation.

C. The presence of over-pressure rupture disks is not acceptable as the initiation of disk rupture would render the system inoperable. No hydrogen shall be vented directly to the hypochlorite storage tank where an accumulation could occur.

D. Under no circumstance will waste hydrogen be allowed to flow from one cell or cell compartment to the next. All hydrogen must immediately be released from each cell pack.

E. Minimum passive venting capability from each electrolytic cell pack shall be 4.0 square inches for every 100 pounds of chlorine production.

F. The hydrogen dilution system shall dilute the hydrogen concentration to below 25% of the LEL or 1% by volume.

G. Generator skid hydrogen dilution shall include passive vents connected to each cell and blower connected to the vent header. Sodium hypochlorite storage tanks shall be evacuated by blower.

H. Under no circumstance will the Hydrogen Safety Management requirements (Part 2.02) be relaxed or modified as they are critical operator safety features and core to the generator design. NOTE: THIS HYDROGEN SAFETY DESIGN MUST BE MET, REGARDLESS OF ONSITE GENERATOR MANUFACTURER SELECTED, AND WILL BE REQUIRED FOR SUBMITTAL APPROVAL.

2.5 ELECTROLYTIC CELL SKID ASSEMBLY

A. An electrolytic cell skid assembly shall be provided with the following overall dimensions:

SYSTEM I.D.	OSHGS SYSTEM	WIDTH	DEPTH	HEIGHT
WTP	MC-200	76”	21”	72”

B. Each electrolytic cell skid assembly shall have the following components and features:

1. 316 Stainless steel brine gear pump, with:
   a. Magnetic drive.
   b. Cavity-style design.
   c. PEEK gear construction.
   d. Integral speed control.
   e. Series GJ by MicroPump.
2. Water solenoid valve.
3. Polycarbonate water and brine rotameters.
4. Electrolytic cells
5. Transformer rectifier.
6. Magnetic flow meter.
7. Optical level switches.
8. Temperature switches.
9. Temperature sensor.
10. Teflon and Kynar interconnecting tubing.
11. 304 stainless steel frame, electrolytically polished for passivation, corrosion resistance, and chemical compatibility.
    a. Horizontal and vertical tube sections shall be of .125-inch wall thickness.
    b. All vertical and horizontal frame connections shall be welded.
    c. The completed frame with all mounted components shall comply with the UBC structural requirements for seismic zone four.

C. The generator shall be factory wired, plumbed, and mounted on a self-contained skid assembly.

D. The generator will be designed and built to allow one of the four electrolytic cells to be removed (replaced with a pipe spool) and still run at 80% production capacity.

E. Each electrolytic cell shall be arranged so that it can be completely drained in place.

F. The rack mounted flow control panel will consist of a water rotameter, water sensor, brine rotameter and a positive displacement gear pump with variable speed drive.

The variable speed drive will respond to a 0-5 VDC signal generated by the PLC algorithm in order to maintain constant current relative to variable water temperature or flow rate.

G. The process shall operate in a batch environment allowing for consistent hypochlorite concentrations and greatest efficiencies.

H. The generator skid will be supplied with a 4-20 mA electrolyte temperature sensor that will function to return a linear signal proportional to 0-100°C, which will allow continuous operation up to 130°F without interruption. Under no circumstance will bimetallic "snap" switches be permitted as the primary over-temperature sensor.

I. The generator package shall have the following redundant interlocked safety features:

1. Cell high temperature switch.
2. Low level switch for each cell.
3. Water flow sensor.
4. Transformer high temperature switch.
5. Automatic current regulation.

J. All electrical equipment and enclosures will be built and certified to UL 508 standards and will possess the appropriate label.

K. The generation system shall be pre-piped and skid-mounted.

1. The OSHGS skid frame shall be constructed of 304 stainless steel tube for structural strength. Horizontal and vertical tube sections shall be of .125-inch wall thickness and have a depth no greater than twenty four inches by a length not exceeding six feet. The entire skid shall undergo electrolytic polishing for ultimate passivation, chemical compatibility, and corrosion resistance. The completed frame with all mounted components shall comply with the UBC structural requirements for seismic zone four.

2. The skid frame shall be configured to allow easy access to all components, including the electrolytic cells. All vertical and horizontal frame connections shall be welded. Under no circumstances can water/liquids handling and/or cells be located immediately above the power supplies. The skid frame shall support, as a minimum, the following mounted equipment:

a. Generator electrolytic cells
b. Power supply/rectifier
c. Water and brine rotameters
d. Control panel
e. Interconnect pipes valves and fittings
f. Interconnect conduit and wiring
g. Water flow sensor
h. Variable-speed, positive-displacement brine pump

2.6 ELECTROLYTIC CELLS

A. Multiple electrolytic cells shall be provided as follows:

SYSTEM I.D.	CELL QUANTITY	CELL CAPACITY	ACTIVE SURFACE
WTP	5	40	4” x 12”

Any system using fewer electrolytic cells than that specified above must demonstrate its ability to achieve 80% production capacity with one of the cells removed from service.

B. The electrolytic cell bodies shall be constructed of and clear acrylic materials, allowing for front and rear visual inspection of the electrodes from all angles.

C. Each electrolytic cell will be constructed utilizing DSA coated titanium anodes and titanium cathodes. The cells must be configured in a vertical format with a recirculating loop provided for each cell. This recirculating loop will also allow the passive removal of hydrogen from each cell via the upper hydrogen vent. Under no circumstance will hydrogen be allowed to be driven from one cell or cell loop to the next.

D. Each cell loop will also incorporate an optical level sensor so as to preclude any possibility of exposing an active electrode surface.

E. The wetted cell components will consist only of the electrodes and acrylic cell body. No internal baffles, spacers, or connecting hardware will be allowed.

F. Cells shall utilize titanium bolting hardware.

2.7 TRANSFORMER RECTIFIER

A. The 6-pulse D.C. Rectifier will consist of a fully isolated three phase step down transformer and bridge rectifier. D.C. voltage output will be fixed with multiple primary taps for + 5-10% voltage correction. Under no circumstance will switching rectifiers or phase angle fired SCR voltage correction be permitted. D.C. ripple will be less than 4% with a power factor of 99% or better.

B. The transformer rectifier will be a fixed voltage unit where the current will be allowed to float as a function of electrolyte conductivity.

1. Constant current will be achieved via an active feedback loop where rectifier amperage is measured and reported to the PLC. The control algorithm calculates the appropriate amount of brine to mix with the incoming water so as to maintain constant current.
2. SCR-controlled rectifiers will not be allowed.

C. Rectifier efficiency will be 97% or greater.

D. The transformer/rectifier will house a 4-20 mA D.C. current transducer and NEMA 4X digital display of amperage.

E. The rectifier cabinet and base frame will be constructed of 304 Stainless Steel and will be of a modular design. All internal wiring connections and components will be easily accessible by removing the front access panel.

F. The transformer enclosure will be removable from the skid assembly as one piece, allowing for unobstructed access to the transformer.

G. The transformer rectifiers shall be designed for the following operating conditions in addition to the 30A PLC control panel requirement:

OSHGS LOCATION	CAPACITY (KVA)	PRIMARY VOLTAGE	SECONDARY VOLTAGE
WTP	24	480VAC/3PH/50A	N/A

A. The stepdown transformer rectifier shall be provided with the following accessories:

1. DC bridge rectifier utilizing three diode assemblies and an aluminum heat sink with 120 VAC cooling fan.
2. Panel-mounted electrical disconnect switch.

2.8 ELECTRICAL CONTROL PANEL

A. The OSHGS Supplier shall provide a NEMA 4X, 304 stainless steel, electrical control panel, which shall include controls for the entire sodium hypochlorite generation and feed system. The panel shall be mounted onto the generator skid and pre-wired at the factory to system components. The control panel shall house the operator interface terminal (OIT), PLC, hydrogen blower controls, and terminal strips to fully support the functions of generator operation, tank level, and metering pump proportional control.

B. All controls and operations logic specified herein and as shown on the instrumentation loop diagrams required for the system shall be programmed in a Programmable Logic Controller (PLC). The control cabinet logic will function at the PLC level where operating

parameters will be measured, corrected, scaled, reported, and controlled. Contractor shall coordinate with OSHGS Supplier and instrumentation supplier for proper integration of the system.

C. The control panel shall display all relevant operating parameters and/or alarm conditions. The OIT will serve as the operator interface, data input screen, and alarm log.

D. At a minimum, the panel shall have the following features, components, and functionality:

1. The generator shall automatically start and stop based on the high and low levels in the sodium hypochlorite storage tank.
2. The generator shall shut down and alarm for the following conditions:

    a. Low electrolyte level in cell.
    b. Hypochlorite temperature exceeds 130°F (55°C).
    c. Inlet flow falls below a preset value.
    d. Rectifier high or low amperage.
    e. Rectifier high temperature.
    f. Hydrogen dilution blower failure.

3. Low-low level alarm for hypochlorite storage tank.
4. High-high level alarm for hypochlorite storage tank.
5. Enclosure cabinet, 24" x 24" x 8", with ample interior volume so as to be easily wired and serviced.
6. Minimum 6" color touchscreen human-machine interface (HMI) with dedicated screens, including help dialogs covering all basic operations and detailed alarm explanations, for each portion of the process and Ethernet communications for PLC connection.
7. Allen Bradley MicroLogix 1400 programmable logic controller (PLC) with Ethernet communication protocol.
8. Rectifier controls.
9. Blower controls.
10. Logging and storing alarm history.
11. Security protection.
12. Dedicated 24 VDC power supply for PLC and HMI.
13. Emergency stop pushbutton.
14. Cabinet-mounted electrical disconnect switch.
15. Start-up shall be accomplished without the need for a laptop computer or proprietary software.
16. The electrical control panel shall be able to work with the Owner's SCADA system to control the chemical metering pumps to regulate the amount of sodium hypochlorite being dosed into the system based on the appropriate flow, target chlorine residual, bulk sodium hypochlorite concentrations (0.8% up to 15%), injection point, and/or compound loop algorithms.

E. The OSHGS Supplier shall be responsible for programming the Generation System package control software. The OSHGS Supplier shall deliver to the Owner all PLC and HMI code for future reference prior to final acceptance.

2.9 HYDROGEN DILUTION BLOWER

A. A hydrogen dilution blower shall be designed for the following operating conditions:

OSHGS LOCATION	CAPACITY (ACFM)	STATIC PRESSURE (IN WC)	MOTOR HP	ELECTRICAL SERVICE
WTP	406	3.36	1	240V/1Ph/60Hz

B. The blower shall be AMCA type B spark resistant of cast aluminum construction. The blower shall be cast with commercial grade 319 cast aluminum, having a 3/16” minimum wall thickness. Housing halves should be attached with tapered lugs having a minimum 45 degree taper from centerline for additional strength. Inlets and outlets shall be round.

C. The blower wheel hub shall be an integral part of the wheel casting. The wheel shall be a radial-type wheel. The blower shall be statically balanced by removal of material only – no additional weights are to be used in the balancing process.

D. The blower shall be arrangement 4 with a base of 12 gauge steel (minimum).

E. Hydrogen dilution blower shall be PB Series by Cincinnati Fan or equal.

F. The hydrogen dilution blower shall be provided with the following accessories:

1. Inlet guard.
2. Teflon shaft seal.
3. Current sensor.
4. Differential pressure switch positioned in the dilution ductwork vent stack.
5. Software controlled safety interlocks to detect control system sequence failure.

2.10 WATER FILTER

A. A wall-mounted large-capacity cartridge type filter housing holding a 10" cartridge for dirt, rust, and particulate matter from softener's feed water shall be provided. The filter housing shall be feature NPT inlet and outlet connections and a mounting bracket that must be non-metallic construction. A polypropylene cap with Buna-N O-ring shall be supplied.

B. The filter cartridge shall be a 4-1/2” diameter, 50-micron, disposable cartridge. Cartridge shall be manufactured from a pleated non-woven and reusable polyester fabric with polypropylene core.

C. Two (2) pressure gauges shall be provided to measure the pressure drop across the filter.

2.11 WATER SOFTENER

A. A dual-tank automatic water softening system shall be provided to remove hardness in the feed stream to the OSHGS, plus provides brine water makeup. The softener shall be designed for the following operating conditions:

OSHGS LOCATION	DUAL TANK DIMENSIONS	EFFICIENCY (SEE NOTE 1)	KINETICO MODEL NO.
WTP	17" ø x 46" H	4,000	CP-208S

Note 1: Expressed as grains exchanged per pound of salt

B. Softener shall remove hardness to less than ½ gpg. One tank will be on-line during service. A water meter shall automatically initiate system regeneration. The water meter shall measure the processed volume and be adjustable. Water softeners that regenerate on a fixed time will not be acceptable. When the ion exchange capacity of one resin tank is nearly exhausted, the hydraulically-driven, flow-controlled switchover valve will automatically divert flow to the alternate tank while initiating brine backwashing of the first tank for regeneration of the ion exchange resin. During regeneration cycles, one tank shall provide water to service and to the regenerating tank. Regeneration shall use salt solution from the brine tank.

C. The regeneration control valve shall be top mounted (top of media tank), and manufactured from non-corrosive materials. Control valve shall not weigh more than four pounds. Control valve shall provide service and regeneration control for two media tanks. Inlet and outlet ports shall accept a quick connect, double O-ring sealed adapter. Interconnection between tanks shall be made through the regeneration valve with a quick connect adapter. Control valve shall operate using a minimum inlet pressure of 25 psi. Pressure shall be used to drive all valve functions. No electric hook-up, electric timers, or gear motors shall be required. Control valve shall incorporate four operational cycles including; service, brine draw, slow rinse, and a combined fast rinse and brine refill. The brine cycle shall flow shall be opposite the service flow, providing a countercurrent regeneration. Control valve shall contain a fixed orifice eductor nozzle and self-adjusting backwash flow control. The control valve will prevent the bypass of hard water to service during the regeneration cycle.

D. The tanks shall be designed for a maximum working pressure of 125 psi and hydrostatically tested at 300 psi. Tanks shall be made of polyethylene and reinforced with fiberglass wrapping. Each tank shall include a 2.5 in. threaded top opening. Upper and lower distribution system shall be of a slot design. Distributors will provide even flow of regeneration water and the collection of processed water.

E. Each softener shall include a non-solvent, high capacity cation resin having a minimum exchange capacity of 30,000 grains/ft³ when regenerated with 15.0 lbs/ft³. The media shall be solid, of a proper particle size and shall contain no plates, shells, agglomerates or other shapes, which might interfere with the normal function of the water softener.

F. The water softener shall be provided with the following accessories:

1. 1-1/2-inch inlet and outlet pipe connections.

2. 1/2-inch HDPE tube with in-line check valve for feeding brine for regeneration.
3. 1/4-inch wastewater discharge to sewer for backwash waste.

2.12 BRINE TANK

A. High density cross-linked polyethylene (HDXLPE) salt/brine storage tank shall be provided as follows:

OSGHS LOCATION	APPROX. DIAMETER	OVERALL HEIGHT	SALT CAPACITY (LBS)	BRINE CAPACITY (GALLONS)
WTP	73”	114”	14,000	1,700

B. Design Criteria

1. The brine tank vessels shall be designed for the following criteria:
   a. Chemical Stored: Salt Brine
   b. Concentration: approx. 26%
   c. Resin: XLPE with Oxidation Resistant System
   d. Fitting Material: PVC
   e. Gasket Material: EPDM
   f. Bolt Material: 316 SS
   g. Specific Gravity: 1.9
   h. Exposure: Indoors
   i. Design Temperature: 120° F
   j. Pressure: Atmospheric

2. Brine tank vessels shall conform to the following structural design criteria:

Working Pressure:	Atmospheric
Seismic:	Site Class D
Maximum Temperature:	120 °F

C. Tanks shall be manufactured by one of the following:

1. Brine Maker
   3300 E. 19th Street
   Signal Hill, CA 90755
   (800) 998-7345
   www.Brinemaker.com

2. Poly Processing
   8055 S. Ash St.
   French Camp, CA 95231
   (866) 765-9957
   www.Polyprocessing.com

D. Materials and Construction

1. Each brine tank shall be upright, cylindrical, flat bottom, one-piece, rotationally-molded high density crosslinked polyethylene. A high-quality, chemically-resistant plastic with high stress crack and impact resistance shall be used. Tank colors shall be natural (unpigmented) and translucent. The plastic shall contain a minimum of 0.25% to a maximum 0.5% long term U.V. stabilizer.
2. Tanks shall be adequately vented for pneumatically filling.
3. Tanks with 3000 gallon capacity or larger shall have at least 3 lifting lugs. Lugs shall be designed for lifting the tank when empty.
4. All lower-sidewall tank fitting attachments shall be equipped with flexible connections designed to deflect based upon tank loading, chemical temperature, and storage time duration. Tank piping flexible couplers shall be designed to allow design movement in any direction.
5. Anchorage: Each tank shall be furnished with concrete anchors and hold down lugs, complete with 304 stainless steel plates, for proper anchoring of the tank as required by the design calculations. A minimum of four (4) hold down lugs shall be provided.
6. Unless otherwise specified, all fasteners, and metal attachments, such as anchors, brackets, etc. shall be ANSI 316SS.
7. Unit shall be complete with flanges, nozzles, manways, lifting lugs, anchor lugs, and other appurtenances.
8. Tank fittings and manways shall be according to the fitting schedule below and as shown on the plans. Manufacturer may submit an alternative fitting to the Engineer for review based on the project plans and their standard layout.

TANK I.D.	ITEM	SIZE	CONNECTION	ORIENTATION	HEIGHT	GASKET	MATERIALS/ HARDWARE
WTP	Manway (see Note 1)	24”	Bolted	0°	Top	--	Polyethylene
	Salt Fill (see Note 2)	3”	3” Flange x 2” FPT	180°	Top, Radius 24”	EPDM	316SS
	Vent	4”	Flange	90°	Top (see Note 3)	EPDM	316SS
	Water Fill (see Note 5)	1”	Bulkhead / Threaded	45°	Top (see Note 3)	EPDM	PVC
	Salt Level (see Note 5)	4”	4” Flange x 3” NPT	215-310°	Top (see Note 3)	EPDM	PVC/316SS
	Brine Level (See Note 5)	2”	Flange	310°	Side, 6”	EPDM	PVC/316SS
	Brine Outlet	1”	Bulkhead / Threaded	35°	Side, 6”	EPDM	PVC
	Drain	2”	Bulkhead (see Note 4)	270°	Side, 6”	EPDM	PVC
	Manway (Note 6)	24”	Bolted	0°	Side, 36”	EPDM	FRP/316SS

Note 1: Manway shall be fume tight with inspection port.

Note 2: Pneumatic fill with 2" stainless steel fill piping connected to flange.
Note 3: Locate within 24" / arm's reach from the top edge of tank
Note 4: Manufacturer to include 2" FPT welded coupler on inside with downturn pipe and fittings to allow for complete drainage.
Note 5: The location on the drawings may be different than what is listed in the table. The table locations listed here should take precedence. Final locations to be coordinated during submittal review.
Note 6: Not shown on the drawings, but still need to include.

E. Accessories

1. Each brine tank shall be provided with a full-radiused Sch 40 304 stainless steel salt fill line designed to receive salt pneumatically unloaded from a truck. Long-radius fittings shall be used. One aluminum quick connect adapter and cover shall be provided to connect the truck's hose to the brine tank salt fill line as indicated on the drawings. One gooseneck vent shall be integrally molded into the brine tank dome. A vent dust collector bag shall be furnished and installed. The dust collector shall be properly sized for the salt fill rate and the brine tank capacity. The dust collector shall be polyester cloth material.
2. A water distribution system and a brine collection plenum shall be provided for each tank. Each assembly shall be securely installed in the brine/salt storage tank. Each assembly shall be designed to produce a saturated brine solution as required by the hypochlorite generators.
3. Each brine tank shall be provided with a liquid level control assembly, including:
   a. A pressure sensing-type electronic level transmitter.
   b. Normally-closed, solenoid pilot-operated diaphragm valve shall have a brass body be ASCO 8210 Series. The solenoid valve shall open when brine solution level in the Brine Storage Tank is low. The solenoid valve shall close when the brine solution level in the Brine Storage Tank is high.
4. For tanks using granular or fine grade (less than 12 mesh) solar salt, a quartz rock filter bed shall be installed in the sump. The filter bed shall consist of a 5" layer of 0.125" x 0.125" on top of a 7" layer of 0.250" x 0.250". The filter bed shall be evenly-distributed over the entire bottom of the vessel. All quartz rock shall be AWWA-washed and NSF-certified.
5. The salt level sensor shall be a cable measurement transmitter. Cable measurement transmitter shall continuously measure salt level in the brine tank with 0.25% accuracy. Measuring cable length shall extend the entire height of the brine tank to measure salt at all levels. The cable shall be constructed of material resistant to saturated brine. Transmitter shall be Bin Master "Smart Bob II A.O." or equal.
6. An OSHA-approved fiberglass ladder shall be provided for each tank. The ladder shall be mounted to the vessel, but fully supported by concrete or other suitable support base. Attachment fasteners shall be 316 stainless steel.
7. Tanks shall be marked to identify the manufacturer, date of manufacture and serial number, capacity volume, and specific gravity.
8. Tanks shall include a 10" x 14" adhesive label identifying the tank contents as "SALT BRINE".
9. Unless otherwise specified, all pipe and fittings shall be Sch 80 PVC and all fasteners 316 stainless steel.

2.13 BRINE FILTERS

A. A wall-mounted cartridge type filter housings holding a 10" cartridge for dirt, rust, and particulate matter from the brine stream shall be provided. The filter housing shall be feature NPT inlet and outlet connections and mounting bracket that must be non-metallic construction. A polypropylene cap with Buna-N O-ring shall be supplied.

B. The filter cartridge shall be a 50-micron, disposable cartridge.

2.14 SODIUM HYPOCHLORITE STORAGE TANK

A. High density cross-linked polyethylene (HDXLPE) sodium hypochlorite storage tank shall be provided as follows:

OSHGS LOCATION	DIAMETER	OVERALL HEIGHT	CAPACITY (GALLONS)
WTP	85”	102”	2,000

B. Design Criteria

1. The chemical tank vessels shall be designed for the following criteria:
   a. Chemical Stored: Sodium Hypochlorite
   b. Concentration: ≤15%
   c. Resin: XLPE with Oxidation Resistant System
   d. Fitting Material: CPVC
   e. Gasket Material: Viton/EPDM
   f. Bolt Material: Titanium
   g. Specific Gravity: 1.9
   h. Exposure: Indoors
   i. Design Temperature: 120° F
   j. Pressure: Atmospheric

2. Chemical tank vessels shall conform to the following structural design criteria:
   a. Working Pressure: Atmospheric
   b. Seismic: Site Class D
   c. Maximum Temperature: 120 °F

B. Tanks shall be manufactured by one of the following:

1. Brine Maker
   3300 E. 19th Street
   Signal Hill, CA 90755
   (800) 998-7345
   www.Brinemaker.com

2. Poly Processing
8055 S. Ash St.
French Camp, CA 95231
(866) 765-9957
www.Polyprocessing.com

C. Materials and Construction

1. Each brine tank shall be upright, cylindrical, flat bottom, one-piece, rotationally-molded high density crosslinked polyethylene. A high-quality, chemically-resistant plastic with high stress crack and impact resistance shall be used. Tank colors shall be natural (unpigmented) and translucent. The plastic shall contain a minimum of a U.V. 15 stabilizer as compounded by the resin manufacturer.
2. Tanks shall be properly vented and have a minimum of three inches clearance on all sides to allow for expansion and contraction.
3. Tanks with 3000 gallon capacity or larger shall have at least 3 lifting lugs. Lugs shall be designed for lifting the tank when empty.
4. All lower-sidewall tank fitting attachments shall be equipped with flexible connections designed to deflect based upon tank loading, chemical temperature, and storage time duration. Tank piping flexible couplers shall be designed to allow design movement in any direction.
5. Anchorage: Each tank shall be furnished with concrete anchors and hold down lugs, complete with 304 stainless steel plates, for proper anchoring of the tank as required by the design calculations. A minimum of four (4) hold down lugs shall be provided.
6. Unless otherwise specified, all fasteners, and metal attachments, such as anchors, brackets, etc. shall be ANSI 316SS.
7. Unit shall be complete with flanges, nozzles, manways, lifting lugs, anchor lugs, and other appurtenances.
8. Tank fittings and manways shall be according to the fitting schedule below and as shown on the plans. Manufacturer may submit an alternative fitting to the Engineer for review based on the project plans and their standard layout.

TANK I.D.	ITEM	SIZE	CONNECTION	ORIENTATION	HEIGHT	GASKET	MATERIALS/ HARDWARE
WTP	Manway	18”	Threaded	0°	Top	--	Polyethylene
	Vent	4”	Flange	180°	Top (see Note 1)	EPDM	Titanium
	Fill	2”	Bulkhead / Threaded	90°	Top (see Note 1)	EPDM	CPVC
	Level	1.5”	Flange	65°	Top (see Note 1)	EPDM	PVC/Titanium
	Blower Connection	4”	Flange	270°	Top, 6”	EPDM	PVC/Titanium
	Chemical Outlet	2”	Bulkhead / Threaded (see Note 2)	315°	Side, 6”	EPDM	CPVC

TANK I.D.	ITEM	SIZE	CONNECTION	ORIENTATION	HEIGHT	GASKET	MATERIALS/ HARDWARE
	Drain	2”	Bulkhead / Threaded (see Note 2)	90°	Side, 6”	EPDM	CPVC
	Overflow	2”	Bulkhead / Threaded	90°	Side, 110”±	EPDM	CPVC

Note 1: Locate within 24” / arm’s reach from the top edge of tank
Note 2: Manufacturer to include 2” FPT welded coupler on inside with downturn pipe and fittings to allow for complete drainage.

D. Accessories

1. The OSHGS Supplier shall provide a Siemens HydroRanger 200 controller with LR110 radar level sensor each tank with 4-20 mA level signal for proper operation of the generation equipment and alarm initiation. Level controls for the tank shall be brought to the operator interface.
2. An OSHA-approved fiberglass ladder shall be provided for each tank. The ladder shall be mounted to the vessel, but fully supported by concrete or other suitable support base. Attachment fasteners shall be 316 stainless steel.
3. Tanks shall be marked to identify the manufacturer, date of manufacture and serial number, capacity volume, and specific gravity.
4. Tanks shall include a 10” x 14” adhesive label identifying the tank contents as “SODIUM HYPOCHLORITE” and also include NFPA 704 diamond placard.
5. Unless otherwise specified, all pipe and fittings shall be Sch 80 CPVC and all fasteners titanium.

2.15 COMMERCIAL STRENGTH HYPOCHLORITE DILUTION PANEL

A. Under emergency conditions commercially available sodium hypochlorite (10-12 percent solution) can be added if required via a commercial strength hypochlorite dilution panel provided by the OSHGS Supplier as part of the OSHGS.

B. The commercial strength sodium hypochlorite dilution panel shall include a wall-mounted PVC panel with the following instruments and accessories:

1. Venturi eductor, polypropylene construction.
2. Hypochlorite pump.
3. Polysulfone inline potable water rotameter.
4. Polysulfone inline commercial strength sodium hypochlorite rotameter.
5. Two (2) manually-operated flow control valves.
6. Outlet check valve.
7. Sch 80 CPVC piping and fitting.

2.16 SODIUM HYPOCHLORITE METERING PUMPS

A. Under normal operating conditions, site generated sodium hypochlorite (nominally 0.8% ± 0.05%) will be injected into the process at locations shown on the drawings for disinfection.

B. The OSHGS electrical control panel shall control the metering pumps to regulate the amount of sodium hypochlorite being dosed into the system.

C. The following metering pumps shall be provided as shown in the plans:

OSGHS LOCATION	PUMP I.D.	INJECTION POINT
WTP	MP-101	PRE-FILTRATION, BYPASS VALVE VAULT
WTP	MP-102	POST-FILTRATION, BYPASS VALVE VAULT
WTP	MP-103 (SHELF SPARE)	N/A

D. Metering pumps shall be model DME 375-10 AR-PV/V/G-S/31A4A4B as manufactured by Grundfos. Each pump shall meet the following design criteria:

1. Flow capacity: 100 gallons per hour (gph)
2. Discharge pressure: 145 psi
3. Horsepower: 1.0 hp
4. Power: 240 volt/3-phase/60 Hz

E. The metering pumps shall be suitable to operate 24-hours per day.

F. The metering pumps shall be provided as a pre-assembled skid-mounted assembly as shown in the drawings and as follows:
1. WTP Duplex Skid (with two separate injection points): Grundfos Model DSS-C2-DME-375-AR-FV1-PVFDV-J[SEE ELECTRICAL SHEETS]-C1010 or equal.

G. All piping and fittings shall be CPVC and connected with orange IPS 724 solvent cement for chemical service.

H. The OSHGS supplier shall provide the following accessories for the sodium hypochlorite metering pumps and as shown on the plans (D-sheets, I-sheets, and CD-sheet detail 15311 for the WTP) to ensure a complete operable system:

1. CPVC calibration columns.
2. CPVC chargeable pulsation dampeners.
3. CPVC backpressure relief valves.
4. CPVC pressure relief valves.
5. Wye strainers.
6. Pressure gauges with CPVC isolator using a Teflon membrane.

2.17 HYDROGEN DETECTOR

A. A hydrogen gas monitoring system shall be provided to continuously measure and display gas concentration and provide alarms when preset limits are exceeded. A transmitter will send the signal to the control panel.

B. The gas monitoring system shall have a NEMA 4X enclosure and two-line, eight-alphanumeric character LCD display with linear 4-20 mA output signal.

C. The gas detector shall be model CN06 by Conspec Controls.

2.18 ACID CLEANING CART/ 7 GALLON SYSTEM (BUCKET)

A. A pre-assembled, mobile cart including acid cleaning tank and centrifugal pump shall be provided by the OSHGS Supplier for periodic washing of the electrolytic cells.

B. The cart shall be pre-piped and pre-wired prior to shipment. All piping, fittings, and valves shall be Sch 80 PVC. The 120VAC, single-phase plug shall be included for connection to a standard electrical receptacle.

C. A discharge hose, quick-connect couplings, and appurtenance shall be included to transfer acid to and from the electrolytic cells.

2.19 TOOLS, SPARE PARTS, AND MAINTENANCE MATERIALS

A. The OSHGS Supplier shall furnish one set of the following spare parts for each onsite sodium hypochlorite generator system:

1. One (1) electrolytic cell level sensor
2. One (1) electrolytic cell temperature sensor
3. One (1) brine pump spare parts kit
4. One (1) spare parts kit for each backpressure and pressure relief valve
5. One (1) complete electrolytic cell including cell housing (loose electrodes are not acceptable)
6. One (1) shelf spare pump as noted in paragraph 2.16.C

B. Spare parts shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the Owner at the completion of the contract.

C. The OSHGS Supplier shall furnish an initial supply of all greases and lubricants required to start operations. Supply an amount of these materials necessary for one year of continuous operation.

2.20 PIPING

A. See specification 15100. The standard for chemical pipe, fittings, and components is Chem Proline fused polyethylene system downstream of the chemical metering pump skid unless noted elsewhere in the specifications or drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The Owner shall inspect all equipment and materials against approved Shop Drawings at time of delivery. Equipment and materials damaged or not meeting requirements of the approved Shop Drawings shall be immediately returned to the OSHGS Supplier for replacement or repair.

B. Equipment and materials shall be stored in a dry location and protected from the elements according to the OSHGS Supplier's instructions.

C. Equipment and materials shall be handled in an approved manner according to the OSHGS Supplier's instructions.

3.2 INSTALLATION

A. The OSHGS Supplier shall inspect the installation of the Generation System and the Contractor shall correct any deficiencies. Following the correction of all errors, the OSHGS Supplier shall provide a Certification of Proper Installation for the Generation System.

B. Installation of the generator, metering pumps, tanks and appurtenances shall be performed by the Contractor and shall be in accordance with the Drawings and with the OSHGS Supplier’s instructions and recommendations. Conflicts of information shall be called to the attention of the Engineer.

C. All equipment units or assemblies shall be installed on concrete bases and secured with anchor bolts in accordance with the OSHGS Supplier's recommendations and as shown. The concrete bases shall be poured up to 1-inch below the metal bases, legs or soleplates. Equipment legs or base plates shall be accurately shimmed to grade and the spaces between filled with an approved non-shrink grout. After the grout has reached its initial set, exposed edges shall be cut back 2 inches and the edges neatly finished with 1 to 2-cement mortar. Where channel base plates are used, the void inside the channel shall be filled with non-shrink mortar and the open ends plastered with 1 to 2-cement mortar. Contractor shall be responsible for the design of the equipment pads. The contractor shall coordinate with OSHGS supplier for skid placement and anchoring.

D. Contractor shall inspect all concrete pads for proper elevation, dimensions, cutouts, evenness and anchor bolt locations and correct if necessary.

E. Contractor shall provide a drain for each piece of equipment, according to the OSHGS Supplier's instructions.

F. Installation shall include furnishing and applying an initial supply of lubricants, as provided by the OSHGS Supplier.

G. Contractor shall support piping independent of equipment. Equipment shall be free from all loads and stresses induced by the piping.

H. All equipment including motors, belts and drives shall be aligned to the best industrial standards. Field check and adjust all equipment alignments in the presence of the Engineer.

I. The contractor shall inspect all equipment before installation, if damaged; notify the Engineer and OSHGS Supplier promptly. Do not install damaged equipment until the OSHGS Supplier makes repairs in accordance with OSHGS Supplier's written instruction and approval.

J. Tie-down lugs for tanks shall be grouted or shimmed to prevent excessive loads being transferred to the tank shell.

K. Make all electrical connections in conformance with the requirements of the electrical specifications.

L. The sodium hypochlorite generator shall be installed in accordance with the manufacturer's recommendations as approved by the Engineer. Prior to startup of the equipment, a field service engineer technician trained by the manufacturer shall inspect the assembled equipment, make necessary minor final adjustments and certify the equipment ready for operation.

M. A certified electrician and MANUFACTURER representative shall approve the installation.

3.3 STARTUP SERVICES

A. The OSHGS equipment manufacturer shall furnish the services of a qualified factory trained field service representative to check installation, start-up and operation of the sodium hypochlorite generator equipment, and instruct operating personnel in the proper operation and maintenance of the equipment per the schedules.

B. Contractor and OSHGS Supplier shall verify that structures, equipment, pumps and motors are compatible for an efficient system.

C. Contractor and OSHGS Supplier shall make equipment adjustments required to place system in proper operating condition.

D. Contractor and OSHGS Supplier shall test the sodium hypochlorite feed system for proper operation in the presence of the Owner and Engineer.

E. The OSHGS Supplier shall furnish all testing equipment and devices required.

F. If the sodium hypochlorite feed system fails to meet any of the specified performance requirements, Contractor and/or OSHGS Supplier shall modify and/or replace defective equipment until it meets specified requirements. Re-test system to verify satisfactory operation.

G. Demonstrate the accuracy of each metering pump using installed calibration column.

H. The Contractor shall, after installation of storage tanks is complete but before piping connections are made, block all outlets and fill each tank with water to again check for leaks. No leakage will be permitted.

I. The OSHGS Supplier's field services:

1. Retain, for the specified number of days for installation supervision, startup and training of the onsite generation system, factory trained representatives with demonstrated ability and experience in the installation and operation of the equipment. For each installation, the representative shall perform the services listed below:

a) Inspect the completed installation and prepare an inspection report.

b) Test, calibrate and adjust all components for optimum performance.

c) Assist in initial start-up and field-testing.

d) Instruct Owner's personnel in the operation and user maintenance of all components. Conduct a training seminar at the site.

e) Supervise the correction of any defective or faulty work before and after acceptance by Owner.

J. The field service representative shall instruct the Owner's personnel in the proper operation and maintenance of the equipment.

3.4 FIELD PERFORMANCE TESTING

A. The OSHGS Supplier shall perform functional, performance and start-up testing of the Generation System. The Contractor shall notify the OSHGS Supplier at least 14 days before the scheduled date for performing these tests and shall coordinate testing requirements and scheduling with the Engineer.

B. After startup and prior to final acceptance, the Contractor shall conduct Engineer witnessed performance demonstration tests on the sodium hypochlorite generator.

C. The field service representative shall cause the sodium hypochlorite generator to perform all of its design functions. Tests shall be scheduled with the Engineer at least two weeks prior to the planned test date.

D. The field service representative shall submit to the Engineer a written report stating that the equipment has been checked and is suitable for operation and shall include the performance test results.

E. Performance tests shall measure the sodium hypochlorite salutation concentration and the generation capacity.

1. Sodium hypochlorite solution concentration samples shall be taken at the outlet of the sodium hypochlorite generator.

a) Sodium hypochlorite solution concentration samples shall be taken at the outlet of the sodium hypochlorite generator.
b) A minimum of three samples shall be taken.
c) Samples shall be analyzed for available chlorine concentration in accordance with Standard Methods Method 4500-Cl G. DPD Colorimetric Method as adapted by Bradford (2010) for concentrated neat solutions to use the Hach Company Method 8201 Chlorine, Free by the DPD Method.

2. Generation Capacity
a) The generating capacity of the unit shall be calculated by multiplying the system flow rate (GPH) with the free available chlorine concentration times 0.0002 using a 15 second graduated cylinder flow measurement.
b) The generator capacity shall be reported in equivalent pounds per day.
c) The test shall be deemed successful if the generator capacity is greater than 20 lbs/day or whatever the minimum output for the OSHGS equipment.

3.5 TRAINING

A. Two (2) days of no less than eight (8) hours per day of onsite technical assistance for installation checkout, equipment startup, and operator training. One trip is included.

B. One (1) day of onsite follow-up operator refresher training in 90 days

The OSHGS Supplier shall train Owner's personnel and provide detailed instructions in the operation of the Generation Equipment.

3.6 IDENTIFICATION AND MARKING

A. The OSHGS, along with all applicable components, shall be marked and identified for all health, flammability, and reactivity of hazardous materials as required by all applicable jurisdictional building codes, statues, standards, regulations, and laws.

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SECTION 11600
UNDERGROUND DETENTION TANKS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Underground Water / Detention Tanks:

1.2 RELATED SECTIONS

A. Section 01300 - Submittals.

B. Section 01400 - Quality Control.

C. Section 01650 - Starting of Systems.

D. Division 02 – Site Works.

E. Division 03 - Concrete.

1.3 REFERENCES

A. American Concrete Institute (ACI) standard ACI 318, Building Code Requirements for Structural Concrete.

B. ANSI/AWWA D120 - Thermosetting Fiberglass-Reinforced Plastic Tanks.

C. NSF/ANSI Standard 61: Drinking Water System Components - Health Effects.

D. Tank manufacturer shall be recognized as a manufacturer of tanks listed to the ANSI/ UL 1316:2018 Underwriters Laboratories (UL) Standard for Fiber Reinforced Underground Tanks for Flammable and Combustible Liquids.

1.4 SUBMITTALS

A. Submit under provisions of Section 01300 - Submittals.

B. Product Data: Submit manufacturer's data sheets on each product to be used, including, but not limited to, the following:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation manual and operating guidelines.

C. Shop Drawings: Tank manufacturer shall submit the following for review and approval prior to fabrication of the tanks:
   1. Detailed shop drawings of each tank complete with all accessories supplied by the manufacturer.
   2. Detailed shipping, handling and installation instructions.
   3. Buoyancy calculations.

1.5 QUALITY ASSURANCE

A. Perform work in accordance with manufacturer’s Tank Installation Checklist.

B. Contractor shall provide the Owner and Engineer with a copy of the completed Tank Installation Checklist in order to facilitate any warranty claim. Initial each step to verify that the item has been performed or installed per Installation Manual specifications.

C. Comply with applicable requirements of the laws, codes, ordinances, and regulations of federal, state, provincial and municipal construction, health, safety and environmental codes, and local authorities having jurisdiction.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with tank manufacturer's Installation and Operating Guidelines recommendations for delivery, storage, and tank handling.

B. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.7 WARRANTY

A. Furnish one-year manufacturer warranty against material defects.

B. Furnish thirty year manufacturer warranty against internal corrosion, external corrosion, and structural failure.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Xerxes Corporation fiberglass underground water / detention tanks were used as basis of design for the project.

B. The manufacturer's representative is:

Darrin Tremain
Territory Sales Manager
Office: (780) 784-0705
Mobile: (780) 913-9799
Email: darrin.tremain@mattr.com
Website: www.mattr.com | www.xerxes.com

C. The acceptable manufacturers must still conform to all elements of this specification. Approved equals must be presented to the Engineer for consideration during the bid phase per the General Conditions.

2.2 UNDERGROUND WATER TANKS

A. Design Criteria:
1. Quantity: Two (2) single wall tanks
2. Diameter: 10 feet
3. Nominal capacity: 40,000 gallons
4. Tank inlet size: 12 inch
5. Tank outlet size: 6 inch
6. Manways: Three (3) 30 inch manways per tank

B. Tank Design - Fiberglass reinforced plastic (FRP) tanks:

1. The tank size, fittings and accessories shall be as shown on the drawings.
2. Tanks shall be manufactured with structural ribs which are fabricated as an integral part of the tank wall.
3. Tanks shall be manufactured with a laminate consisting of resin and glass fiber reinforcement only. No sand/silica fillers or resin extenders shall be used.
4. Tanks shall be vented to atmospheric pressure.
5. Tanks shall be capable of handling liquids with specific gravity up to 1.1.
6. Tanks shall be compatible with liquids identified in the manufacturer's standard limited warranty.

C. Loading Conditions - Tank shall meet the following design criteria:
1. Internal Load Tank shall be designed to withstand a 5-psig air-pressure test with a 5:1 safety factor.
2. Surface Loads Tank shall be designed to withstand surface H-20 and HS-20 axle loads when properly installed according to manufacturer's current Installation Manual and Operating Guidelines.
3. External Hydrostatic Pressure for Underground Water Tank shall be designed for 7 feet of overburden over the top of the tank, the hole fully flooded, and a safety factor of 5:1 against general buckling.

D. Tank Accessories:
a. Tank Anchoring:
1) Straps, turnbuckles, and deadmen shall be provided by the tank manufacturer.
2) Anchor straps shall be as supplied by tank manufacturer and designed for a maximum load of 25,000 lbs.
3) Galvanized turnbuckles shall be supplied by the tank manufacturer.
4) Prefabricated concrete anchors shall be supplied by the tank manufacturer, designed to the ACI 318 standard, manufactured with 4,000 psi concrete and shall have adjustable anchor points. Deadmen anchors shall be 18” wide x 8.75” high x 18’ long or as recommended by the manufacturer.
b. Manway Openings:
1) Each tanks shall have three (3) manways openings as shown in the drawings.
2) The standard manway shall be flanged, 30 inches I.D. and complete with gaskets, bolts and cover.
3) Manway openings shall be designed to withstand 5-psig test pressure with a 5:1 safety factor.
4) Manway extensions shall be FRP and shall be supplied by tank manufacturer.
5) One manway opening per tank shall include a connection for the level sensor as shown in the drawings.
6) See drawings for access manway watertight and traffic-rated cover detail.
c. Piping and Fittings:
1) Tank shall be equipped with internal factory-installed piping that meets NSF/ANSI Standard 61.

2) All flanged nozzles shall be flanged and flat-faced and conform to Class 150 bolting patterns as specified in ANSI/ASME/ B16.5.
3) Stainless steel NPT fittings shall withstand a minimum of 150 foot-pounds of torque and 1,000 foot-pounds of bending, both with a 2:1 safety factor.

d. Suction/Fill Tubes:
1) Suction/fill tubes shall be manufactured with materials listed under NSF/ANSI Standard 61 and factory installed.
2) Suction/fill tubes shall terminate 4 inches above the bottom of the tank.

e. Ladders:
1) Ladders shall be the standard FRP ladder listed under NSF/ANSI Standard 61 as supplied by tank manufacturer.
2) Ladders shall be installed at each manway opening.
3) Ladders shall be safety yellow color.

PART 3 EXECUTION

3.1 TESTING

A. Tank shall be tested according to the tank manufacturer's Installation Manual and Operating Guidelines in effect at time of installation.

3.2 INSTALLATION

A. Tank shall be installed according to the tank manufacturer's Installation Manual and Operating Guidelines in effect at time of installation.

B. Complete the Tank Installation Checklist and Initial each step to verify that the item has been performed or installed per Installation Manual specifications.

C. Clean and flush after installation.

END OF SECTION

SECTION 12357 – STAINLESS STEEL CASEWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Stainless steel casework.
2. Casework hardware.
3. Specialty cabinets.

B. Related Requirements:

1. Section 06100 "Rough Carpentry" for wood blocking for anchoring casework.
2. Section 09221 "Non-Structural Metal Framing" for reinforcements in metal-framed partitions for anchoring casework.
3. Section 12361 "Metal Countertops" for stainless steel countertops, sinks, and shelves.

1.3 COORDINATION

A. Coordinate layout and installation of framing and reinforcements for support of casework.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Shop Drawings: For casework.

1. Include plans, elevations, sections, and attachments to other work, including locations of blocking and reinforcements required for installation.
2. Show fabrication details, including types and locations of hardware.
3. Indicate locations of and clearances from adjacent walls, doors, windows, other building components, and equipment.

4. Include coordinated dimensions for equipment specified in other Sections.
5. Indicate manufacturer's catalog numbers for casework.

C. Samples: For casework and hardware finishes.
D. Samples for Initial Selection: For casework and hardware finishes.
E. Samples for Verification: For the following:

1. Hardware Finishes: For each type of exposed hardware indicated, in full-size units.
2. Base Cabinet: One full-size, 16-inch- wide, finished base cabinet complete with hardware, doors, and drawers but without countertop.
3. Wall Cabinet: One full-size, 12-inch- wide, finished wall cabinet complete with hardware, doors, and adjustable shelves.
4. Full-Size Samples: Maintain at Project site during construction in an undisturbed condition as a standard for judging the completed Work. Unless otherwise indicated, approved sample units may become part of the completed Work if in undisturbed condition at time of Substantial Completion. Notify Architect of their exact locations.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.

1.6 FIELD CONDITIONS

A. Established Dimensions: Where casework is indicated to fit to other construction, establish dimensions for areas where casework is to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.
B. Locate concealed framing, blocking, and reinforcements that support casework by field measurements before enclosing them and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Blickman, Inc.
2. Carr Corporation.
3. Continental Metal Products Co. Inc.

4. InnerSpace Corporation.
5. Scientek Technology Corp.
6. Skytron.

B. Source Limitations: Obtain from single source from single manufacturer.

C. Product Designations: Drawings indicate sizes and configurations of casework by referencing designated manufacturer's catalog numbers. Other manufacturers' metal casework of similar sizes, of similar door and drawer configurations, and complying with the Specifications may be considered. See Section 01 6000 "Product Requirements."

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 4000 "Quality Requirements," to design casework installation.

B. Seismic Performance: casework, including attachments to other work, shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Component Importance Factor: 1.0.

2.3 STAINLESS STEEL CASEWORK

A. Stainless Steel Sheet: ASTM A240/A240M, Type 304, stretcher-leveled standard of flatness.

1. Nominal Stainless Steel Thicknesses:

a. Sides, Ends, Fixed Backs, Bottoms, Cabinet Tops, Soffits, and Items Not Otherwise Indicated: 0.050 inch. Bottoms may be 0.038 inch if reinforced.
b. Back Panels, Doors, Drawer Fronts and Bodies, and Shelves: 0.038 inch except 0.050 inch for unreinforced shelves more than 36 inches long.
c. Intermediate Horizontal Rails, Center Posts, Tubular Legs, and Top Gussets: 0.062 inch.
d. Drawer Runners and Hinge Reinforcements: 0.078 inch.
e. Leveling and Corner Gussets: 0.109 inch.

2.4 CASEWORK HARDWARE

A. Provide casework manufacturer's standard, commercial-quality, heavy-duty hardware complying with requirements indicated for each type.

B. Door Hinges: Stainless steel, five-knuckle hinges complying with BHMA A156.9, Grade 1, with antifriction bearings and hospital tips. Provide two hinges for doors 48 inches high or less, and provide three for doors more than 48 inches high.

C. Hinged-Door and Drawer Pulls: Back-mounted pulls of solid aluminum, stainless steel, or chrome-plated brass. Provide two pulls for drawers more than 24 inches wide.

1. Design: Wire pulls.
2. Overall Size: 1 by 4-1/2 inches.
3. Design and Size: Round, 1-3/4 inches in diameter by 1/8 inch deep.

D. Door Catches: Nylon-roller spring catches. Provide two catches on doors more than 48 inches high.

E. Drawer Slides: Manufacturer's standard; complying with ANSI/BHMA A156.9.

F. Label Holders: Stainless steel, aluminum, or chrome plated; sized to receive standard label cards approximately 1 by 2 inches, attached with screws or rivets. Provide where indicated.

G. Locks: Cam or half-mortise type; brass with chrome-plated finish; complying with BHMA A156.11, Type E07281, E07261, E07111, or E07021.

1. Tumbler: Disc Five pin.
2. Lock Locations: Provide on drawers and doors.
3. Keying: Key locks alike within each room, and key each room separately.

    a. Master key for up to 225 key changes.

4. Key Quantity: Minimum of two keys per lock.
5. Master Key System: Key all locks to be operable by master key.

    a. Master Keys: Provide two.

2.5 CASEWORK FABRICATION

A. General: Assemble and finish units at point of manufacture. Use precision dies for interchangeability of like-size drawers, doors, and similar parts. Perform assembly on precision jigs to provide units that are square. Reinforce units with angles, gussets, and channels. Integrally frame and weld to form a dirt- and

vermin-resistant enclosure. Maintain uniform clearance around door and drawer fronts of 1/16 to 3/32 inch.

B. Metal Flush Doors: Outer and inner pans that nest into box formation, with full-height channel reinforcements at center of door. Fill doors with noncombustible, sound-deadening material.

C. Hinged Doors: Mortise doors for hinges and reinforce with angles welded inside inner pans or hollow-metal stiles at hinge edge.

D. Metal Drawers: Fronts made from outer and inner pans that nest into box formation, with no raw metal edges at top. Sides, back, and bottom fabricated in one piece with rolled or formed top of sides for stiffening and comfortable grasp for drawer removal.

E. Metal Shelves: Front, back, and ends formed down, with edges returned horizontally at front and back to form reinforcing channels.

F. Shelf Supports: Provide clips, brackets, pilasters, or other means to support shelves from cabinet ends and to allow height of shelves to be adjusted in increments of not more than 2 inches.

G. Sloping Tops: Unless tops are concealed by other construction, provide sloping tops on cabinets with tops 60 inches or more above the finished floor. Slope tops 25 degrees or more and construct of same material and with same finish as cabinets.

H. Toe Space: Unless casework is fully recessed, provide metal toe space, fully enclosed, 4 inches high by 3 inches deep, with no open gaps or pockets.

I. Filler Strips: Provide as needed to close spaces between casework and walls, ceilings, and indicated equipment. Fabricate from same material and with same finish as casework and with hemmed or flanged edges.

J. Trim Flanges: Formed metal trim fabricated from same material and with same finish as casework. Provide at perimeter of recessed cabinets.

2.6 STAINLESS STEEL FINISH

A. Grind and polish surfaces to produce uniform, directional-satin finish matching ASTM A480/A480M, No. 4 finish, with no evidence of welds and free of cross scratches. Run grain with long dimension of each piece. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces clean.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of reinforcements, and other conditions affecting performance of healthcare casework.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install casework level, plumb, and true in line; shim as required using concealed shims. Where healthcare casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical. Do not exceed the following tolerances:

1. Variation of Tops of Base Cabinets from Level: 1/16 inch in 10 feet.
2. Variation of Bottoms of Upper Cabinets from Level: 1/8 inch in 10 feet.
3. Variation of Faces of Casework from a True Plane: 1/8 inch in 10 feet.
4. Variation of Adjacent Surfaces from a True Plane (Lippage): 1/32 inch.
5. Variation in Alignment of Adjacent Door and Drawer Edges: 1/16 inch.

B. Recessed Cabinets: Set cabinets in openings and fasten to partition framing, wood blocking, or reinforcements in partitions with fasteners spaced not more than 24 inches o.c. Bolt adjacent cabinets together with joints flush, tight, and uniform.
C. Base Cabinets: Fasten cabinets to partition framing, wood blocking, or reinforcements in partitions with fasteners spaced not more than 16 inches o.c. Bolt adjacent cabinets together with joints flush, tight, and uniform.
D. Wall Cabinets: Fasten to hanging strips, masonry, partition framing, blocking, or reinforcements in partitions. Fasten each cabinet through the back, near the top, at not less than 16 inches o.c. unless continuously hung from hanging strips.
E. Install door and drawer hardware uniformly and precisely.
F. Adjust operating hardware so doors and drawers align and operate smoothly without warp or bind and so contact points meet accurately. Lubricate operating hardware as recommended by manufacturer.

3.3 CLEANING

A. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish as approved by Architect.

END OF SECTION 12357

SECTION 12361 - METAL COUNTERTOPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Stainless-steel countertops.
2. Stainless-steel sinks.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Shop Drawings: For metal fabrications.

1. Include plans, sections, details, and attachments to other work. Detail fabrication and installation, including field joints.
2. For countertops, show locations and sizes of cutouts and holes for items installed in metal countertops.
3. For wall-mounted shelves, indicate requirements for blocking or reinforcements in supporting construction.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver products only after casework and supports on which they will be installed has been completed in installation areas.
B. Keep finished surfaces of products covered with polyethylene film or other protective covering during handling and installation.

1.5 FIELD CONDITIONS

A. Field Measurements: Where products are indicated to fit to other construction, verify dimensions of other construction by field measurements before

fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 STAINLESS-STEEL FABRICATIONS

A. Countertops: Fabricate from 0.062-inch-thick, stainless-steel sheet. Provide smooth, clean exposed tops and edges in uniform plane, free of defects. Provide front and end overhang of 1 inch over the base cabinets.

1. Joints: Fabricate countertops without field-made joints.
2. Weld shop-made joints.
3. Sound deaden the undersurface with heavy-build mastic coating.
4. Extend the top down to provide a 1-inch-thick edge with a 1/2-inch return flange.
5. Form the backsplash coved to and integral with top surface, with a 1/2-inch-thick top edge and 1/2-inch return flange.
6. Provide raised (marine) edge around perimeter of tops containing sinks; pitch tops containing sinks two ways to provide drainage without channeling or grooving.

B. Stainless-Steel Sinks: Fabricate from stainless-steel sheet, not less than 0.050-inch nominal thickness. Fabricate with corners rounded and coved to at least 5/8-inch radius. Slope the sink bottoms to outlet without channeling or grooving. Provide continuous butt-welded joints.

1. Provide sizes indicated or manufacturer's closest standard size of equal or greater volume, as approved by Architect.
2. Factory punch holes for fittings.
3. Provide sinks with stainless-steel strainers and tailpieces.
4. Factory weld sinks to stainless-steel countertops to provide one, integral unit.
5. Apply 1/8-inch-thick coating of heat-resistant, sound-deadening mastic to undersink surfaces.

2.2 MATERIALS

A. Stainless-Steel Sheet: ASTM A240/A240M, Type 304.
B. Sealant for Countertops: Manufacturer's standard sealant that complies with applicable requirements in Section 07 9200 "Joint Sealants" and the following:

1. Mildew-Resistant Joint Sealant: Mildew resistant, single component, nonsag, neutral curing, silicone.

2. Joint Sealant: Latex.
3. Color: Clear.

2.3 STAINLESS-STEEL FINISH

A. Grind and polish surfaces to produce uniform, directional satin finish matching No. 4 finish, with no evidence of welds and free of cross scratches. Run grain with long dimension of each piece. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces clean.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of products.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install metal countertops level, plumb, and true; shim as required, using concealed shims.
B. Field Jointing: Where possible, make field jointing in the same manner as shop jointing; use fasteners recommended by manufacturer. Prepare edges to be joined in shop so Project-site processing of top and edge surfaces is not required. Locate field joints where shown on Shop Drawings.
C. Secure countertops to cabinets with Z- or L-type fasteners or equivalent; use two or more fasteners at each front, end, and back.
D. Abut top and edge surfaces in one true plane, with internal supports placed to prevent deflection.
E. Seal junctures of countertops, splashes, and walls with sealant for countertops.
F. Wall-Mounted Shelves: Fasten to supporting construction through upturned back edge at not less than 24 inches o.c.

1. For framed construction, fasten through wall or partition finishes directly to framing, blocking, or reinforcements.

3.3 CLEANING AND PROTECTION

A. Repair or remove and replace defective work as directed on completion of installation.
B. Clean finished surfaces. Remove and replace damaged products or touch up and refinish damaged areas to match original factory finish, as approved by Architect.
C. Protection: Provide 6-mil plastic or other suitable water-resistant covering over countertop surfaces. Tape to underside of countertop at a minimum of 48 inches o.c. Remove protection at Substantial Completion.

END OF SECTION 12361

SECTION 14300
BRIDGE CRANE AND MONORAIL

PART 1 – GENERAL

1.1 DESCRIPTION

A. SCOPE

1. This section specifies a bridge crane, monorail, and hoisting equipment for the installation and removal of water treatment equipment.
2. Runway system must meet the requirements of Section 2.04.

B. CRANE SUMMARY

1. Bridge Crane
   a. Location: Indoors, Normal Humidity, 40-110 degrees F operating temperature
   b. Span: 42 ft., (nominal- refer to plans for specific dimensions)
   c. Capacity: 2.5 Tons
   d. Crane type: Top running single girder
   e. Classification: Crane shall be designed and constructed to CMAA Specification #70 or #74, as applicable, for Class "C" service requirements and operation in a non-hazardous indoor environment.
   f. Crane speed: 100 FPM, infinitely variable
   g. Crane drive: Dual motor drive
   h. Trolley speed: 65 FPM, infinitely variable
   i. Trolley drive: Motorized
   j. Hoist speeds: 20 and 3.3 FPM, two speed
   k. Hoist type: Electric wire rope
   l. Hoist lift required: 18'-0" ft
   m. Control: Pendant from independent track on bridge
   n. Options: Hand held radio remote control with spare transmitter
2. Monorail
   a. Location: Indoors, Normal Humidity, 40-110 degrees F operating temperature
   b. Span: 20 ft., (nominal- refer to plans for specific dimensions)
   c. Capacity: 2.5 Tons
   d. Crane type: Electric hoist and trolley
   e. Classification: Crane shall be designed and constructed to CMAA Specification #70 or #74, as applicable, for Class "C" service requirements and operation in a non-hazardous indoor environment.
   f. Crane speed: See plan.
   g. Crane drive: See plan.
   h. Trolley speed: See plan.
   i. Trolley drive: Motorized

j. Hoist speeds: See plan.
k. Hoist type: Electric wire rope
l. Hoist lift required: 18’-0” ft
m. Control: See plan.
n. Options: Hand held radio remote control with spare transmitter

C. WORK INCLUDES THE FOLLOWING:

1. Detailed design of completed crane system, including bridge, end trucks, trolley, hoists, cabling, controls, and all appurtenances specified hereinafter.

2. Shop drawings.

3. Fabrication of a complete crane.

4. Inspection and shop testing.

5. Onsite load testing.

6. Documentation and schedules.

1.2 REFERENCES

A. OSHA Occupational Safety and Health Administration
Part 1926.554 - Overhead Hoists
Part 1910.179 – Overhead and Gantry Cranes

B. CMAA Crane Manufacturer’s Association of America
Specifications for Top Running Bridge & Gantry Type Multiple Girder Electric Overhead Traveling Cranes - No. 70 (2004)
Specifications for Top Running and Under Running Single Girder Electric Overhead Cranes Utilizing Under Running Trolley Hoist - No. 74 (2004)

C. ANSI / ASME:
American National Standards Institute /
American Society of Mechanical Engineers
ANSI / ASME HST-4 - 1999 Performance Standard For Overhead Electric Wire Rope Hoists
ANSI / ASME B30.16 – 2003 Overhead Hoists (Underhung)
ANSI / ASME B30.2 - 2001 Overhead and Gantry Cranes
(Top Running Bridge, Single Or Multiple Girder, Top Running Trolley Hoist)
ANSI / ASME B30.11 – 2004 Monorails and Underhung Cranes
ANSI / ASME B30.17 – 2003 Overhead and Gantry Cranes (Top Running Bridge, Single Girder, Underhung Hoist)

D. NEMA
National Electric Manufacturer’s Association

E. NEC

National Electric Code – 1999
Article 100, Article 240-1, Article 430-31, Article 430-51, Article 610-1, Article 610-31

1.3 SUBMITTALS

A. SHOP DRAWINGS AND EQUIPMENT DATA

1. Manufacturer's catalog data for hoist.

2. Dimensional drawings and details for bridge crane system.

3. Wiring schematics. – ship with crane

B. OPERATIONS AND MAINTENANCE MANUALS (one set of Owner's manuals in paper and in digital format)

1. Equipment function, normal operating characteristics, and limiting conditions.

2. Assembly, installation, alignment, and maintenance instructions.

3. Lubrication and maintenance instructions.

4. Guide to "troubleshooting".

5. Parts list.

6. As-built drawing.

7. Test results.

1.4 APPLICABLE STANDARDS

A. Contractor shall adhere to OSHA, state, and local safety guidelines, laws, rules, and regulations.

B. Contractor shall conform to all applicable ANSI, CMAA, and HMI specifications and/or standards.

C. Comply with CMAA specification 74 or 70, as applicable.

D. Long lead items [hoist, end trucks, drives and controls] will be ordered by contractor upon receipt of purchase order and credit approval. Steel will not be ordered until shop drawings and submittals have been approved by the customer.

E. All electric equipment shall be UL, CSA c/us or ETL labeled.

1.5 WARRANTIES

A. Provide one-year equipment warranty.

PART 2 - PRODUCTS

2.1 ACCEPTABLE PRODUCTS

A. Materials and equipment shall be standard products of manufactures regularly engaged in the fabrication, Sales and Service of overhead cranes and shall have been in business for a minimum of 10 years prior to bid opening.

B. Manufacturers

1. HOJ Innovations
2. Dearborn Overhead Crane
3. Or Approved Equal

C. 'Approved Equals' will be accepted in accordance with Instructions to Bidders Article 11.

D. Hoist shall be electric wire rope type as described in these specifications.

2.2 MATERIALS

Components	Material
Bridge beams	Steel, ASTM A992
End trucks	Steel, ASTM A36 (or equal)
Trolley	Steel, ASTM A36 (or equal)
Wheels	Cast iron or steel
Hooks	Forged steel

2.3 EQUIPMENT

A. HOIST AND TROLLEY

1. Top-running and under-running single girder cranes shall utilize the low headroom or standard headroom electric wire rope hoists

2. Top-running double girder cranes shall utilize double girder trolley electric wire rope hoists

3. The hoist shall be equipped with an electro-mechanical load-limiting device that shall prevent lifting more than 110% of the rated load.

4. Hoist and trolley motors shall be per 1.1B above, as applicable.

5. Hoisting motor(s) shall be two-speed/two winding squirrel cage type with a speed ratio of 6:1.

6. Hoisting motor(s) shall be totally enclosed with IP55 protection, minimum class F insulation, Klixon type bimetal switch for thermal protection and shall have a 60% ED rating.

7. Trolley shall be furnished with an adjustable frequency inverter drive and two-step or infinitely variable speed control for smooth acceleration and deceleration.

8. Trolley motors shall be inverter duty motors with minimum class “F” insulation and motor enclosures shall be TENV [totally enclosed non-ventilated].

9. Rotary cam type limit switch equipped with 4 micro-switches shall be provided. Limit switch shall provide upper and lower limit of hoist travel, hoist slow down prior to reaching upper limit and phase sequence supervision at upper limit. An additional block operated limit shall be included.

10. Hoist motor brake shall be DC disc type with adequate torque to stop and hold over 125% of the hoist rated load.

11. Large diameter rope drum with a minimum of 36:1 drum to wire rope diameter ratio. Groove depth shall be at least 35% of rope diameter. The rope drum shall be equipped with a rope guide to help keep the rope aligned in the grooves of the drum.

12. Wire rope shall be constructed from galvanized steel having a minimum safety factor of 5.

13. Hoist reeving shall be single reeved. Lateral hook drift shall not exceed 1/8 inch per foot of vertical travel on single reeved models.

14. The hoist nameplate is to carry a CSA c/us rating. The actual hoist control enclosure rating shall be at least equivalent to IP55 / NEMA 4 type.

15. Hooks shall be made of forged alloy steel (34CrMo4QT or 34CrNiMo6QT) and shall be fitted with a spring-loaded flipper-type safety latch.

16. Hoist shall have a duty rating suitable for the load class and load cycles of the application.

17. AGMA quality class 12 machine cut, hardened and precision ground hoist gearing. The gears inside the hoist gearboxes on models up to 5 ton capacity are lubricated by semi-fluid grease. On models over 5 ton capacity the gears inside the hoist gearbox are lubricated with semi-fluid grease or oil.

18. AGMA quality class 10, hardened and precision ground trolley drive gearing, lubricated by semi-fluid grease.

19. Trolleys shall have safety drop lugs and energy absorbing bumpers.

B. BRIDGE GIRDER

1. Bridge girder shall be per 1.01B above, as applicable.

2. Bridge girders shall be constructed from welded box girders or Structural beams, Steel, ASTM A992, as required.

C. END TRUCKS AND BRIDGE DRIVE

1. End trucks shall be designed in accordance with CMAA specifications as applicable.

2. End trucks shall be bolted to bridge girder.

3. Bridge drive shall be dual-motor (A-4 arrangement per CMAA).

4. Bridge drive shall be designed to stop the bridge within CMAA specifications.

5. End trucks shall be equipped with rail sweeps and energy-absorbing rubber bumpers.

6. Travel limit switches to be provided as necessary for safe operation.

7. Bridge shall be furnished with an adjustable frequency inverter drive and two-step or infinitely variable speed control for smooth acceleration and deceleration.

8. Bridge motors shall be inverter duty motors with minimum class “F” insulation and motor enclosures shall be TENV [totally enclosed non-ventilated].

9. AGMA quality class 10, hardened and precision ground bridge drive gearing, lubricated by semi-fluid grease.

D. POWER SUPPLY

1. Power supply for the hoist shall be 460 volt, 3 ph., 60 Hz. All power required for the operation of the hoist, trolley, and end trucks shall be developed from this source.

2. Runway electrification shall be 4-bar safety type rigid conductors as manufactured by Insul-8, Duct-O-Wire Company or Wampfler and designed for crane load. Wall mounted disconnect switch and power to runway conductors provided by Electrical Contractor.

3. Cross bridge electrification shall be flat cable style festoon system with terminal box, multi-conductor cord, plug connectors (when available) and accessories. Cables are to be hardwired when plug connectors are not available.

E. CONTROLS

The following controls shall be included as part of the crane system:

1. Six-way operation, plug-in pushbutton pendant suspended from independent festoon track.

2. Hand held radio remote control unit with spare transmitter.

3. Pendant shall include Start (momentary) button and Emergency Stop (push to maintain, turn to release) that controls a mainline contactor in the bridge control panel.

4. Pushbutton shall be clearly marked with hoist, trolley and bridge travel directions.

5. Hoist shall be 2 speed magnetic reversing type (standard) and the trolley and bridge controls shall be variable frequency inverter control (standard), as required per Section 1.1B.

6. Electrical control enclosures shall be IP55 or NEMA 4 type. Pushbutton enclosure shall have a rating of IP65, NEMA 4X, 4 or 5.

7. Warning device Horn or Light required

F. LABELING

1. Hoist and bridge beam shall be permanently labeled with load rating.

2. A corrosion-resistant nameplate shall be fixed to the bridge with the following information:

   a. Name of manufacturer
   b. Mfg.'s model number and serial number
   c. Capacity
   d. Date of manufacture (month and year)

G. PAINTING

1. Hoist and trolley shall be factory painted (2-part epoxy) per manufacturer's standards.

2. Bridge shall be shop cleaned, primed, and painted per manufacturer's standards.

3. The following items shall not be painted:

   a. Rail surfaces in contact with wheels
   b. Wheel running surfaces
   c. Hoist wire rope
   d. Conductor bar, festoon cables and supports

2.4 RUNWAY SYSTEM

1. Design runway system in accordance with local codes, AISC and CMAA standards.

2. Furnish and install runway system with columns and column supports per the plans.

3. Furnish and install ASCE rail system complete with hardware and attachment bolts.

4. Furnish and install 4 bar runway electrification sized for the crane loads.

5. Wall mounted disconnect switch and power to runway conductors shall be furnished and installed by Electrical contractor.

PART 3 – EXECUTION

3.1 INSTALLATION AND INSPECTION

A. Inspect runway structure and crane rail erection for conformance with reviewed shop drawings, contract documents and CMAA specifications prior to installation of equipment. Bring nonconforming work to the attention of Owner prior to proceeding with crane installation. Non-conforming runway structure or installation must be corrected prior to load testing of crane system. Costs of delays or additional work due to nonconforming runway structure will be the responsibility of the Contractor.

B. Bridge crane shall be installed in conformance with manufacturer's instructions and inspected by a manufacturer's representative. Provide all necessary accessories to make bridge crane complete, usable, and capable of meeting the operating requirements specified in the Operating Requirements. Test, adjust and clean equipment for acceptance by Owner.

3.2 TESTING

A. All crane equipment shall be operated through a complete lift and lowering cycle and through a complete travel of the bridge and trolley to determine that the equipment shall perform smoothly and safely and that pendant cable length is sufficient to permit operation from desired floor levels. All tests shall be carried out with the bridge crane equipment loaded at 125 percent of capacity. The Owner shall provide the test weight

loads. Any defects shall be corrected by the bridge crane provider without any expense to the Owner.

B. Inspection / start-up and load test sheets provided to Owner or representative after completion.

3.3 USE BY CONTRACTOR

A. Crane shall not be used by Contractor unless authorized by Owner. If crane is used by the Contractor, it shall be repaired, repainted, and otherwise refurbished to like new condition prior to its acceptance. The Contractor assumes all responsibility for operation and maintenance until the crane has been accepted by Owner.

3.4 CLEANUP

A. Upon completion of work, area shall be cleaned and restored to original condition, acceptable to the Owner.

END OF SECTION

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SECTION 15060
PIPE AND FITTINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. PVC Pipe and Fittings

B. Polyethylene Pipe and Fittings

C. Ductile Iron Pipe and Fittings

D. Steel Pipe and Fittings

E. Galvanized Iron Pipe and Fittings

F. Stainless Steel Pipe and Fittings

G. Pipe Penetration Seals

H. Couplings

I. Cam-Lock Couplings

J. Mechanical Joint Restraints

K. Thrust Blocks

L. Hardware

M. Tests

N. Valve Boxes

O. Pipe Saddles

P. Locating Wire and Marking Tape

1.2 RELATED SECTIONS

A. Section 01300 - Submittals

B. Section 01400 - Quality Control

C. Division 2

D. Division 9

E. Section 15100 - Hydraulic Valves and Gauges

1.3 REFERENCES

A. ANSI/AWWA C104/A21.4: Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water

B. ANSI/AWWA C110/A21.10: Ductile Iron and Gray-Iron Fittings for Water and Other Liquids

C. ANSI/AWWA C111/A21.11: Rubber Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings

D. ANSI/AWWA C115/A21.15: Flanged Ductile Iron Pipe with Threaded Flanges

E. ANSI/AWWA C150/A21.50: Thickness Design of Ductile Iron Pipe

F. ANSI/AWWA C151/A21.51: Ductile Iron Pipe

G. ANSI/AWWA C153/A21.53: Ductile Iron Compact Fittings

H. AWWA 206: Field Welding of Steel Water Pipe

I. AWWA C207: Steel Pipe Flanges for Waterworks Service, Sizes 4In. Through 144 In.

J. AWWA 606: Grooved and Shouldered Joints

K. ANSI/AWWA C900: Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In., for Water Distribution.

L. ANSI/AWWA C901: Polyethylene (PE) Pressure Pipe, Tubing, and Fittings, 1/2 inch through 3-inch, for Water.

M. ANSI/AWWA C905: Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameters 14 In. Through 36 In.

N. ASME/ANSI B16.1: Cast Iron Pipe Flanges and Flanged Fittings

O. ASME/ANSI B16.3: Malleable Iron Threaded Fittings

P. ASME/ANSI B16.21: Nonmetallic Flat Gaskets for Pipe Flanges

Q. ASTM A53: Pipe, Steel, Black and Hot Dipped Zinc Coated, Welded and Seamless

R. ASMT A139: Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)

S. ASTM A335/A335M: Standard Specification for Seamless Ferritic Alloy-Steel Pipe for High-Temperature Service

T. ASTM A536: Ductile Iron Castings

U. ASTM D1330: Rubber Sheet Gaskets

V. ASTM D1784: Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds

W. ASTM D1785: Polyvinyl Chloride (PVC) Plastic Pipe Schedules 40, 80, and 120

X. ASTM D2000: Rubber Products in Automotive Applications

Y. ASTM D2464: Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

Z. ASTM D2466: Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40

AA. ASTM D2467: Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

BB. ASTM D2564: Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems

CC. ASTM D2855: Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings

DD. ASTM D3034: Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings

EE. ASTM D3139: Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

FF. ASTM D3212: Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals

GG. ASTM D3261: Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

HH. ASTM D5162: Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates

II. ASTM F437: Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80

JJ. ASTM F439: Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80

KK. ASTM F493: Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings

LL. ASTM F441: Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

MM. ASTM F477: Elastomeric Seals (Gaskets) for Joining Plastic Pipe

NN. ASTM F493: Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings

OO. ASTM F679: Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings

PP. ASTM F2164: Field Leak Testing of Polyethylene (PE) Pressure Piping Systems using Hydrostatic Pressure

QQ. ASTM F 2618: Standard Specification for Chlorinated Poly Vinyl Chloride (CPVC) Pipe and Fittings for Chemical Waste Drainage up to 220°F

RR. Granger-Hunter Improvement District Standard Specifications and Drawings, latest edition

SS. AWWA C200: Steel Water Pipe

TT. International Building Code (IBC), current edition adopted by local jurisdiction

UU. Uniform Plumbing Code (UPC), current edition adopted by local jurisdiction

1.4 SUBMITTALS

A. Submit Under Provisions of Section 01300.

B. Submit manufacturer's certification under provisions of Section 01300 that pipe and fittings, meet or exceed specified requirements.

C. Submit manufacturer's installation instructions.

D. Submit shop drawings showing accurate dimensions of pipe, valves, fittings, pumps, support system, and appurtenances for all above ground or exposed piping systems. Drawings shall also show connection types. Submit calculations verifying that the system can withstand all pipe system forces.

1.5 QUALITY ASSURANCE

A. All welders and welding operators shall be qualified by an ASME-approved testing laboratory before performing any welding under this section. Qualification tests shall be in accordance with Section IX, Article III of the ASME Boiler and Pressure Vessel Code. Welders and welding operators shall be qualified for making groove welds in Type 316L stainless steel pipe in position 6G for each welding process to be used.

B. Qualification tests may be waived if evidence of prior qualification is deemed suitable by the Engineer. The manufacturer or Contactor shall retest any welders at any time the Engineer considers the quality of the welder’s work substandard. When Engineer requests the retest of a previously qualified welder, the labor costs for the retest will be at the Owner’s expense if the welder successfully passes the test. If the welder fails the retest, all cost shall be at the manufacturer’s or Contractor’s expense, including any rework required due to substandard work.

1.6 PROJECT RECORD DOCUMENTS

A. Accurately record actual location of constructed pipe lines in relation to existing permanent benchmarks and/or improvements.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Unload, store and load pipe in a manner that prevents shock, damage or excessive exposure to sunlight and weather.

B. Coated pipe shall be shipped on padded bunks with nylon belt tiedown strips or padded banding.

PART 2 MATERIALS

2.1 GENERAL

A. Piping material specifications are as described herein. Pressure class rating and pipe stiffness requirements are specified on the piping schedule or identified on the plans.

B. Interior pipe and fittings shall be as called out on the Plans, or if not called out, shall satisfy the requirements of the Uniform Plumbing Code (latest edition) and all other applicable state and local regulations.

2.2 PVC PIPE AND FITTINGS

A. Gravity PVC Pipe and Fittings:

1. Less than 4-Inch Pipe:

a. Schedule 40 PVC pipe conforming to ASTM D1785, Type 1.

i. Schedule 40 PVC fitting material conforming to ASTM D1784. Fittings shall conform to ASTM D2466. Fittings as noted on the Contract Drawings. Fabricated fittings are not permitted. FNPT fitting shall have external SS reinforcing band.

ii. Solvent weld joints shall conform to ASTM D2855. Solvent welds shall use solvent cement that conforms to ASTM D2564 and solvent primer.

b. Schedule 80 CPVC pipe conforming to ASTM F 2618 for DWV (drain waste vent) piping. Charlotte ChemDrain pipe and Fitting System, or approved equivalent.

i. Solvent weld joints shall conform to ASTM F 493.

2. 4- through 15-Inch Pipe:

a. PVC pipe and fittings conforming to ASTM D3034 SDR 35 with integral bell gasket joints.

b. Rubber gaskets shall be factory installed and conform to ASTM F477. Pipe joints shall conform to ASTM D3212.

c. For gravity piping less than 8-inch beneath structures, piping shall be Schedule 40 PVC conforming to ASTM D1784 and associated fittings, unless otherwise noted.

3. 18- through 48-Inch Pipe:

a. PVC pipe and fittings conforming to ASTM F679 SDR 35 with integral bell gasket joints.

b. Rubber gaskets shall be factory installed and conform to ASTM F477. Pipe joints shall conform to ASTM D3212.

c. For gravity piping less than 8-inch beneath structures, piping shall be Schedule 40 PVC conforming to ASTM D1784 and associated fittings, unless otherwise noted.

d. A 5-year warranty, starting from date of Notice of Substantial Completion, will be implemented on the following pipe segments due to sagging discovered during final video of new pipelines:

i. 18" PVC segment between MH SSWR-4 to MH SSWR-3, and MH SSWR-2 to Sewer Interceptor Vault.

B. Pressure PVC Pipe and Fittings:

1. Less than 4-Inch Pipe:

a. Schedule 80 PVC Pipe:

i. Schedule 80 PVC pipe conforming to ASTM D1785, Type 1, Grade 1.

ii. Schedule 80 PVC fitting material conforming to ASTM D1784. Socket fittings shall conform to ASTM D2467. Threaded fittings shall conform to ASTM D2464. Solvent weld or threaded fittings as noted on the Contract Drawings. Fabricated fittings are not permitted. FNPT fitting shall have external SS reinforcing band.

iii. For non-chemical use:

1. Solvent weld joints shall conform to ASTM D2855. Solvent welds shall use solvent cement that conforms to ASTM D2564 and solvent primer, and shall be NSF 61 approved when in potable water applications.

iv. For chemical service:

1. Solvent weld joints shall conform to ASTM D2855. Solvent welds shall use orange IPS 724 solvent cement, or an equivalent solvent cement that conforms to ASTM F493, and solvent primer, and shall be suitable and compatible for the chemical being conveyed in the specific process piping. Submit product information and chemical compatibility.

b. Schedule 80 CPVC Pipe:

i. Schedule 80 CPVC pipe conforming to ASTM F441.

ii. Schedule 80 CPVC fitting material conforming to ASTM D1784. Socket fittings shall conform to ASTM F439 and be of injection molded type. Threaded fittings shall conform to ASTM F437. Solvent weld or threaded fittings as noted on the Contract Drawings. Fabricated fittings are not permitted.

iii. Solvent weld joints shall conform to ASTM D2855. Solvent welds shall use orange IPS 724 solvent cement, or an equivalent

solvent cement that conforms to ASTM F493, and solvent primer.

1. For non-chemical use, the solvent shall be NSF 61 approved.

2. For chemical use, the solvent shall be suitable and compatible for the chemical being conveyed in the specific process piping. Submit product information and chemical compatibility.

2. 4- through 12-Inch Pipe:

   b. PVC water pipe conforming to ANSI/AWWA C900 CL 235, DR 18 with bell and spigot ends conforming to ASTM D3139. Rubber gaskets shall be factory installed and conform to ASTM F477.

3. 14- through 36-Inch Pipe:

   b. PVC water pipe conforming to ANSI/AWWA C900 CL 235, DR 18 with bell and spigot ends conforming to ASTM D3139. Rubber gaskets shall be factory installed and conform to ASTM F477. Furnish in cast-iron equivalent outside diameters. Class specified on plans and pipe schedule by application. Pipe shall be CL 235 unless specifically noted otherwise in the plans or pipe schedule.

   c. PVC water pipe conforming to ANSI/AWWA C900 CL 165, DR 25 with bell and spigot ends conforming to ASTM D3139. Rubber gaskets shall be factory installed and conform to ASTM F477. Furnish in cast-iron equivalent outside diameters. Pressure Class shall be specified on plans and pipe schedule.

4. Fittings for 4- through 48-Inch Pipe:

   a. Ductile iron mechanical joint fittings with accessories, 3-inch through 48-inch, conforming to ANSI/AWWA C110/A21.10 and ANSI/AWWA C111/A21.11 or ANSI/AWWA C153/A21.53 and ANSI/AWWA C111/A21.11 (current revisions). Ductile iron mechanical joint fittings 3 inch through 24-inch shall be rated for 350 psi working pressure. Ductile iron mechanical joint fittings 30 inch through 48-inch shall be rated for 250 psi working pressure.

   b. Gaskets shall be made of vulcanized styrene butadiene rubber (SBR) and shall conform to ANSI/AWWA C111/A21.11, unless otherwise noted.

   c. Provide restrained joints on all ductile iron fittings for buried PVC piping, unless otherwise noted in the Contract Drawings and pipe schedule.

   d. All buried ductile iron fittings shall be wrapped in wax tape in accordance with GHID standards.

5. Joints Restraints for 4- through 36-Inch Pipe:

a. Provide restrained joints on all buried PVC piping, unless otherwise noted in the Contract Drawings and pipe schedule.

b. All pressure fittings and valves shall include mechanical joints with thrust blocks or mechanical joint restraints in accordance with the drawings and specifications, unless otherwise detailed herein. If mechanical joint restraints are used, provide push-on joint restraint harnesses for all pipe joints within 40' of all directions from the fitting (2 joints min. each direction).

c. All buried ductile iron fittings shall be wrapped in wax tape in accordance with GHID standards.

2.3 POLYETHYLENE PIPE AND FITTINGS

A. Less than 4-Inch Pipe

1. High density polyethylene (HDPE) 3608 pipe conforming to AWWA C901 with iron pipe size (IPS) outside diameter and with a minimum pressure rating of 250 psi (DR 9).

a. Manufacturer shall be Chem Proline for all pipe and fittings

2. Joints:

a. Butt heat fusion per ASTM D3261 shall be required unless called out otherwise in the plans.

b. Brass compression coupling or pack joints with stainless steel inserts, where specifically allowed on the Drawings. No joints are allowed beneath building slabs and foundations.

i. Manufacturer shall be Chem Proline, FORD, or approved equal.

3. Fittings:

a. For non-chemical service:

i. All brass or stainless steel with MNPT or FNPT iron pipe size threads.

b. For chemical service:

i. Polyolefin fittings as manufactured by Chem Proline shall be required unless called out otherwise in the plans.

ii. PVC to HDPE transition adapter for enabling plain end schedule 80 PVC pipe to be connected to HDPE pipe. All materials shall be suitable and compatible for the chemical being conveyed in the

specific process piping. Submit product information and chemical compatibility.

iii. Restrained mechanical transition coupling. All materials shall be suitable and compatible for the chemical being conveyed in the specific process piping. Submit product information and chemical compatibility.

c. For ½" tubing and less:

i. All polypropylene push-connect compression fittings shall be manufactured by John Guest or approved equivalent. All materials shall be suitable with excellent compatibility for the chemical being conveyed in the specific process piping. Submit product information and chemical compatibility.

4. Natural gas piping shall be MDPE conforming to ASTM D2513, Cell Class per ASTM D3350, PPI-Listed Material (TR-4) PE 2406/2708.

B. Greater than 4-Inch Pipe

1. High density polyethylene (HDPE) 4710 pipe conforming to AWWA C906 with iron pipe size (IPS) outside diameter and with a minimum pressure rating of 125 psi (SDR 17).

2. Joints: Butt heat fusion per ASTM D3261.

3. Foul Air Piping shall be HDPE per ASTM F2306 or AASHTO M294 Type S. The pipe shall have a smooth interior and annular exterior corrugations. Material shall be high-density polyethylene conforming with the minimum requirements of cell classification 435400C as described in the latest version of ASTM D3350, except the carbon black content shall not exceed 4%.

4. A 5-year warranty, starting from date of Notice of Substantial Completion, will be implemented on the following pipe segments due to sagging discovered during final video of new pipelines:

a. 20" fused HDPE (IPS) DR-21 segment between MH SSWR-3 to MH SSWR-2.

2.4 DUCTILE IRON PIPE AND FITTINGS

A. Pipe:

1. Mechanical, Grooved, or Push-On Joint Pipe: Conform to ANSI/AWWA C151/A21.51 with a 350 psi pressure rating.

2. Flanged Joint Pipe: Conform to ANSI/AWWA C115/A21.15 with a 350 psi pressure rating.

3. Ductile iron pipe thickness shall conform to ANSI/AWWA 150/A21.50.

4. Minimum thickness class shall be as follows:

Use	Required Class
General Use, 12" Diameter and Smaller	52
General Use, Over 12" Diameter	50 or 51
Threaded Taps	52
Grooving, for Grooved Joints	53
Threading, for Threaded Flanges	53

5. Where taps are shown on fittings, tapping bosses shall be provided.

B. Joints:

1. Push-on Joints: Conform to ANSI/AWWA C151/A21.51. Provide restrained joints on all buried ductile iron piping with push-on joints, unless otherwise noted in the Contract Drawings and pipe schedule.

2. Mechanical Joints: Conform to ANSI/AWWA C110/A21.10 and ANSI/AWWA C111/A21.11 or ANSI/AWWA C153/A21.53 and ANSI/AWWA C111/A21.11. Provide mechanical restrained joints on all buried ductile iron piping, unless otherwise noted in the Contract Drawings and pipe schedule.

3. Flanged Joints: Conform to ANSI/AWWA C115/A21.15. Gray-iron threaded flanges shall not be permitted.

4. Grooved Joints: Conform to AWWA C606.

5. All buried ductile iron pipe and fittings shall be wrapped in wax tape in accordance with GHID standards.

C. Fittings:

1. Coated and lined same as pipe.

2. Flanged Fittings:

   a. Flanged fittings, 3-inch through 48-inch, shall be manufactured of ductile iron in accordance with all applicable terms and provisions of standards ANSI/AWWA C110/A21.10 (current revisions). Flange surface shall be faced and drilled in accordance with ANSI Class 125 B16.1.

   b. All ductile iron flanged fittings shall be rated for a minimum water pressure of 250 psi.

   c. Gray iron flanges shall not be permitted.

3. Mechanical Joint Fittings:

a. Ductile iron mechanical joint fittings with accessories, 3-inch through 48 inch, conforming to ANSI/AWWA C110/A21.10 and ANSI/AWWA C111/A21.11 or ANSI/AWWA C153/A21.53 and ANSI/AWWA C111/A21.11 (current revisions). Ductile iron mechanical joint fittings 3 inch through 24-inch shall be rated for 350 psi working pressure. Ductile iron mechanical joint fittings 30 inch through 48-inch shall be rated for 250 psi working pressure.

b. All exterior buried fittings greater than 3 inches shall be ductile iron mechanical joint with mechanical joint restraints, unless otherwise noted on the Contract Drawings and pipe schedule.

4. Grooved Fittings:

a. AWWA Grooved Piping System – Mechanical grooved pipe couplings and fittings, as manufactured by Victaulic Company of America or approved equivalent. Grooved pipe couplings and fittings shall conform to the following requirements. Grooved end product manufacturer to be ISO-9001 certified.

b. Grooved end cast or ductile iron pipe shall conform to ANSI/AWWA C606 (current revisions).

c. Fittings shall be ductile, ASTM A-536, conforming to the requirements of AWWA-C110 for center to end dimensions, AWWA-C153 for wall thickness, and AWWA-C606 rigid radius grooving dimensions for end preparation.

d. Grooved coupling shall be a Victaulic Style 31 grooved coupling for ductile iron piping, or approved equivalent, with ductile iron body with Tnemec coating suitable for submergence in wastewater, and 316 stainless steel bolts and nuts.

e. Grooved flange adapter: Coupling shall be a Victaulic Style 341 grooved flange adapter or approved equivalent. The coupling shall have a ductile iron body with nitrile gaskets or orange enamel coating and 316 SS bolts and nuts.

5. All buried ductile iron pipe and fittings shall be wrapped in wax tape in accordance with GHID standards.

D. Gaskets:

1. Gasket pressure rating to equal or exceed the system hydrostatic test pressure.

2. Push-On, Mechanical, and Proprietary Restrained Joints: Gaskets shall be made of vulcanized styrene butadiene rubber (SBR) and shall conform to ANSI/AWWA C111/A21.11, unless otherwise noted.

3. Flanged, Water and Sewage Service: ⅛-inch thick, red rubber (SBR), hardness 80 (Shore A), rated to 200° F, conforming to ANSI B16.21, AWWA C207, and ASTM D1330, Grades 1 and 2.

4. Flanged, Hot Air: ⅛-inch thick, homogeneous black rubber (EPDM), hardness 60 (Shore A), rated to 300° F, conforming to ANSI B16.21 and ASTM D1330 Steam Grade

5. Grooved End Joints: Halogenated butyl conforming to ASTM D2000 and AWWA C606.

6. Blind flanges shall be gasketed covering the entire inside face with the gasket cemented to the blind flange.

E. Ductile Iron Wall Spools and Sleeves:

1. DIP wall spools shall conform to ANSI/AWWA C110, ductile iron with connecting end type as called for on the plans, and compatible with connecting piping and valving.

2. Spools and sleeves shall be rated at 350 psi working pressure, and withstand the anticipated bury depths.

3. Wall spools shall incorporate a statically cast thrust collar ring, which is positioned to accommodate cast-in-place concrete placement, as shown on the plans.

4. Minimum laying length shall be 24 inches.

F. Coatings (Exterior):

1. Buried: Exterior coated with asphaltic coating, 1 mil minimum thickness, per ANSI/A WWA C151/A21.51 and ANSI/AWWA C110/A21.10

2. Exposed or Submerged: Primed and painted in accordance with Section 09900.

G. Linings (Interior):

1. Pipe and fitting linings shall consist of the following, as noted on the Contract Drawings and/or pipe schedule.

2. Cement Mortar Lining: Cement mortar lining meeting the requirements of ANSI/AWWA C104/A21.4.

3. Epoxy Lining: 40 mils nominal dry film thickness ceramic epoxy; Protecto 401 (amine cured Novalac Epoxy), as manufactured by Pacific States Cast Iron Pipe Company.

4. Glass-Lined Ductile Iron Pipe and Fittings

a. The glass lining applied to pipe and fittings shall be vitreous material that is hard, smooth, continuous, and formulated to prevent the

adherence of grease in sludge and scum lines, and to resist the adherence of crystalline metal salt deposits (Struvite and Vivionite) to sludge and centrate lines. It shall be applied to properly prepared pipe and fittings using accepted industry standards, and shall be tested per applicable standards, including ASTM D-5162-01, NACE RP 0188-99, and SSPC Coating Manual, Volume 1, Section XIV.

i. Lining shall be VITCO SG-14, Fast Fabricators/Waterworks Manufacturing MEH-32, or approved equal.

ii. The applicator shall have a minimum of 5 years of successful experience in the application of high temperature glass and porcelain coatings.

b. The lining material shall consist of vitreous and inorganic material applied to the internal surfaces that have been prepared by blasting. The lining shall be applied in a minimum of two (2) coats, separately applied and separately fired. The items shall be exposed to a maturing temperature of approximately 1400° F, at which point the vitreous and inorganic materials melt and fuse to the base metal, forming an integral molecular bond with the base metal surface. Subsequent coatings will be in similar manner, forcing an integral molecular bond with the base coat. The entire finished coating shall be a minimum of 10 mils (.010) and a maximum of 25 mils (.025") as tested with a micro test or other acceptable dry film thickness gauge. 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.

c. The lining shall have a hardness of 5-6 on the MOHS scale, and a density of 2.5-3.0 grams per cubic centimeter as measured by ASTM D-792. The glass lining shall be capable of withstanding an instantaneous thermal shock of 350° F. differential without crazing, blistering or spalling. It shall be resistant to corrosion of between PH-3 and PH-10 at 125° F. There shall be no- visible loss of surface gloss to the lining after immersing a production sample in an 8 percent sulfuric acid solution at 148° F for a period of 10 minutes. When tested according to ASTM C-283, it shall show a weight loss of not more than 3 milligrams per square inch.

d. 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 and which represent less than 0.01 percent of the total glassed surface. 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.

e. The finished glass lined pipe shall not deviate more than 0.0125 inch per foot of length from a centerline perpendicular to the square pipe end or flange face.

f. Handle pipe according to lining manufacturer's recommendations.

g. Taps and welds shall be done before lining. Field cut and repair field cuts in accordance with manufacturer's recommendations.

5. None: No lining shall be provided on pipes used for air service.

2.5 STEEL PIPE AND FITTINGS

A. Steel Pipe and Fittings: ANSI/AWWA C200, ASTM A53, Type S, Grade B, Schedule 40.

B. Joints: Butt-welded or flanged, as required.

1. Field welding shall be performed per AWWA C206. Shop welding and fabrication shall conform to AWWA C207.

2. Flanged fitting shall be hub style, slip-on in accordance with AWWA C207, Class D. Flat faced or raised face to be compatible with connecting piping, ANSI B16.1 Standard.

3. Gasket: Sized to match mating flange.

4. Pipe interior lining shall be NSF approved fusion bonded epoxy. Scotchcoat 134 or 206N, unless noted otherwise.

2.6 CARBON STEEL SEEMLESS CASING PIPE

A. Steel Pipe: ASTM A139, Grade B

B. Joints: Electric-fused welded per ASTM A335

C. Minimum yield strength: 35,000 ksi

D. Wall thickness: 5/8-inch

E. Pipe exterior coated with bituminous asphalt.

2.7 GALVANIZED STEEL PIPE AND FITTINGS

A. Galvanized Steel Pipe and Fittings: ASTM A53, Type S, Grade B, Schedule 40, galvanized.

B. Joints: Threaded or flanged, as required.

1. Threaded fittings shall be Class 150 galvanized malleable iron, conforming ANSI B16.3.

2. Flanged fittings shall be hub style, slip-on in accordance with AWWA C207, Class D. Flat faced or raised face to be compatible with connecting piping, ANSI B16.1 Standard.

3. Gasket: Sized to match mating flange.

2.8 STAINLESS STEEL PIPE AND FITTINGS:

A. Pipe:

1. Pipe sizes less than 30-inch diameter shall be stainless steel ASTM A312, welded process, Grade 304L or 316L, unless otherwise specified hereinafter or shown on the drawings. Schedule as noted or shown. Seamless material may be substituted for welded material but not the reverse.

2. Pipe sizes equal to and larger than 30-inch diameter shall be stainless steel manufactured from ASTM A 240 annealed and pickled sheets and plates in accordance with ASTM A 778 Type 304L or 316L unless otherwise indicated.

3. Pipe 8-inch diameter and smaller shall be manufactured to nominal pipe sizes as listed in ANSI B36.19 and shall have a wall thickness meeting the minimum requirements of Schedule 10S.

4. Pipe larger than 8-inch diameter shall be manufactured to nominal pipe sizes as listed in ANSI B36.19. Calculations showing that the selected wall thickness is acceptable for the service conditions shall be prepared and submitted. Minimum schedule 10S required.

5. Pipe designated for vacuum service on the drawings shall be designed for and subject to full vacuum. Calculations showing that the selected wall thickness is acceptable for the service conditions shall be prepared and submitted. Minimum schedule 10S required.

B. Fittings:

1. Butt Welding Type where noted or shown Rated 150 PSI minimum.

a. Stainless steel, ASTM A 403, Grade WP304L or WP316L, Class W with schedule and material to match connected piping unless noted otherwise. Tees shall have no welds in the throat area and the crotch shall be reinforced with long radius design to eliminate sharp corners.

b. Dimensions in accordance with MSS SP-43 and ANSI B16.9. Branch connections may include wrought tees or reducing tees, forged commercial welding branch fittings, extruded reducing branches, or weld-o-lets.

i. Forged commercial welding branch fittings with butt welded outlet shall be stainless steel, in conformance with ASTM A182, Grade F316L, with schedule and material to match connected piping. No repair welding shall be performed on forged fittings without prior approval of the Engineer.

ii. Branches may be formed by an extrusion method (pulled) from pipe, where the extruded branch connections are less than 75

percent of the nominal diameter of the pipe. For extruded branch connections greater than 75 percent of the nominal diameter of the pipe, provide external reinforcing saddle strap if pipe working pressure is greater than 50 psi.

iii. Weld-o-lets may be used for connections up to 1/2-inch maximum. Construction shall match the connected pipe size, schedule, and FNPT outlet.

2. Grooved End: Where noted or shown.

a. Machine grooves into pipe end (Schedule 40, minimum) in accordance with grooved fitting manufacturer's recommended dimensions, tolerances, and finishes.

b. Roll cutting of grooves into piping will be permitted on Minimum Schedule 40 pipe. The interior pipe wall shall be smooth and free of crevices, gouges, or other anomalies. Per AWWA C606.

c. When used with Schedule 10S pipe, the groove shall be cut or rolled into a Schedule 40 spool piece to be welded to the pipe. The Schedule 40 spool piece shall be taper bored at a 3:1 slope to provide a smooth transition of inside diameters.

C. Branch Connections:

1. Tees or reducing tees in conformance with requirements for "Fittings" above.

2. Extruded reducing branches in conformance with requirements for "Fittings" above.

D. Joints:

1. Shop Fabricated Assemblies:

a. Shop fabricated assemblies shall be butt welded.

b. All welding shall be performed in the shop in accordance with the latest editions of Section IX of the ASME Boiler and Pressure Vessel Code and ASME Code for Pressure Piping, ASME B31.3 (normal service), as applicable.

c. All welds shall have 100 percent penetration. The internal weld bead shall be small, smooth and continuous with no crevices, pits or other voids. The external weld bead shall be well rounded, smooth and continuous with no anomalies.

d. All welded connections shall be parallel and perpendicular to the extent that the piping appears to be correct to the naked eye.

e. Procedure:

i. Pipe edges shall be prepared by machine cutting or shaping using an aluminum oxide blade. Beveled ends shall conform to the requirements of ANSI B16.9.

ii. Clean weld joints and weld joint areas both before and after welding in accordance with ASTM A380 using stainless steel wire brushes or stainless steel wool.

iii. Alignment:

1. Align ends to be joined within commercial tolerances on diameter, wall thickness, and out-of-roundness.

2. When joining pipes of different wall schedule, taper bore the interior of the larger schedule pipe to match the interior diameter of the connecting pipe with a maximum 1:3 slope.

3. Root opening at the joint shall be as stated in the procedure specification.

iv. Welding:

1. The direct current, straight polarity, gas tungsten-arc (GTAW) process shall be used for all welding. Welding may be by manual GTAW or automatic (orbital) GTAW processes.

2. The inside of the pipe shall be purged with Argon gas during welding and while the weld is cooling to prevent oxidation of the weld.

3. Tack Welds:

a.) All tack welds shall be made by a qualified welder.

b.) All tack welds shall be made with welding rod the same as that used for the succeeding root pass.

c.) Tack welds shall be small enough to be readily fused into the bead of the root pass.

d.) Thoroughly clean tack welds with a stainless steel wire brush prior to the root pass to prevent pinholing or excessive porosity.

e.) Tack welds, which have cracked, shall be completely removed prior to making the root pass.

4. Surface defects, which will affect the soundness of the weld, shall be removed, visually inspected, and re-welded.

5. Where permitted, branch connections shall be fitted and groove-welded in accordance with the details described and shown in Chapter V of ASME B31.3.

2. For connections requiring field assembly:

a. Welded: Field welding of stainless steel piping connections will not be allowed.

b. Van Stone: Class 150 or Class 300 Van Stone type flanges with stainless steel stub ends, ASTM A240 Type 316L "as-welded grade", conforming to MSS SP 43, wall thickness same as pipe.

c. Threaded: For connections to weld-o-let outlet for instrument or sample taps only.

d. Union Fittings: Where noted or shown.

e. Flanged: For connections to flanged devices, or where otherwise noted or shown.

i. Type: Forged stainless steel, ASTM A182, Grade F316, lap joint flange with stainless steel stub end, ASTM A240, Type 316L, welded grade conforming to MSS-SP43; schedule to match pipe.

ii. Dimensions: To match connected piping, faced and drilled ANSI Class 150, 1/16-inch raised face, unless otherwise shown or required for connection to equipment.

f. Groove Fittings: Where noted or shown.

i. For liquid service:

a. Size: As noted or shown.

b. Style: Segmented and bolted.

a.) 2 pieces on sizes 12 inch and less

b.) 4 pieces on sizes 14 inch to 22 inch

c.) pieces on sizes 24 inch and larger

3. Materials:

a.) Housings for groove couplings shall be 316SS conforming to ASTM A 351, A 743 and A 744 Grade CF-8M with

b.) Gaskets: EPDM – Food Grade

c.) All bolting shall be Type 316 stainless steel with washers the same material as the bolts.

4. Manufacturer: Victaulic, Style 77; or equal.

5. For air service:

a.) Size: as noted or shown.

b.) Victaulic Style 232S Restrained flexible coupling with silicone gaskets suitable for use with air and rated to 300°F.

3. Gaskets:

a. Gaskets shall be as follows, unless noted otherwise. Gaskets shall be compatible with temperature, pressure, and service of the pipe.

b. Flanged Joints (unless noted otherwise):

i. Test Pressure > 200 psig: Manufactured with spiral wound 316L stainless steel with chlorocarb (non-asbestos) filler and 316 stainless steel inner ring and outer centering ring. The spiral wound component shall be wound from metal preformed in a chevron configuration. Gaskets shall be Spiraseal Style WR as manufactured by Lamons or equal.

ii. Test Pressure < 200 psig: Full faced, 1/8-inch thick, EPDM.

c. Grooved Joints: Food Grade EPDM, unless noted otherwise.

4. Bolting:

a. Flanged Joints: Type 316 stainless steel. ASTM A193, Grade B8M hex head bolts and washers; Grade B8M hex head nuts, or equivalent. Coordinate bolt length to meet flange and device requirements.

b. Grooved Joints: Type 316 stainless steel. Grade B-8M, Class 2; coupling manufacturer's standard size and shapes.

E. CLEANING, DESCALING, PICKLING AND PASSIVATING

1. All stainless steel piping, fabrications, fittings and assemblies shall be shop fabricated and shall be cleaned, descaled, pickled and passivated per ASTM A380-06, ASTMA967-05 and Ferroxyl Inspected per ASTM A967-05.

a. Pickling: Process shall be by immersion method. Spray methods shall not be allowed. Fabrication size shall be constructed and coordinated with the Pickle/Passivation process such that the fabrications can be completely immersed. Contact time shall be minimum of four hours.

b. Passivation: Rinsing must be done directly following pickling so solution does not dry. Rinsing shall use water with chloride content less than 25 mg/L. Contact with air to create passive film on the surface. Repeat pickling/passivation process if foreign material or scale has not been removed.

c. Inspection: Provide written certification that all parts have been cleaned, pickled and passivated per referenced standards. Provide Ferroxyl testing per referenced standards.

d. Shipping and Handling: Cap/seal all openings prior to shipment. Place items on clean wood surfaces and handle with non-ferrous metals for lifting and restraining during shipment. Materials shall be shipped in an enclosed trailer, and shall be stored indoors at all times.

2.9 COPPER PIPE (COMPRESSED AIR, HOT AND COLD WATER)

A. Type L or M hard drawn copper. Wrought copper fittings with 95/5 (no lead) solder. Couplings for copper pipe may also be restrained mechanical joint.

2.10 PIPE PENETRATION SEALS

A. All penetration seals shall be “Link Seal Type S”, as manufactured by Thunderline Link-Seal or approved equivalent.

1. Seal shall be watertight.

2. Seal element shall be EPDM synthetic rubber and have properties designated by ASTM D2000 M3 BA 510.

3. All nuts and bolts shall be stainless steel, Type 316.

4. Seal size shall accommodate inlet piping and sleeve opening

5. Backfill remaining annular space with non-shrink, waterproof grout.

B. Manhole adaptors as called out on the Plans shall be KOR-N-SEAL as manufactured by NPC, Inc. or approved equivalent.

1. Seal shall provide a flexible watertight seal of the pipe to the manhole or concrete structure. No adhesives or lubricants shall be employed in the installation of the connector into the manhole.

2. All hardware shall be stainless steel. Stainless steel elements of the connector shall be totally non-magnetic Series 304 Stainless, excluding the worm screw for tightening the steel band around the pipe which shall be Series 305 Stainless. The work screw for tightening the steel band shall be torqued by a break-away torque wrench and set for 60-70 inch/lbs.

3. The connector shall be of a size specifically designed for the pipe material and size being utilized on the project.

2.11 COUPLINGS

A. Straight and Transition Couplings: (Steel, PVC, and Ductile Iron) Romac Industries Style 501 with fusion bonded epoxy coating, or approved equivalent. Pipe straight coupling joints shall be mechanically restrained unless the requirements for soil/backfill friction length are provided on both sides of the joint. Provide external restraint harness, Romac Series 600, or approved equal to provide longitudinal restraint with vertical joint flexibility.

B. Reducing Coupling for steel to ductile iron connections: Romac Industries Style RC400 with fusion bonded epoxy coating, or approved equivalent.

C. Flange Coupling Adapter (FCA):

1. Type: Fully restrained FCA consisting of hardened steel wedges bearing on the outside pipe wall. Set screw type grips are not acceptable.

2. Rated Operating Pressure: 225 psi.

3. Rated Operating Temperature: 250 degrees F.

4. Nominal Pipe Sizes: Size as required to mate with adjoining pipe.

5. Quantities and Spacing: Install only where shown on the Drawings. Substitution of FCAs is not acceptable in lieu of fittings as specified in Section 15060 – Piping and Fittings, unless approved by submittal by the Owner or Owner's representative prior to installation.

6. Materials:

a. Body: Cast or ductile iron.

b. Flanged Ends: Flat faced, 125-pound per ASME B16.1.

c. Lining and Coating: Manufacturer's standard high build epoxy.

d. Gaskets: EPDM.

7. Manufacturer and Model: EBAA Iron Sales Company, Mega-Flange, or equal.

D. Field Flange: EBAA Iron, Inc. Series 1000 ductile iron flange adapter with fusion bonded epoxy coating, or approved equivalent.

E. Flanged Dismantling Joint:

1. Romac Industries DJ400 with fusion bonded epoxy coating, or approved equal.

F. Stainless Steel Pipe Couplings:

1. Unrestrained (for pipes with external restraint and anchoring): Straub Flex Coupling. 316 SS construction with EPDM elastomers meeting AWWA and NSF requirements. Pressure rating shall be 1.5 times working pressure.

2. Restrained (for pipes without external restraint or anchoring): Straub Metal Grip Coupling. 316 SS construction with EPDM elastomers meeting AWWA and NSF requirements. Pressure rating shall be 1.5 times working pressure.

2.12 STAINLESS STEEL FLEXIBLE CONNECTIONS

A. For connections between hard pipe and equipment

1. Type: braided metal hose

2. Material: Type 304 or 316 stainless steel.

3. Working Pressure: 150 psig.

4. Test Pressure, Minimum: 200 psig

5. Burst Pressure, Minimum: 300 psig

6. Basis of Design: Senior Flexonics, Series 100, or approved equivalent.

2.13 MECHANICAL JOINT RESTRAINTS

A. Wedge action joint restraint glands shall be rated at 350 psi with a 2:1 safety factor. Gland shall be fusion bonded epoxy coated, minimum dry film thickness 20 mils.

1. Ductile iron pipe:

a. DI Push-On Pipe: “Field-Lok” gaskets as manufactured by US Pipe and Foundry Co., or approved equal.

b. DI Mechanical Joints: EBAA Iron, Inc. Series 1100 Megalug or approved equivalent.

2. PVC pipe:

a. PVC Bell and Spigot Push-On Pipe: EBAA Iron, Inc. Series 1500, 1600, or 2800 Megalug or equivalent.

b. PVC Sewer Pipe Bell Joint Restraint (for interceptor in bore): Ford Series 1390-P Uni-flange Restraint Device

c. DI Mechanical Joints: EBAA Iron, Inc. Series 2000PV Megalug or approved equivalent.

3. Straight Coupling Joint Restraint:

a. Pipe straight coupling joints shall be mechanically restrained unless the requirements for soil/backfill friction length are provided on both sides of the joint. Provide external restraint harness, Romac Series 600, or approved equal to provide longitudinal restraint with vertical joint flexibility.

2.14 FLEXIBLE PIPE (EXPANSION) COUPLINGS

A. All Expansion joints shall be rated at 250 psi working pressure.

B. Unless specifically noted otherwise, provide zinc plated restraint rods (extension ears and nuts) for all expansion joints to restrain axial expansion and compression of the expansion joint. Provide 304 or 316SS hardware when mating to SS piping systems.

C. Type 1 - Proco Style 231 single arch, EPDM construction. Wastewater service. Provide external restraint rods/flanges to limit fitting expansion. Rods and hardware shall be galvanized for DI pipe system; SS for SS pipe systems. Couplings shall be installed within manufacturer's recommended piping misalignment limits.

D. Type 2 – Proco Style 440-BE molded PTFE expansion joints for chemical service PVC pipe system applications. Provide external restraint rods/flanges to limit fitting expansion. Rods and hardware shall be SS.

E. Type 3 – Red Valve Red Flex, EPDM construction. Shall be NSF-61 approved for Potable Water Service. Provide external restraint rods/flanges to limit fitting expansion. Rods and hardware shall be galvanized for DI pipe system; SS for SS pipe systems. Couplings shall be installed within manufacturers recommended piping misalignment limits.

F. Type 4 – For use with digester gas piping.

1. Metal expansion joints shall consist of a single metal bellows, three (3) tie rods and Vanstone flange end fittings. Flanges shall be 304 stainless steel and an ASNI 150-lb type. The bellows shall be of a 304 stainless steel.

2. Joints shall be designed to meet the design pressure of 14 inches water column and temperatures between -20°F and 135°F, and shall be capable of accommodating piping system and equipment movements as needed.

3. Joints are to be provided with stainless steel drop-in liners and carbon steel covers. Tie rods shall be included to prevent overextension of the expansion joints from pressure thrust loads. The number and size of the control rods shall be sufficient for the maximum system test pressure.

4. Expansion joints shall be Flexicraft Industries, Bellows Connector, or approved equivalent.

G. Type 5 – Proco Style 231/ET PTFE lined rubber expansion joint for use with ALP piping. Provide stainless steel external control rods and plates. Couplings shall be installed per manufacturer’s recommendations in order to minimize misalignment. Coupling shall have a minimum axial compression of 2.0 inches, a minimum axial extension of 1.0 inches, and a minimum lateral deflection of 1.0 inch.

H. Type 6 – Straight (non-reducing) Expansion Joints: Proco Style 240 Single Sphere Molded Expansion Joints with floating metallic flanges freely rotate on the bellows, compensating for mating flange misalignment. Gaskets are not required with the Style 240, provided the expansion joints are mated against a flat face flange as required in the installation instructions. Flanges shall have plated carbon steel flanges for corrosion protection. Provide 304 or 316 stainless steel flanges when mating to SS piping systems. Position elastomer bellows between full face piping flanges. Do not position against check or isolation valves.

A. Type 7 – Reducing Expansion Joints: Proco Style RE-231 eccentric rubber expansion joint is a single open wide arch type. Eccentric in design, the expansion joint body tapers on one side transitioning two different flange sizes. Position elastomer bellows between full face piping flanges. Do not position against check or isolation valves.

I. Type 8 – Straight (non-reducing) Expansion Joints: Proco Series 440 Molded Expansion Joints for chemical service. Provide inner and outer tube materials compatible with process fluid and associated environment. Submit information for materials selection for review by Engineer.

J. Type 9 – Elastomer bellows flexible connection. Rated Operating Pressure: 225 psi. Rated Operating Temperature: 250 degrees F. Nominal Pipe Sizes: Size as required to mate with adjoining pipe. Quantities and Spacing: As a minimum, install at each pump suction and discharge connection to rigid piping, and where shown otherwise on the Drawings. Materials: Body: EPDM-lined chlorobutyl elastomer. Flanged Ends: Drilled for cast iron 125-pound per ASME B16.1, or carbon steel 150-pound per ASME B16.5. Retaining Rings, Washers, Bolting Hardware: Type 316 stainless steel. Manufacturer and Model: Unisource Manufacturing, Series 1501, or equal.

2.15 AGGREGATE

A. Reference Section 02207 of these Specifications.

2.16 THRUST BLOCKS

A. Concrete for thrust blocks shall conform to Section 03300 of these Specifications.

2.17 HARDWARE

A. Unless otherwise shown or specified, all buried nuts, bolts, and washers shall be zinc plated for corrosion protection; exposed, embedded, or submerged nuts, bolts, and washers shall be 304 stainless steel. During assembly of interior piping, provide never-seize lubricant on all bolt threads. Mechanical joint T-bolts shall be lugged (Corten-style). All bolts shall be manufactured in accordance with ANSI/AWWA C111/A21.11.

2.18 VALVE BOXES

A. Adjustable cast iron valve boxes and lid, as shown on the plans.

B. Provide PVC plastic valve lid insert (beneath the lid) to retain gravel and debris from entering the valve box.

2.19 QUICK CONNECT COUPLINGS

A. Type 1: Twin cam arm actuated, male and female, locking, for chemical loading and transfer.

1. Materials: Glass-filled polypropylene or PVDF with EPDM, Viton-A or Teflon gaskets as recommended for the chemical service by the manufacturer.

2. End Connections: NPT threaded or flanged to match piping connections. Hose shank for chemical installations.

3. Plugs and Caps: Female dust cap for each male end; male dust plug for each female end.

4. Pressure Rating: 125 psi minimum at 70° F

5. Manufacturers and Products

    a. OPW Kamlok

    b. Ryan Herco

B. Type 2: Cam arms lock into adaptor groove for sewage service.

1. Materials: Stainless steel with Buna N gaskets as recommended for the service by the manufacturer.

2. End Connections: NPT threaded or flanged to match piping connections. Hose shank quick connect coupler.

3. Plugs and Caps: Female dust cap for each male end; male dust plug for each female end.

4. Pressure Rating: 75 psi minimum at 70° F

5. Manufacturers and Products:

    a. OPW Kamlok

    b. Dover Corporation

    c. Or equal

2.20 PIPE SADDLES

A. Ford Style FC202 with double strap stainless steel band and fusion epoxy coated body or approved equivalent.

2.21 PIPE SUPPORTS

A. General: Pipe supports shall be properly sized and located to accommodate design loads including seismic, thrust, wind, thermal expansion, lateral and longitudinal sway bracing.

B. Offset Pipe Clamps:

1. Materials: Type 316 stainless steel clamps and fasteners.

2. Nominal Pipe Sizes: Supports 1/2-inch to 12-inch.

3. Mounting Surface: Concrete wall or floor slab.

4. Quantities and Spacing: As a minimum, install where required per design load and manufacturer's specifications, and where shown otherwise on the Drawings.

5. Manufacturer and Model: Eaton B-Line Series, Figure B3148, or equal.

C. Flanged Pipe Support:

1. Materials: Type 316L stainless steel including flange mount, pipe stand, base, and bolting hardware.

2. Nominal Pipe Sizes: Supports 4 to 36 inches.

3. Mounting Surface: Concrete floor slab. Level base plate by backfilling void space with non-shrink waterproof grout, minimum 1-1/2 inches and maximum 2 inches thick, edges finished at 45-degree angle around perimeter of base plate.

4. Flanged Bolt Pattern: Drilled for cast iron 125-pound per ASME B16.1.

5. Quantities and Spacing:

   a. Minimum of one support per valve located on horizontal pipe runs.

   b. Additional supports as required per design load and manufacturer's specifications.

   c. Where shown otherwise on the Drawings.

6. Manufacturer and Model: Eaton B-Line Series, Figures B3088T, B3089, and B3094, or equal.

2.22 LOCATING WIRE AND MARKING TAPE

A. Locating Wire:

1. Locating wire used in open trench construction shall be #12 AWG high strength copper clad steel with minimum 450 lb. break load. Wire shall be insulated with high density polyethylene (HDPE) insulation intended for direct bury. Minimum thickness shall be 30 mil. Insulation shall be color coded per APWA standards for the specific utility being marked.

2. Wire connectors shall be specifically manufactured for use in underground locate wire installation. Connectors shall be dielectric silicon filled to seal out moisture and corrosion, and shall be installed in a manner so as to prevent any uninsulated wire exposure. Non-locking friction fit, twist on, or taped connectors are prohibited.

3. Contractor shall demonstrate correct installation to the engineer by performing a locate/conductivity test.

B. Marking Tape:

1. Material: 75 mm (3 inch), 4 mil polyethylene. Provide green tape for non-potable water lines and blue tape for potable water lines.

2. Labeling: Label marking tape with the designated pipe use listed in the pipe schedule in 1-1/2 inch minimum black lettering.

3. See Section 09900-3.8 for information to label exposed piping.

2.23 PIPE INSULATION

A. Match existing insulation where connecting to existing systems.

B. Protection Against Freezing: All exposed exterior piping shall be provided with electric heat tape and covered with 2" thickness pre-molded glass fiber covering with all-service jacket. Cover pipe insulation with aluminum jacket, lapped 2" at sides and ends, secured with waterproof seal coating at all laps and aluminum circumferential bands.

C. Glass Fiber Pipe Insulation: Glass fiber meeting ASTM C547, rigid molded. "K" value 0.23 at 75 °F. Maximum service temperature, 850 °F. Jacket shall be high density, white Kraft bonded to aluminum foil for vapor barrier, reinforced with fiberglass yarn, permanently treated, secured with self-sealing longitudinal laps and butt strips or AP jacket with outward clinch expanding staples coated with vapor barrier mastic.

1. Manufacturer: Johns Manville "Micro-Lok AP-T Plus," Owens-Corning ASJ/SSLII or Knauf Fiber Glass "Pipe Insulation", or equal.

D. Field Applied Jackets:

1. Canvas Jacket: UL listed fabric, 6 oz./sq.yd. plain weave cotton treated with dilute fire-retardant lagging adhesive.

2. PVC Plastic: One-piece molded type fitting covers and jacketing material, gloss white. Connections, tacks, pressure sensitive color matching vinyl tape.

    a. Manufacturer: Zeston 2000 or Knauf Fiber Glass "Proto Fitting Covers", or equal.

3. Jacketing of Pipes Exposed to Weather: Piping shall be finished with an aluminum jacket over the insulation. Aluminum jacket material shall be embossed or corrugated sheet, 0.016" nominal thickness, conforming to ASTM B209, temper H-14. Jacketing shall be applied with joints lapped not less than 2", and shall be secured with 3/8" x 0.020" thick aluminum bands located at each circumferential lap and not at not more than 9" intervals throughout. Horizontal joints shall lap downward to shed water. Vertical joints shall be sealed with weatherproof silicone sealant.

    a. Manufacturer: Childers or Pabco manufacturer, or equal.

4. Interior Insulated Pipe Jacketing: Pre-impregnated canvas, wetted and smoothed in place.

    a. Manufacturer: Great Lakes Textiles Product Style 1979, or equal.

5. Jacketing of Underground Cellular Glass Pipe: Jacketing shall be precut to fit the contour of the surface to which it is to be applied. Precut sections shall allow for 2-inch overlap. All laps shall be sealed with a glove coat of manufacturer's seal coat.

a. Manufacturer: Pittsburgh Corning “PITTWRAP” with “PITTCOATE 300” or equal.

6. Butt Straps: Materials shall be identical in all respects and appearance to the basic jacket material.

2.24 DIELECTRIC UNIONS AND INSULATING FLANGES

A. Dielectric unions or insulating flanges shall be used to separate all dissimilar metal pipe connections and wherever buried ferrous metal pipe transitions to above grade.

2.25 LUBRICANTS

A. Pipe lubricants shall be supplied by the approved pipe supplier. No substitutes for lubricants from other manufacturers are acceptable.

B. Equipment lubricants shall be supplied by the approved equipment supplier. Refer to Section 11000 – General Requirements for Equipment.

2.26 WAX TAPE

A. All buried metal fittings, joints and bolts shall be wrapped in wax tape in accordance with GHID standards.

PART 3 EXECUTION

3.1 GENERAL

A. Pipe shall be installed in accordance with good trade practice and in strict accordance with the manufacturer's instructions. The methods employed in handling and placing of pipe, fittings and equipment shall be such as to ensure that after installation and testing they are in good condition.

B. Furnish and install all piping and fittings in strict accordance with the Granger-Hunger Improvement District Standard Specifications and Drawings. Where discrepancies are found with the drawings and specifications consult the project Engineer for direction on how to proceed.

3.2 EXAMINATIONS

A. Verify excavation under provisions of Section 02222.

B. Verify that excavation will allow a minimum pipe cover as shown on the Plans and described elsewhere in the Specifications. If existing pipelines are less than minimum cover, connect to existing pipeline and angle pipe, as necessary, to achieve cover requirements.

C. Verify that excavations are to required alignment, grades, dry, and not over-excavated.

D. Examine pipe and fittings for defects or damage.

E. Verify all pipe, fittings, aggregate, and all materials delivered to the site meet the requirements of these Technical Specifications.

F. Examine existing piping locations and structures where connections are to be made.

G. Verify equipment locations and make modifications in piping to properly connect to equipment as necessary, prior to fabrication.

3.3 EXTERIOR PIPE INSTALLATION

A. Remove all water from excavation.

B. Install pipe in accordance with the manufacturer's recommendations.

C. Utilize proper tools for cutting and beveling pipe ends and joining pipe using manufacturer's recommended tools designed for this task.

D. Clean and prepare pipe joint using manufacturer's recommended gasket and lubricant.

E. Utilize proper tools to complete joint, assuring that plain end is inserted "home" in the bell.

F. Assure that no dirt or other foreign material is allowed in pipeline. Plug all pipe ends with water tight plugs when leaving the pipe unattended.

G. Complete trenching and backfilling for utilities in accordance with Section 02225.

H. Install pipe fittings so a constant alignment and level grade is achieved through all the pipe and fittings.

I. Install pipelines to the alignments and grades shown on the Drawings.

J. Restraining Buried Pipe

1. Provide restrained joints unless shown or otherwise specified to prevent movement of piping caused by forces in or on buried piping tees, wye branches, plugs, bends, valves, and plugs as shown and/or specified. All fittings shall be restrained by mechanical joint restraint.

2. Thrust blocks shall be provided in addition to mechanical joint restraint, where shown on the plans.

3. Place thrust blocking only when shown or specified so that it extends from fitting into solid undisturbed earth wall.

4. Restrain pipe joints within minimum distance from restrained fitting joints as shown below. Pipe joints shall be mechanically restrained unless the requirements for soil/backfill friction length are provided.

5. Pipe straight coupling joints shall be mechanically restrained unless the requirements for soil/backfill friction length are provided on both sides of the joint. Provide external restraint harness, Romac Series 600, or approved equal to provide longitudinal restraint with vertical joint flexibility.

Pipe Size (inches)	Length of Restrained Pipe (feet) on Each Side of Bend or Valve		
	Fitting Angle		Valve or Dead End
	0° to 45°	46° to 90°	
6	4	11	19
8	6	14	25
10	7	16	30
12	8	19	35
16	10	25	46
18	11	27	51
20	12	30	56
24	14	35	65

a. Listed lengths are based on a test pressure of 100 psi. To compute the length for a different test pressure, use the following equation:

$$Length = \left(\frac{Test\ \mathrm{Pr}essure}{100}\right)(Table\ Value)$$

b. Listed lengths assume a well graded with little to no fines. If conditions are different, verify restraining lengths with supplier.

c. Listed lengths are based on 4-foot of bury. For bury depths less than four feet, Contractor shall submit calculations for length of restrained pipe required for Engineer's review and approval.

d. Install insulating components where dissimilar metals are joined together.

K. Properly align pipe perforated slots in trench.

L. Enter and exit through structure walls, floors, and ceilings by using penetrations and seals as shown on the Drawings.

M. Pipes passing beneath or through structure footing/foundations shall have a flexible pipe coupling with longitudinal restraint at each location where a pipe leaves or passes out from beneath a structure to accommodate potential differential settlement between the structure and pipe, typical. Reference project standard details.

3.4 NATURAL GAS PIPING INSTALLATION

A. Install dirt legs at lowest end of run where pipe changes elevation and in accordance with local gas codes.

3.5 PLUMBING INSTALLATION: WATER AND DRAIN PIPING

A. Install horizontal runs at a minimum slope of 1/8-inch per foot, unless noted otherwise, and in accordance with local plumbing codes.

3.6 INTERIOR PIPING INSTALLATION

A. All pipe shall be secured in place by use of blocking, hangers, brackets, clamps or other approved methods, and the weight thereof shall be carried independently of equipment. Special hangers and supports shall be as shown on Standard Details or as on the Drawings. Install anchors and supports as necessary to properly support pipe against all static, dynamic, and vibratory loads. Contractor shall submit shop drawings and calculations for proposed pipe support system.

B. Design generally accepted as exemplifying good engineering practice, using stock or production parts, shall be utilized wherever possible.

C. Provide floor stands, wall bracing, concrete piers, etc., for all lines running near the floors or near walls and which can be properly supported or suspended by the walls or floors. Pipelines near concrete or masonry walls may also be hung by hangers carried from wall brackets at a higher level than pipe. Hanging of any pipe from another is prohibited.

D. Equipment shall be so positioned and aligned that no strain shall be induced within the equipment during or subsequent to the installation of pipe work.

E. In erecting the pipe, a sufficient number of screwed unions or flanged joints shall be used to allow any sections or run of pipe to be disconnected without taking down adjacent runs.

F. Flexible couplings shall be installed where shown on the Drawings and at such other points as may be required for ease of installation or removal of the pipe, subject to approval of the Engineer. Flexible couplings shall be of the positive lock type (or with restraint rods) where necessary to prevent separation of pipe due to internal pressures.

G. Installation at Concrete Walls and Fittings:

1. Whenever a pipeline of any material terminates at, or extends through, a structural wall or sump, the Contractor shall install, in advance of pouring of concrete, the fittings or special casting required for the particular installation.

2. Ductile iron or steel pipe to be cast in water bearing walls, or more than two feet below grade, shall have seep rings.

H. Install pipe connectors in strict accordance with the recommendation of the connector manufacturer.

I. Compressed Air (Instrument Air) Piping Installation:

1. Routing of instrument air piping is the responsibility of the Contractor in conformance with Contract Documents.

2. Provide isolation ball valves at all branch lines, and at each instrument.

3. Provide fittings, pipe hangars, brackets, clamps, dielectric unions, etc. as necessary to route piping to point of use.

4. Contractor is required to cross-reference the locations of instruments requiring instrument air-piping.

5. Contractor is required to provide adequately sized piping/tubing as required to operate the instruments on each branch line. ½" diameter minimum for a line serving a single instrument; 1" dia. minimum or larger for any line serving two or more instruments.

6. Contractor shall route tubing such that access to valves, process piping, equipment and electrical components is not limited, or obstructed.

7. Air-flush all lines prior to connection to instruments.

8. Provide copper pipe materials per this Section.

3.7 INSULATION INSTALLATION, PIPING

A. General: Pipe insulation shall be continuous and installed on all fittings and appurtenances unless specified otherwise. Installation shall be with full-length units of insulation and using a single-cut piece to complete a run. Provide jackets for all pipe insulation.

1. Locate insulation and cover seams in least visible locations.

2. Do not apply insulation to connections, joints, welds, flanges, or screwed joints until pipe tests are completed.

3. Do not apply insulation over flanged joints until piping has been brought up to operating temperature and flange bolts have been fully tightened.

4. Neatly finish insulation at supports, protrusions, and interruptions.

5. Provide insulated dual temperature with vapor retardant jackets with self-sealing laps. Insulate complete system.

B. Joints: Joints shall have adjacent sections tightly butted with jackets drawn tight and smoothly cemented down on all longitudinal and end laps. Jacket longitudinal laps shall overlap by at least 1-1/2". Butt joints shall be sealed with pressure-sensitive vapor barrier tape.

1. Jacket laps, butt strips, and exposed ends of insulation shall be cement sealed using either adhesive or factory-applied, self-sealing system. Jacket laps shall be smooth and without fishmouths.

C. Laps: Self-sealing laps (1-1/2" minimum) and butt strips (3" minimum width) shall be used for sealing insulation joints. Staple with outward clinching staples on 4" centers on side laps and 4" on centers to both butted jackets for butt strips. If any open gaps occur, add staples and lagging adhesive or replace jacket totally.

1. For cold applications, provide lagging adhesive on all staples.

D. Flexible Elastomeric Closed-Cell Insulation: Insulation shall be tubular form. Sweat fittings shall be insulated with miter-cut pieces the same size as on adjacent piping. Screwed fitting covers fabricated from miter-cut pieces and shall be overlapped and sealed to the adjacent pipe insulation using Armstrong No. 520 adhesive.

E. Insulation Support at Hangers:

1. Provide support shield and 360 degrees between support shield and piping on piping 1-1/2" diameter and larger. Fabricate hydrous calcium silicate or other heavy density insulating material suitable for the temperature. Shield shall be fabricated of 14 gauge galvanized sheet metal. Insulation shields and inserts shall be not less than the following lengths.

1-1/2" to 2-1/2" pipe size	10" long
3" to 6" pipe size	12" long
8" to 10" pipe size	16" long
12" and larger	22" long

2. Vapor-barrier facing of the insert shall be of the same material as the facing on the adjacent insulation. Seal inserts into the insulation with lagging adhesive for vapor seal. Where anchors are secured to insulated chilled piping, insulate anchors same as piping for a distance not less than four times insulation thickness to prevent condensation. Vapor seal insulation.

F. Sleeves and Wall Chases: Insulation on pipes through walls and floors shall be full size and jacketed same as adjacent insulation. Provide a metal jacket over the insulation on pipe passing through sleeves in non-fire rated walls where caulking is required.

1. Where penetrating interior walls, extend the metal jacket 2 inches out on either side of the wall and secure on each end with a band.

2. Provide adequate support on vertical pipe to prevent slipping.

G. Interior Insulated Piping and Fittings within 10 Feet of any Floor: Surface shall be protected by smooth sheet aluminum jacket material, 0.016" nominal thickness, lapped, banded, and installed same as above.

3.8 THRUST BLOCKS

A. Place thrust blocks at each elbow, tee, cross, and gate valve installed underground when shown or specified.

B. Provide bearing area against undisturbed earth.

C. Place thrust blocks such that fitting can be removed at a later date without damage to the pipeline.

D. Place 6 mil Visqueen plastic between thrust block and fitting.

E. Place concrete so no concrete touches the nuts and bolts of the fitting or valve, and the nuts and bolts can be removed and replaced without removing any concrete.

F. Thrust Block: Sizes are shown on the Plans.

3.9 CLEANING AND FLUSHING

A. Remove all construction debris from piping prior to pressure testing. Flush all piping at a minimum velocity of 2.5 fps following pressure testing and dispose of water per local, state, and federal requirements.

3.10 PRESSURE TESTING

A. Refer to piping schedule for pipelines which will be pressure tested, the testing pressure, and testing method.

B. Pressure taps for test plugs shall be ½-inch FNPT unless otherwise specified.

C. Assure that trench is properly backfilled and thrust blocking has cured to a degree that will allow pressure testing without damage, or pipe/fitting movement.

D. Test Type: G (Gravity)

1. Per International Plumbing Code if indicated on the Pipe Schedule.

2. For pipes that are 24 inches and smaller in diameter (and groundwater is not above the pipe invert) – Per ISPWC Section 501 – Gravity Sewers, Paragraph 3.4.C “Air Pressure Testing”

3. For pipes that are larger than 24 inches in diameter, or pipes 24 inches and smaller with groundwater conditions above pipe invert – Per ISPWC Section 501 – Gravity Sewers, Paragraph 3.4.D “Hydrostatic Exfiltration Testing.”

E. Test Type: H (Hydrostatic)

1. Fill pipe with water to the pressure shown on piping schedule. Expel all air.

2. Verify that, in a two-hour (2) test, the pipe does not leak in excess of the allowable leakage, as defined by the following formula in which Q is the allowable leakage in gallons per hour.

$$Q = \frac{LD\sqrt{P}}{148{,}000}$$

Where:

Q = allowable leakage (gallons per hour)

L = length of pipe section being tested (feet)

D = nominal pipe diameter (inches)

P = average test pressure during the hydrostatic test (psi)

3. Pressure test HDPE pipe per ASTM F2164-02 “Field Leak Testing of Polyethylene (PE) Pressure Piping Systems using Hydrostatic Pressure”.

F. Test Type P (Pneumatic)

1. Per ISPWC Section 501 – Gravity Sewers, Paragraph 3.4.C with pressure as indicated on the Pipe Schedule

G. Certify test results meet these specifications for Section 01300.

3.11 DEFLECTION TESTING

A. Deflection test all flexible pipelines no sooner than 30 days after trench backfill and compaction is completed. Unless otherwise provided in the Contract, Contractor to bear costs associated with completing surface repair or other work prior to all required testing. The maximum allowable deflection is to be 5.0% of the nominal pipe diameter.

B. Provide test mandrels with a diameter at least 95% of the actual inside diameter (ID) of the pipe. For pipes with controlled outside diameter, calculate the actual ID of the pipe by taking the average outside diameter (OD) as set by the ASTM standard and subtracting two (2) times the minimum wall thickness as set by the ASTM standard. For pipes with controlled inside diameter, use the ID set by the ASTM standard.

C. Pull the appropriate mandrel through the pipe using one of the following methods:

1. Pull the mandrel through the pipe by hand. If the pipe will not allow the mandrel to pass, repeat the test from the opposite direction to determine the limits of failure.

2. As a part of the CCTV inspection, where required, pull the mandrel through the pipe by connecting it in front of the CCTV camera lens at a distance equal to the camera’s focal length. Notify Engineer of time and date of test at least 24 hours prior to testing to allow for Engineer, at Engineer’s discretion, to witness test. Provide tag line to reverse mandrel and camera should mandrel fail to pass through line. Perform test as a separate step from the CCTV inspection, where required, thus a separate VHS tape record must be made of the mandrel test. Clearly mark tape identifying project name, mandrel test, and the pipe will not allow the mandrel to pass, repeat the test from the opposite direction to determine the limits of failure.

D. Uncover and, if required by the Engineer, remove and reinstall new pipe sections for reaches with excessive deflection or recompact bedding if, in the opinion of the Engineer, existing pipe is not damaged. Retest pipe after any repair work is completed. Do not reinstall damaged pipe.

E. Use a “Go-Nogo” pin gauge instead of a mandrel if “Insta-Tap” tee fittings are used for service connections. Use test diameter per paragraph 3.8.B.

F. The Owner may conduct additional deflection testing prior to expiration of the warranty

period. Uncover and reinstall sections of the pipe found to have excessive deflection. Do not reinstall damaged pipe.

3.12 LOCATING WIRE AND MARKING TAPE

A. Place locating wire and marking tape at the locations shown on the plans for the entire length of a pipeline. Repair all cuts and splices in accordance with the manufacturer's recommendations. Assure continuity of all locating wire before submitting final payment. Payment will not be made for pipe where the locating wire does not have electrical continuity.

3.13 DISINFECTION OF POTABLE WATER LINES

A. Provide disinfection of potable water main in accordance with Section 02675.

3.14 CONNECTIONS TO EXISTING MAINS

A. Expose existing main and verify line size and type of pipe.

B. Provide the necessary fittings that comply with these Specifications and connect to the existing main. Properly align pipe to interface with existing pipeline so no unusual stresses are applied to the pipe.

C. Maximum allowable pipe gap at compression couples is one-half (1/2) inch maximum.

3.15 PIPE SCHEDULE

A. The Pipe Schedule is included in the Plans.

3.16 TOLERANCES FOR SEWER INTERCEPTOR INSTALLATION

A. The sewer interceptor pipe slope shall conform to the slope set forth in the plans. For each pipe segment, the minimum slope shall be 0.046% and the maximum slope shall be 0.10%. Reverse slope on gravity pipe is prohibited. Manhole flow channels that pond water are unacceptable. Line segments and manholes not meeting these tolerances shall be rejected and replaced at the Contractor’s expense.

B. The horizontal alignment of the pipeline shall conform to +/- 1-foot from true alignment shown on the plans. The pipeline shall also maintain the separation distance requirement from potable water lines shown on the Contract Documents. Line segments not meeting these tolerances and/or requirements shall be rejected and replaced at the Contractor’s expense.

C. The Contractor shall conduct quality control surveys, at each manhole and as needed throughout sewer interceptor installation, to ensure that project requirements and tolerances are satisfied. Engineer shall survey each manhole to determine if tolerances were satisfied within one working day of installation (assuming Monday through Friday construction) for quality assurance purposes only. Contractor shall provide a minimum 48-hour advance written notice to the Engineer for survey request.

END OF SECTION

SECTION 15100
HYDRAULIC VALVES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Furnishing and installing valves as shown and specified. In addition, valve-operating units, stem extensions and other accessories shall be furnished and installed by the Contractor where shown, or where required in the opinion of the Engineer, to provide for convenience in operation. Where buried valves are indicated, the Contractor shall furnish and install valve boxes to grade per the Standard Details – see Drawings. All valves shall be new and of current manufacture.

B. Not all valves and operators listed in this section are used in this project.

1.2 RELATED SECTIONS

A. Section 09900 – High Performance Coatings

B. Section 11000 - General Requirements for Equipment

C. Section 15060 - Pipe and Fittings

D. Division 16 - Electrical

1.3 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Shop drawings of all valves and operators, including wiring diagrams and electrical data, shall be furnished as specified in Section 01300.

C. Submit manufacturer's installation instructions and maintain copy at job site.

D. Project Record Drawings: Record actual locations of valves, operators, and accessories.

E. Service: Valve shall be suitable for the specific service conditions, (e.g., raw sewage, sludge, specific chemical, potable water, and etc.). Submit product information verifying valve is compatible with intended service conditions.

1.4 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 01730.

B. Maintenance Data: Include installation and maintenance instructions, recommended spare parts lists, and exploded view of valves, gates, operators, and accessories.

1.5 QUALITY ASSURANCE

A. Manufacturer's name and pressure rating marked on valve body.

B. Perform work in accordance with manufacturer's recommendation.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products at job site under provisions of Section 01600.

B. Accept valves, operators, and accessories in shipping containers with labeling in place in accordance with AWWA C-501. Inspect for damages.

C. Seal valve ends and gate ends to prevent entry of foreign materials.

1.7 TAGS AND IDENTIFICATION

A. Permanent tags shall be provided for every valve, instrument and gate. See Section 11000.

1.8 DEFINITIONS

A. Abbreviations used in Detailed Valve Specification Sheets:

ARV-Air Release Valve
BV- Ball Valve
BFV - Butterfly Valve
CV- Check Valve
CS- Corporation Stops
CB - Circuit Balancing Valve
DPV – Diaphragm Valve
FLV-Flap Valve
GL- Globe Valve
GV- Gate Valve
KGV-Knife Gate Valve
MV - Mud Valve
NV - Needle Valve
PRV-Pressure Regulating Valve
PIV-Pinch Valve
PV - Plug Valve
SGV – Shear Gate Valve
SV – Solenoid Valve

1.9 PROCESS FLUIDS COMMODITY LIST

A. Reference 15060 and Piping Schedule

PART 2 PRODUCTS

2.1 GENERAL

A. Unless otherwise specified, each valve body shall be tested under a test pressure equal to twice its design water-working pressure.

B. Unless otherwise specified, all interior bronze parts of valves except gate valve stems shall conform to the requirements of the "Specification for Composition Bronze or Ounce Metal Castings," (ASTM B62). Gate valve stems shall be of bronze containing not more than 5% of zinc nor more than 2% of aluminum, and shall have a minimum tensile strength of 60,000 psi, a yield strength of 40,000 psi, and an elongation of at least 10% in 2 inches, as determined by a test coupon poured from the same ladle from which the valve stems to be furnished are poured.

C. The flanges of valves may be raised or plain faced. Flanges of valves for water-working pressures of 175 psi or less shall be faced and drilled to 125-lb American Standard template. Flanges of valves for water-working pressures greater than 175 psi shall be faced and drilled to 250-lb American Standard template.

D. Valve Operators:

1. Unless otherwise shown or specified, manual handwheel operators, with position indicators, shall be provided for valves 6 inches and larger. Lever operators may be supplied on quarter-turn-type valves smaller than 6 inches; however, operator force shall not exceed 40 pounds under any operating condition, including initial breakaway.
2. Operators of the worm-and-gear-type shall have self-locking worm gears. The operators on quarter-turn-type valves shall be of the self-locking-type to prevent the plug or disc from creeping, and shall be provided with position indicators to show the position of the plug or disc. Lever-type operators on exposed valves shall have some means of being fixed in any position to prevent movement.
3. Buried operators on valves larger than 2 inches shall have a 2-inch AWWA operating nut. Buried operators on valves 2-inch and smaller shall have a T-handle for operation by forked key, unless otherwise shown or specified.
4. All buried valves shall be installed with valve boxes. When the valve centerline is more than 4 feet below the finished grade, extension stems are required.

E. All moving parts of buried valves and operators shall be enclosed in the housing to prevent contact with the soil.

F. Unless otherwise shown or specified, all exposed nuts, bolts, washers, and springs shall be stainless steel.

G. Where designated, certain valves shall be furnished with electric operators provided by the valve manufacturer. All operators of a given type shall be furnished by the same

manufacturer. Where these operators are supplied by different valve manufacturers, the Contractor shall coordinate their operator selections to provide uniformity of each type of electric operator.

H. Unless specifically required to be equipped with other types of operators, all valves with centerline more than 6 feet above the operating floor shall be equipped with chain wheels and operating chains. Each chain-wheel-operated valve shall be equipped with a chain guide that will permit rapid handling of the operating chain without “gagging” of the wheel. Lever operated valves shall be provided with operating chains.

I. Valves and operators in particular locations may require a combination of units, sensors, limit switches, and controls specified in other divisions of these Specifications. It shall be the responsibility of the Contractor to properly assemble and install these various items so that all systems are compatible and operating properly. The relationship between interrelated items shall be clearly noted on shop drawing submittals.

J. Strainer shall be provided ahead of any electric solenoid control valves and regulators.

K. Valve Boxes: Valve boxes, except those noted as special design required on the Drawings, shall be of cast iron of the two-piece extension-type with cast iron cover. The extension shall provide for the maximum depth of cover over the pipe in which the valves are to be used. Valve boxes shall have walls not less than 3/16-inch thick at any point, and the internal diameter shall be not less than 5 inches. Valve box covers shall have the word "SEWER" or "WATER" cast into them as appropriate to their place of use. All valves underground shall be installed with valve boxes.

L. Miscellaneous Valves: Where indicated on the Drawings, but not specifically identified, Contractor shall furnish and install miscellaneous valves per this specification. Valves shall be high quality and suitable for the indicated service, and approved by the Engineer.

2.2 VALVE DATA PRODUCT INFORMATION SHEETS

A. Individual data sheets for each valve type are included following this section.

PART 3 EXECUTION

3.1 INSTALLATION

A. All valves shall be installed in accordance with good trade practices and the manufacturer's instructions and recommendations.

B. Unless otherwise indicated on the Drawings, all valves installed in horizontal pipe runs having a centerline elevation 4'-6" or less above the finished floor shall be installed with their operating stem vertical. If adjacent piping prohibits this, the valves shall have their operating stems orientated to facilitate the most practical operation. Valves installed in horizontal pipe runs having a centerline elevation greater than 4'-6" above the finished

floor shall be installed with their operating stems horizontal. If adjacent piping prohibits this, the stems shall be installed above the valve horizontal centerline as close to horizontal as possible. Valves installed in vertical runs of pipe shall have their operating stems orientated to facilitate the most practicable operation.

C. Provide all necessary fittings to install valve at the location shown in the Plans.

D. All plug valves installed in sludge lines shall be installed with the seat on the upstream side.

3.2 PAINTING

A. All valves unless otherwise specified, shall be painted in accordance with Section 09900.

i. The exterior surfaces of all interior and submerged valves shall be epoxy coated with 3 to 5 MDFT of epoxy-polyamide primer in preparation for coating, as specified in Section 09900.

B. All buried valves shall be coated with the manufacturer's fusion bonded epoxy, suitable for buried service.

3.3 TESTING

A. All equipment shall be tested in accordance with Section 11000, Part 1.4 and Section 15060 as part of a completed system.

B. Valves shall be tested at the same time that the adjacent pipeline is tested. Joints shall show no visible leakage under test.

Table of Contents – Valve Types

Air Release Valve

TYPE OF VALVE		**SYMBOL**	
Air Release Valve		***ARV-1***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**ITEM**	**ITEM**	**ITEM**
Shell	Cast Iron ASTM A536	**Type of Service**	Water (Note 2)
Body/Base	Reinforced Nylon (A.R.I.) Cast Iron (GA)	**Reference Document**	AWWA C512
Discharge	Brass ASTM B-124	**Size Range**	½" to 1"
Seals	EPDM	**Body/Valve Ends**	NPT
Float	Foamed Polypropylene	**Pressure Rating (psi)**	10 to 150 (GA) 3.0 to 250 (A.R.I.)
O-Ring	Buna-N	**Temperature Rating (deg C)**	60 C
Bolts/Screws	Stainless Steel	**Testing**	
Strainer	Nylon	**Operator**	NA
NOTES			
1. For Potable Water Applications, Valve shall be NSF 61 certified– Lead free.			
2. Suitable for venting small amounts of air under normal service conditions.			
3. Provide all necessary fittings and isolation to install the valve at the location shown in the plans.			
ACCEPTABLE PRODUCTS			
A.R.I. S-050-C	GA Industries Figure 905		

Air Release Valve

TYPE OF VALVE		**SYMBOL**	
Combination Air Vacuum / Release Valve		***ARV-2***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS (Note 1)**	**Type of Service**	Water (Note 2)
Shell	Stainless Steel	**Reference Document**	AWWA C512
Body/Base	Stainless Steel	**Size Range**	1/2" to 2"
Discharge	Polypropylene	**Body/Valve Ends**	NPT
Seals	EPDM	**Pressure Rating (psi)**	3 to 250
Float	Foamed Polypropylene	**Temperature Rating (deg C)**	
O-Ring	Buna-N	**Testing**	
Bolts/Screws	Stainless Steel	**Operator**	NA
Strainer	None	**Actuator**	NA

NOTES

1. For Potable Water Applications, Valve shall be NSF 61 certified– Lead free.
2. Suitable for venting air and protection from vacuum under normal service conditions.
3. Provide all necessary fittings and isolation to install the valve at the location shown in the plans.
4. Install the combination air release/vacuum valve on the discharge piping as shown in the plans to rid the piping of entrapped air during normal operating conditions and allow air to exit/enter the piping during filling/emptying conditions.

ACCEPTABLE PRODUCTS

A.R.I. D-040-ST-ST		

Air Release Valve

TYPE OF VALVE		SYMBOL	
Combination Air Vacuum / Release Valve		***ARV-3***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS**	**Type of Service**	Sewage (Note 1)
Shell	No Shell	**Reference Document**	AWWA C512-15
Body/Base	316 SS	**Size Range**	2" to 4" (Note 3) 2" to 8" (Note 4)
Discharge	Polypropylene	**Body/Valve Ends**	NPT or FL per plans
Seals	EPDM	**Pressure Rating (psi)**	1.0 to 150 (Note 3) 3.0 to 250 (Note 4)
Float	Foamed Polypropylene	**Temperature Rating (deg C)**	60 C
O-Ring	Buna-N	**Testing**	
Bolts/Screws/Springs	Stainless Steel SAE 316	**Operator**	NA
Strainer	None	**Actuator**	NA
NOTES			
1. Install the combination air release/vacuum valve on the discharge piping as shown in the plans to rid the piping of entrapped air during normal operating conditions and allow air to exit/enter the piping during filling/emptying conditions.			
2. Provide all necessary fittings and isolation to install the valve at the location shown in the plans			
3. 2" to 4", reduced height unit, 1.0 to 150 psi			
4. 2" to 8", full height unit, 3.0 to 250 psi			
ACCEPTABLE PRODUCTS			
A.R.I. D-025 (Note 3)	A.R.I.-D-026 (Note 4)	GA Industries 842 SS	

Example sizing chart:

A.R.I. D-26 Combination Valve Sizing Chart			
	Maximum Flow Rate (A, B)		
Nominal Valve Size (in)	**(cfs)**	**(cfm)**	**(gpm)**
2	8	500	3,740
3	17	1,000	7,481
4	33	2,000	14,961
6	83	5,000	37,403
8	183	11,000	82,286
(A) Maximum flow rate is the maximum orifice flow rate anticipated through a broken process pipe at the lowest point (elevation) in system. Orifice size is assumed to be either ½ or 1/3 of nominal pipe diameter. *(B) When filling or draining process pipeline.* *(C) Submit manufacturer sizing chart for alternative valve selections.*			

Air Release Valve

TYPE OF VALVE		**SYMBOL**	
Air Release Valve		***ARV-4***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS**	**Type of Service**	Sewage (Note 1)
Shell	N/A	**Reference Document**	AWWA C512
Body/Base	Reinforced Nylon	**Size Range**	2”
Discharge	Polypropylene	**Body/Valve Ends**	NPT or FL per plans
Seals	EPDM	**Pressure Rating (psi)**	3 to 150
Float	Foamed Polypropylene	**Temperature Rating (deg C)**	60 C
O-Ring	Buna-N	**Testing**	
Bolts/Screws/Springs/Stems	Stainless Steel SAE 316	**Operator**	NA
Strainer	None	**Actuator**	NA

NOTES
1. Suitable for venting air small amounts of accumulated air under normal service conditions.
2. Provide all necessary fittings and isolation to install the valve at the location shown in the plans.

ACCEPTABLE PRODUCTS		
A.R.I. S-025		

Air Release Valve

TYPE OF VALVE		SYMBOL	
		ARV-5	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**ITEM**	**ITEM**	**ITEM**
Shell		**Type of Service**	Chemical
Body/Base	PVDF	**Reference Document**	AWWA C512
Discharge	Polypropylene, PVDF	**Size Range**	½" to 2"
Seals	Viton	**Body/Valve Ends**	NPT
Float	Foamed ASA	**Pressure Rating (psi)**	3.0 to 250 (A.R.I.)
O-Ring	Viton	**Temperature Rating (deg C)**	60 C
Bolts/Screws		**Testing**	
Strainer		**Operator**	NA
NOTES			
4. For Potable Water Applications, Valve shall be NSF 61 certified– Lead free.			
5. Suitable for venting air and protection from vacuum under normal service conditions.			
6. Provide all necessary fittings and isolation to install the valve at the location shown in the plans.			
ACCEPTABLE PRODUCTS			
A.R.I. D-040			

Ball Valve

TYPE OF VALVE		**SYMBOL**	
Ball Valve		***BV-1***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS** (Note 1)	**Type of Service**	Air or Water
Body	Bronze	**Reference Document**	
Ball	Hard chrome plated brass ball	**Size Range**	≤2”
Seats	Glass reinforced Durafil or PTFE	**Body/Valve Ends**	NPT, FNPT, Solder as required on drawings with Single Union, union end type
Shaft/Stem	Brass ASTM B16 or SS	**Pressure Rating (psi)**	600 pound WOG
Elastomers		**Temperature Rating (deg C)**	200 °F
Seals	PTFE	**Testing**	
		Operator	Lever Handle-and with screwed ends; 2” Nut (Buried Service)
		Actuator	Manual, lever type
NOTES			
1. Bronze Valves shall be used in copper pipe lines. Valves shall be NSF 61 Certified for Potable Water application–Lead free.			
ACCEPTABLE PRODUCTS			
Watts Series B-6000	Mueller	Apollo 70LF-100 / 200	

Ball Valve

TYPE OF VALVE		**SYMBOL**	
Ball Valve		***BV-2***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS** (Note 1)	**Type of Service**	Air, Water, Process Water
Body	SS	**Reference Document**	
Ball	SS	**Size Range**	<3”
Seats	Teflon	**Body/Valve Ends**	NPT, FNPT, Solder as required on drawings with Single Union
Shaft	SS	**Pressure Rating (psi)**	600 pound WOG
Elastomers		**Temperature Rating (deg C)**	
		Testing	
		Operator	Lever Handle
		Actuator	

NOTES

1. SS Valves shall be used in SS pipe lines. Valves shall be NSF 61 Certified for Potable Water applications -Lead free.
2. Ball valve must have a union fitting, lockable handle, and imprinted tagging.

ACCEPTABLE PRODUCTS

Watts	Mueller	Apollo 76F-100 / 200
	Swagelok Series 40 (up to ¾”)	

Ball Valve

TYPE OF VALVE		**SYMBOL**	
Ball Valve		***BV-3***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS**	**Type of Service**	Chemical – Sodium Hypochlorite <15%,(or Chlorine Gas Solution)
Body	PVC Type 1	**Reference Document**	
Ball	PVC Type 1 – ***VENTED PORT BALL***	**Size Range**	<2"
Seats	PTFE Seats	**Body/Valve Ends**	True Union with Socket Weld (Note 1)
Shaft		**Pressure Rating (psi)**	150 PSI
Elastomers	PTFE seats or Viton/FKM	**Temperature Rating (deg C)**	
		Testing	
		Operator	Lever Handle or T Handle
		Actuator	

NOTES

1. Valve shall have threaded double-union body that can be removed from the line without disengaging the end connections
2. Valves for sodium hypochlorite service shall be provided with a vented ball and viton/FKM seals.
3. Valves used for Sodium Hydroxide Service shall have flanged connections

ACCEPTABLE PRODUCTS

Georg Fischer Type 546	Asahi/America Type-21	Spears Mfg. Company 1839V series
Hayward Flow Control		

Ball Valve

TYPE OF VALVE		**SYMBOL**	
Ball Valve		***BV-4***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS**	**Type of Service**	Water, Process Water, Chemical (Ferric Chloride, Sodium Bisulfite, Aluminum Sulfate, Sodium Hydroxide (Note 2), or Citric Acid
Body	PVC Type 1	**Reference Document**	
Ball	PVC Type 1	**Size Range**	4" and smaller
Seats	PTFE	**Body/Valve Ends**	True Union with Socket Weld (Note 1)
Shaft		**Pressure Rating (psi)**	150 PSI
Elastomers	PTFE Seats, EPDM or Viton/FKM (Note 2)	**Temperature Rating (deg C)**	
		Testing	
		Operator	Lever Handle or T Handle
		Actuator	Electric (when noted)

NOTES

1. Valve shall have threaded double-union body that can be removed from the line without disengaging the end connections
2. When used with sodium hydroxide, valve elastomers shall be PTFE only.

ACCEPTABLE PRODUCTS

Georg Fischer Type 546	Asahi/America Type-21 (Series 94 electric actuator when noted)	Cabot - Chemtrol True Union (TU) Series
	Hayward Flow Control	Spears Mfg. Company 1829/1839 series (CTQ series electric actuator when noted)

Butterfly Valve

TYPE OF VALVE		**SYMBOL**	
Butterfly Valve		***BFV-1***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS** (Note 1)	**Type of Service**	Water, Compressed Air; Interior Exposed Mechanical
Body	One piece cast iron or ductile iron body.	**Reference Document**	AWWA C504
Disc	The disc shall be secured to the shaft using at least two Type 316 stainless steel pins or self-locking setscrews. 316 stainless steel disc.	**Size Range**	3" to 30"
Bushings/ Bearings	All valves shall be furnished with two upper bearings/bushings and one lower bearing/bushing of PTFE material **or Nylatron.**	**Body/Valve Ends**	125/150# pattern Lugged Style (Note 2) AWWA Valves to be Flanged
Pins	Stainless Steel.	**Pressure Rating (psi)**	150 PSI Liquid, Air or Vacuum Service for AWWA Valves, Bi-Directional "dead end" or 175 psi with directional (with disc)/100 psi (against disc) "dead end" bubble tight shutoff capability without the use of backing flanges.
Shaft/ Stem	316 or 416 Stainless Steel. Shaft seals shall be provided to prevent leakage and to protect bearings from internal or external corrosion.	**Temperature Rating (deg C)**	
Seats/ Seals	Valve seats shall be of the reinforced resilient type and shall be field replaceable (in sizes over 24" on AWWA valves). Seats on Lugged Valves shall also act as a body liner to prevent flow from contacting the body casting. Seats on Industrial Valves shall have flange sealing to provide a positive seal without use of flange gaskets. Water Service: EPDM; Compressed Air Service (high pressure): PTFE; Process Air Service (low pressure): Fluorocarbon (Viton, RTFE, or Fluorinated Hydrocarbon Elastomer ASTM D1418) rated for 350° minimum or higher if required by process.	**Testing**	Factory Testing shall be conducted on each valve in accordance with Manufacturer's Quality Control procedures.
Packing		**Operator**	4" Lever Handle,

			>4” Geared Handwheel /Chainwheel
Backing Ring		**Actuator**	Electric actuators or Pneumatic or Manual as shown on the plans and as specified in Section 15106 and Division 16. (Note 2). Include Manual Override.
NOTES			
1. For Potable Water Applications, Valve shall be NSF 61 certified – Lead free and AWWA Compliant 2. Valve shall be capable of being installed vertically or horizontally; and have the ability to be installed with the disc in the closed position.			
ACCEPTABLE PRODUCTS			
Bray Series 30/31	Keystone	Pratt Series BF, 2FII or Triton	

Butterfly Valve

TYPE OF VALVE		**SYMBOL**	
Butterfly Valve		***BFV-2***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS** (Note 1)	**Type of Service**	Water. Exposed Interior Mechanical Service Automated – Modulating and Cyclic Service (Note 3). Exterior, non-automated-double eccentric/ high performance butterfly valve.
Body	316 Stainless Steel	**Reference Document**	ASME B16.10 API 609 Category B
Disc	316 Stainless Steel	**Size Range**	2" to 66"
Bushings/ Bearings	316 Stainless Steel w/TFE	**Body/Valve Ends**	125/150# pattern Lugged Style ASME B16.34 MSS SP 68 (Note 2)
Pins	17-4PH Stainless Steel	**Pressure Rating (psi)**	150 PSI Liquid, Air or Vacuum Service Bi-Directional. Valves shall provide ANSI Class VI shutoff. Rated for working pressures of no less than 250 psi and shall provide zero leakage at full rated pressure. ASME 150
Shaft/ Stem	17-4PH Stainless Steel	**Temperature Rating (deg C)**	-52 to 260°C
Seats/ Seals	Water Service: Reinforced PTFE w/Silicone Energizer PTFE packing seals the stem and a carbon fiber anti–extrusion ring contains the packing Compressed Air Service (high pressure): PTFE, Teflon; Process Air Service (low pressure): Fluorocarbon (Viton or RTFE or Fluorinated Hydrocarbon Elastomer – ASTM D1418) rated for 300° minimum or higher if required by process	**Testing**	Factory Testing shall be conducted on each valve in accordance with Manufacturer's Quality Control procedures. API 598 MSS SP 61
Packing	PTFE	**Operator**	4" Lever Handle, >4" Geared Handwheel /Chainwheel
Backing Ring	Stainless Steel	**Actuator**	Electric actuators or Pneumatic as shown on the plans and as specified in Section 15106 and Division

			16. (Note 3). Include Manual Override.
NOTES			
1. For Potable Water Applications, Valve shall be NSF 61 certified – Lead free.			
2. Valve shall be capable of being installed vertically or horizontally; and have the ability to be installed with the disc in the closed position.			
3. Valve shall be suitable for pneumatically or electrically automated in on/off service, modulating, or throttling service and classified as a "High Performance Butterfly Valve," and shall utilize an offset disc design with a soft seat.			
ACCEPTABLE PRODUCTS			
Bray/McCannalok Series 40/41	Keystone K-LOK Series 36/37	Dezurik BHP	

Butterfly Valve

TYPE OF VALVE		**SYMBOL**	
Butterfly Valve		***BFV-3***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS** (Note 1)	**Type of Service**	Water with chlorine solution 50 ppm to 1000 ppm. Interior Exposed Mechanical.
Body	One piece cast iron or ductile iron body	**Reference Document**	
Disc	PVDF Coated Disc	**Size Range**	2" to 12"
Bushings/ Bearings	All valves shall be furnished with two upper bearings/bushings and one lower bearing/bushing of PTFE material. Shaft seals shall be provided to prevent leakage and to protect bearings from internal or external corrosion	**Body/Valve Ends**	125/150# pattern Lugged Style (Note 2)
Pins	Stainless Steel	**Pressure Rating (psi)**	150 PSI Liquid, Air or Vacuum Service Bi-Directional
Shaft/ Stem	316 or 416 Stainless Steel	**Temperature Rating (deg C)**	
Seats/ Seals	Valve seats shall be of the reinforced resilient type and shall be field replaceable. Seats shall also act as a body liner to prevent flow from contacting the body casting. Seats shall have flange sealing to provide a positive seal without use of flange gaskets EPDM or Viton as required by service conditions and chemical exposure. Verify material is suitable for specific chemical exposure.	**Testing**	Factory Testing shall be conducted on each valve in accordance with Manufacturer's Quality Control procedures.
Packing		**Operator**	4" Lever Handle, >4" Geared Handwheel /Chainwheel
Backing Ring		**Actuator**	Electric actuators or Pneumatic as shown on the plans and as specified in Section 15106 and Division 16. (Note 2). Include Manual Override.

NOTES		
1. For Potable Water Applications, Valve shall be NSF 61 certified – Lead free.		
2. Valve shall be capable of being installed vertically or horizontally; and have the ability to be installed with the disc in the closed position.		
ACCEPTABLE PRODUCTS		
Bray Series 22/23	Keystone - Resilient Seated Valve Types 920	Pratt Series BF

Butterfly Valve

TYPE OF VALVE		**SYMBOL**	
Butterfly Valve		***BFV-4***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS** (Note 1)	**Type of Service**	Water. Buried.
Body	Cast iron (ASTM A-126)	**Reference Document**	AWWA C504
Disc	Ductile iron	**Size Range**	4" to 36"
Bushings/ Bearings		**Body/Valve Ends**	125/150# pattern FL or MJ as shown on the drawings (Note 2)
Pins		**Pressure Rating (psi)**	150 PSI Liquid, Air or Vacuum Service Bi-Directional
Shaft/ Stem	316 stainless steel shaft with o-ring seals	**Temperature Rating (deg C)**	
Seats/ Seals	BUNA-N seal	**Testing**	Factory Testing shall be conducted on each valve in accordance with Manufacturer's Quality Control procedures.
Packing		**Operator**	2" Nut, fully gasketed. Minimum 24 turns from open to closed
Backing Ring		**Actuator**	NA

NOTES
1. For Potable Water Applications, Valve shall be NSF 61 certified – Lead free.
2. Valve shall be capable of being installed vertically or horizontally.

ACCEPTABLE PRODUCTS		
Pratt – Groundhog	Mueller	Clow BFV 4500 (3" to 24") Clow BFV 1450 (30" to 36")

Butterfly Valve

TYPE OF VALVE		**SYMBOL**	
Butterfly Valve		***BFV-5***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS** (Note 1)	**Type of Service**	Water
Body	PVC or CPVC (Note 3)	**Reference Document**	ANSI B16.10
Disc	PVC or CPVC (Note 3)	**Size Range**	2" to 12"
Bushings/ Bearings		**Body/Valve Ends**	125/150# pattern FL (Note 2)
Pins		**Pressure Rating (psi)**	150 PSI Liquid, Air or Vacuum Service Bi-Directional
Shaft/ Stem	316 stainless steel shaft	**Temperature Rating (deg C)**	
Seats/ Seals	Nitrile liner	**Testing**	Factory Testing shall be conducted on each valve in accordance with Manufacturer's Quality Control procedures.
Packing		**Operator**	
Backing Ring		**Actuator**	NA
NOTES			
1. For Potable Water Applications, Valve shall be NSF 61 certified – Lead free.			
2. Valve shall be capable of being installed vertically or horizontally.			
3. Body and disc material shall match that of the process pipe on which it is installed.			
ACCEPTABLE PRODUCTS			
Hayward Flow Control			

Butterfly Valve

TYPE OF VALVE	**SYMBOL**
Butterfly Valve	***BFV-6***

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS** (Note 1)	**Type of Service**	Water. Exposed Interior Mechanical Service Automated – Modulating and Cyclic Service (Note 3). Exterior, non-automated-double eccentric/ high performance butterfly valve.
Body	316 Stainless Steel.	**Reference Document**	
Disc	316 Stainless Steel.	**Size Range**	2" to 54"
Bushings/ Bearings	Stainless steel with PTFE Fabric Liner 2"-24"; 316 Stainless steel with PTFE Fabric Liner 30"-48"	**Body/Valve Ends**	125/150# pattern Lugged, Style ASME B16.34 MSS SP 68 (Note 2)
Pins	17-4PH Stainless Steel	**Pressure Rating (psi)**	Rated for working pressures of no less than 250 psi and shall provide zero leakage at full rated pressure.
Shaft/Stem	17-4PH Stainless Steel	**Temperature Rating (deg C)**	-52 to 260°C
Seats/Seals	Reinforced PTFE w/Silicone Energizer PTFE packing seals the stem and a carbon fiber anti–extrusion ring contains the packing.	**Testing**	Factory Testing shall be conducted on each valve in accordance with Manufacturer's Quality Control procedures.
Packing	PTFE	**Operator**	-
Backing Ring	Stainless Steel	**Actuator**	Nut operator.

NOTES

1. For Potable Water Applications, Valve shall be NSF 61 certified – Lead free.
2. Valve shall be capable of being installed vertically or horizontally; and have the ability to be installed with the disc in the closed position.
3. Valve shall be suitable for pneumatically or electrically automated in on/off service, modulating, or throttling service and classified as a "High Performance Butterfly Valve," and shall use an offset disc design with a soft seat.

ACCEPTABLE PRODUCTS

Bray/McCannalok Series 40	Keystone K-LOK Series 36/37	Dezurik BHP High Performance Butterfly Valve

Check Valve

TYPE OF VALVE		**SYMBOL**	
Swing Check Valve		***CV-1***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS** (Note 1)	**Type of Service**	Liquid (Water or Sewage)
Body	PVC	**Reference Document**	PVC shall conform to ASTM D1784 cell classification 12454
Hardware		**Size Range**	< 8”
Ball		**Body/Valve Ends**	FL (Note 2)
Type of Disc	Swinging Inclined Disc	**Pressure Rating (psi)**	150 PSI
Disc	PVC	**Temperature Rating (deg C)**	
Trim	316 SS	**Testing**	
Packing	EPDM Seals	**Operator**	External SS Spring Assist. Or Lever/weight
Shaft	316 SS	**Actuator**	
Seats	EPDM		
Bonnet	PVC Removable w/ SS hardware		
Elastomers			
Cover			
NOTES			
1. For Potable Water Applications, Valve shall be NSF 61 certified– Lead free.			
2. Valve shall be capable of being installed vertically or horizontally.			
ACCEPTABLE PRODUCTS			
Asahi/America		Spears Mfg. Company 4423 series	

Check Valve

TYPE OF VALVE		**SYMBOL**	
Swing Check Valve		***CV-2***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS** (Note 1)	**Type of Service**	Liquid (Water or Sewage)
Body	Cast Iron, factory epoxy coated interior	**Reference Document**	AWWA C508
Type of Disc	Swinging Inclined Disc	**Size Range**	4" to 24"
Disc	Cast Iron, epoxy coated	**Body/Valve Ends**	FL or MJ per drawings
Trim	304 SS	**Pressure Rating (psi)**	
Shaft	304 SS	**Temperature Rating (deg C)**	
Seats	Bronze with (NBR) rubber seat ring	**Testing**	
Packing		**Operator**	External SS Spring Assist or Lever and adjustable Weight.
Bonnet	Cast Iron, factory epoxy coated interior	**Actuator**	
Elastomers	NBR rubber	**Installation**	(Note 2)
NOTES			
1. For Potable Water Applications, Valve shall be NSF 61 certified– Lead free.			
2. Valve shall be capable of being installed vertically or horizontally.			
ACCEPTABLE PRODUCTS			
Mueller	Kennedy	Pratt Series 8001	Golden Anderson (VAG/GA Industries)

Check Valve

TYPE OF VALVE		**SYMBOL**	
PVC Ball Check Valve		***CV-3***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS**	**Type of Service**	Chemical – Sodium Hypochlorite <15%,(or Chlorine Gas Solution)
Body	PVC Type 1	**Reference Document**	
Hardware		**Size Range**	<2”
Ball	PVC Type 1	**Body/Valve Ends**	Union with Socket Weld (Note 1)
Type of Ball		**Pressure Rating (psi)**	150 PSI
Disc		**Temperature Rating (deg C)**	
Trim		**Testing**	
Packing		**Operator**	
Shaft		**Actuator**	
Seats	PTFE seats or Viton/FKM		
Bonnet			
Elastomers			
Cover			

NOTES

1. Valve shall be capable of being installed vertically or horizontally.
2. The valve shall permit flow in direction only and close tightly, without slamming, when its discharge pressure exceeds its inlet pressure.
3. The valve shall operate without hydraulic shock and require no maintenance.
4. Valve flow area shall be 100% of the nominal pipeline diameter cross sectional area. Valve body interior shall be designed with smooth surfaces with no projections or pockets to trap solid material.

ACCEPTABLE PRODUCTS

Georg Fischer Type 561	Asahi/America Ball Check	Spears Mfg. Company 4539 series
Hayward Flow Control		

Check Valve

TYPE OF VALVE		**SYMBOL**	
PVC Ball Check Valve		***CV-4***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS**	**Type of Service**	Chemical – Ferric Chloride, Sodium Bisulfite, Aluminum Sulfate or Citric Acid
Body	PVC Type 1	**Reference Document**	
Hardware		**Size Range**	<2”
Ball	PVC Type 1	**Body/Valve Ends**	Union with Socket Weld (Note 1)
Type of Ball		**Pressure Rating (psi)**	150 PSI
Disc		**Temperature Rating (deg C)**	
Trim		**Testing**	
Packing		**Operator**	
Shaft		**Actuator**	
Seats	PTFE Seats, EPDM or Viton /FKM		
Bonnet			
Elastomers			
Cover			
NOTES			
1. Valve shall be capable of being installed vertically or horizontally.			
ACCEPTABLE PRODUCTS			
Georg Fischer Type 561	Asahi/America Ball Check	Spears Mfg. Company 4529 /4539 series	
Hayward Flow Control			

Check Valve

TYPE OF VALVE		**SYMBOL**	
PVC Ball Check Valve		***CV-5***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS**	**Type of Service**	Chemical – Sodium Hydroxide (Caustic Soda)
Body	PVC Type 1	**Reference Document**	
Hardware		**Size Range**	<2”
Ball	PVC Type 1	**Body/Valve Ends**	Union with Socket Weld (Note 1)
Type of Ball		**Pressure Rating (psi)**	150 PSI
Disc		**Temperature Rating (deg C)**	
Trim		**Testing**	
Packing		**Operator**	
Shaft		**Actuator**	
Seats	EPDM, PTFE		
Bonnet			
Elastomers			
Cover			
NOTES			
1. No threaded connections shall be permitted.			
ACCEPTABLE PRODUCTS			
Georg Fischer Type 561	Asahi/America Ball Check	Spears Mfg. Company 4529 Series	
Hayward Flow Control			

Check Valve

TYPE OF VALVE		**SYMBOL**	
Ball Check Valve		***CV-6***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS**	**Type of Service**	Sewage Sludge and Solids
Body	Cast Iron (ASTMA126-B) Ductile Iron ASTM A536	**Reference Document**	
Hardware	Stainless Steel Grade 304 or 316	**Size Range**	4" to 24"
Ball	Vulcanized Buna-N (nitrile) rubber cover over hollow metal ball core Ductile Iron ASTM A536, Grade 65-45-12 Vulcanized with Buna-N Rubber	**Body/Valve Ends**	FL per drawings (Note 2), integrally cast 125# inlet and outlet flanges
Type of Ball	Non-Clog, no slam (Note 2)	**Pressure Rating (psi)**	150 PSI
Disc		**Temperature Rating (deg C)**	
Trim	SS	**Testing**	
Packing	Mfr standard	**Operator**	
Shaft	SS	**Actuator**	
Seats	Buna N		
Bonnet		**O-Ring**	Buna-N
Elastomers		**Flanges**	ASME B16.1 Class 125
Cover	Cast Iron (ASTMA126-B) Ductile Iron ASTM A536, Grade 65-45-12		
NOTES			
1. Valve shall be capable of being installed vertically or horizontally.			
2. Valve flow area shall be 100% of the nominal pipeline diameter cross sectional area.			
3. Internal & External Thermosetting Fusion Bonded Epoxy Coating			
ACCEPTABLE PRODUCTS			
AV-TEK Series 4900			

Check Valve

TYPE OF VALVE		**SYMBOL**	
Globe Style Check Valve		***CV-7***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS** (Note 1,3)	**Type of Service**	Potable Water
Body	Ductile iron body ASTM A-536 65-45-12	**Reference Document**	-
Type of Disc	Dual guided (top and bottom)	**Size Range**	4" to 24"
Disc	Stainless steel ASTM type 304	**Body/Valve Ends**	FL per drawings (Note 2), 125# ANSI flat face flanges
Guide bushing	304 Stainless Steel	**Pressure Rating (psi)**	150 PSI
Guide pins	Type 304 Stainless Steel	**Temperature Rating (deg C)**	-
Helical or conical spring	ASTM A313 Type 304 Stainless Steel	**Testing**	-
Packing		**Operator**	-
Shaft		**Actuator**	-
Seats	Stainless steel ASTM type 304		
Bonnet			
Elastomers			
Cover			
NOTES			
1. For Potable Water Applications, Valve shall be NSF 61 certified– Lead free.			
2. Valve shall be capable of being installed vertically or horizontally.			
3. Check valve to have a minimum open area in the body of 110% of the area of the entering or corresponding pipe**.**			
4. Verify the adjacent upstream flange for the adjacent pipe/fitting/valve, internal diameter will adequately support/restrain the check valve internal mechanism within the check valve body. Provide filler flange as necessary.			
ACCEPTABLE PRODUCTS			
Pratt	Milliken	Mueller	Kennedy

Check Valve

TYPE OF VALVE		**SYMBOL**	
Backwater Check Valve		***CV-8***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS** (Note 1)	**Type of Service**	Water, Sewage
Body	EPDM	**Reference Document**	
Hardware	SS	**Size Range**	4” to 36”
Ball		**Body/Valve Ends**	FL per drawings (Note 2)
Type of Disc		**Pressure Rating (psi)**	150 PSI, (Note 3)
Disc		**Temperature Rating (deg C)**	
Trim		**Testing**	
Packing		**Operator**	
Shaft		**Actuator**	
Seats			
Bonnet			
Elastomers			
Cover			
NOTES			
1. For Potable Water Applications, Valve shall be NSF 61 certified– Lead free.			
2. Valve shall be capable of being installed vertically or horizontally.			
3. Valve shall open under 2-inch WC differential pressure.			
ACCEPTABLE PRODUCTS			
Proco 710 (FL) 730 (Plain End)	Red Valve - TideFlex Series 35 or 35-NSF61		

Check Valve

TYPE OF VALVE		**SYMBOL**	
Globe Style Check Valve		***CV-9***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS** (Note 1,3)	**Type of Service**	Water
Body	316 Stainless Steel, ASTM A351, GR-CF8M	**Reference Document**	-
Type of Disc	Dual guided (top and bottom)	**Size Range**	4" to 24"
Disc	316 Stainless Steel, ASTM A351, GR-CF8M	**Body/Valve Ends**	FL per drawings (Note 4), 125# ANSI flat face flanges
Guide bushing	316 Stainless Steel	**Pressure Rating (psi)**	150 PSI
Guide pins	316 Stainless Steel	**Temperature Rating (deg C)**	-
Helical or conical spring	ASTM A313 Type 316 Stainless Steel	**Testing**	-
Packing	-	**Operator**	-
Shaft	-	**Actuator**	-
Seats	EPDM		
Bonnet	-		
Elastomers	-		
Cover	-		
NOTES			
1. For Potable Water Applications, Valve shall be NSF 61 certified– Lead free.			
2. Valve shall be capable of being installed vertically or horizontally.			
3. Check valve to have a minimum open area in the body of 110% of the area of the entering or corresponding pipe**.**			
4. Verify the adjacent upstream flange for the adjacent pipe/fitting/valve, internal diameter will adequately support/restrain the check valve internal mechanism within the check valve body. Provide filler flange as necessary.			
ACCEPTABLE PRODUCTS			
Flomatic	Dezurik		

Check Valve

TYPE OF VALVE		**SYMBOL**	
Inline Check Valve		***CV-10***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS** (Note 1)	**Type of Service**	Water, Sewage
Body	EPDM	**Reference Document**	
Hardware	SS	**Size Range**	6” to 24”
Ball		**Body/Valve Ends**	Plain End per drawings (Note 2)
Type of Disc		**Pressure Rating (psi)**	(Note 3)
Disc		**Temperature Rating (deg C)**	
Trim		**Testing**	
Packing		**Operator**	
Shaft		**Actuator**	
Seats			
Bonnet			
Elastomers			
Cover			

NOTES

1. Hydraulic testing results shall be provided under free discharge and submerged conditions.
2. Valve shall be capable of being installed vertically or horizontally.
3. Valve shall crack open under 1-inch WC differential pressure.

ACCEPTABLE PRODUCTS

Red Valve - TideFlex CMUF-SL CheckMate Ultraflex		

CORPORATION STOPS

TYPE OF VALVE		**SYMBOL**	
Corporation Stops		***CS-1***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS** (Note 1)	**Type of Service**	Water, Buried.
Body	Bronze	**Reference Document**	AWWA C800
Gasket	EPDM	**Size Range**	¾" to 2"
		Body/Valve Ends	NPT
		Pressure Rating (psi)	300 PSI Liquid, Air or Vacuum Service
		Temperature Rating (deg C)	-
		Testing	Factory Testing shall be conducted on each valve in accordance with Manufacturer's Quality Control procedures.
		Operator	T-head fork handle
		Actuator	-
NOTES			
1. For Potable Water Applications, Valve shall be NSF 61 certified – Lead free.			
ACCEPTABLE PRODUCTS			
Ford Meter Box Company	Mueller		

Diaphragm Valve

TYPE OF VALVE		**SYMBOL**	
Diaphragm Valve		***DPV-1***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS**	**Type of Service**	Chemical – Sodium Hypochlorite <15%,(or Chlorine Gas Solution)
Body	PVC Type 1	**Reference Document**	-
Bonnet	PVC Type 1	**Size Range**	<=4”
Elastomers	PTFE seats or Viton/FKM	**Body/Valve Ends**	Union with Socket Weld or FL (Note 1)
Diaphragm Pattern	Saunders pattern EPDM/PTFE 3-layer with PVDF gas barrier	**Pressure Rating (psi)**	150 PSI
		Temperature Rating (deg C)	-
		Testing	
		Operator	Wheel RS, manual
		Actuator	-

NOTES		
1. Valve shall be capable of being installed vertically or horizontally.		
2. Provide with position indicator.		
3. Diaphragm valves shall be installed in all chlorine solution and chemical feed lines, between the appropriate storage tanks and point of application and as located on the Drawings.		
Georg Fischer	Asahi/America Type-14	Hayward Flow Control

Diaphragm Valve

TYPE OF VALVE		**SYMBOL**	
Diaphragm Valve		***DPV-2***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS**	**Type of Service**	Chemical – Ferric Chloride, Aluminum Sulfate, Sodium Bisulfite
Body	PVC Type 1	**Reference Document**	
Bonnet	PVC Type 1	**Size Range**	≤ 2 inch
Elastomers	PTFE Seats, EPDM or Viton /FKM	**Body/Valve Ends**	Union with Socket Weld or FL (Note 1)
Diaphragm Pattern	Saunders pattern with PTFE/EPDM depending on service	**Pressure Rating (psi)**	150 PSI
		Temperature Rating (deg C)	
		Testing	
		Operator	Wheel RS, manual
		Actuator	

NOTES
1. Valve shall be capable of being installed vertically or horizontally.
2. Provide with position indicator.
3. Diaphragm valves shall be installed in all chlorine solution and chemical feed lines, between the appropriate storage tanks and point of application and as located on the Drawings.

ACCEPTABLE PRODUCTS		
Georg Fischer	Asahi/America Type-14	Hayward Flow Control

Diaphragm Valve

TYPE OF VALVE		**SYMBOL**	
Diaphragm Valve		***DPV-3***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS**	**Type of Service**	Chemical – Sodium Hydroxide (Caustic Soda)
Body	PVC Type 1	**Reference Document**	
Bonnet	PVC Type 1	**Size Range**	≤4 inch
Elastomers	EPDM, PTFE	**Body/Valve Ends**	Union with Socket Weld or Flanged (Note 1)
Diaphragm Pattern	Saunders pattern with EPDM/ PTFE depending on service	**Pressure Rating (psi)**	150 PSI
		Temperature Rating (deg C)	
		Testing	
		Operator	Wheel RS
		Actuator	

NOTES

1. No threaded connections shall be permitted.
2. Provide with position indicator.
3. Diaphragm valves shall be installed in all chlorine solution and chemical feed lines, between the appropriate storage tanks and point of application and as located on the Drawings.

ACCEPTABLE PRODUCTS

Georg Fischer	Asahi/America Type-14	Hayward Flow Control

Flap Valve

TYPE OF VALVE		**SYMBOL**	
Flap Valve		***FLV-1***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS** (Note 1)	**Type of Service**	Liquid (Water or Sewage, Mixed Liquor)
Body/ Flap	Cast iron conforming to ASTM Specifications A126 Class B or Fabricated 304/316 SS	**Reference Document**	-
Hinge Pin	Bronze B62 or 304/316 SS mounts, offset single pivoted hinge, and shall unseat and swing open under unseating pressure. SS	**Size Range**	4" to 24" .
Seat Ring	The flap gate seat ring shall either be rolled into a dove-tailed groove under pressure to make one inseparable unit. The body seat ring shall be threaded and screwed into place in the body. Both gate and body seat ring faces shall be machined to a smooth finish. Bronze B62 or a self-adjusting lip design of EPDM.	**Body/Valve Ends**	ANSI B16.1, Class 125/ANSI B16.5, Class 150 flanges
Wedges/ Seal Faces	Shall bolt on with stainless steel hardware to permit replacement.	**Pressure Rating (psi)**	- As per specification
		Temperature Rating (deg C)	- As per specification
		Testing	- As per specification
		Operator	Handle, with extensions and catch bracket shall be furnished to elevations shown on Plans. As per specifications Orbinox Complies
		Actuator	- As per specification/drawings

NOTES
1. For Potable Water Applications, Valve shall be NSF 61 certified– Lead free. Pending

ACCEPTABLE PRODUCTS		
Kennedy	Clow	M&H
Orbinox RR or RC		

Gate Valve - Resilient Seat

TYPE OF VALVE		**SYMBOL**	
Resilient Seat Gate Valve		***GV-1***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS** (Note 1)	**Type of Service**	WOG (Liquid)
Body	Bronze	**Reference Document**	-
Type of Disc	Solid wedge	**Size Range**	<2 ½ inches
Disc	Mfr standard	**Body/Valve Ends**	NPT or FNPT
Trim	Bronze	**Pressure Rating (psi)**	200 WOG operating, 300 design
Packing	Mfr standard	**Temperature Rating (deg C)**	-
Shaft	SS	**Testing**	-
Seats	Mfr standard	**Operator**	Rising Stem
Bonnet	Union	**Actuator**	-
NOTES			
1. For Potable Water Applications, Valve shall be NSF 61 certified– Lead free.			
ACCEPTABLE PRODUCTS			
Jenkins Bros			

Gate Valve - Resilient Seat

TYPE OF VALVE		**SYMBOL**	
Resilient Seat Gate Valve		***GV-2***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS** (Note 1, 3)	**Type of Service**	Liquid
Body	Ductile Iron (Note 2)	**Reference Document**	AWWA C509 and 515
Type of Disc	Full Round Port	**Size Range**	2 to 12 inches
Wedge	Ductile Iron or Cast Iron (Note 2)	**Body/Valve Ends**	FL or MJ per drawings
Trim	Mfr Standard	**Pressure Rating (psi)**	200 operating, 400 design, min.The valve shall seal at full rated pressure with flow from either direction.
Packing	Double O-Ring seal	**Temperature Rating (deg C)**	
Shaft	Mfr Standard	**Testing**	
Seats	Steel Reinforced Rubber, replaceable, or fully encapsulated Rubber	**Operator**	NRS; Handwheel (exposed) or 2-inch square nut (buried).
Bonnet	Mfr Standard	**Actuator**	
NOTES			
1. For Potable Water Applications, Valve shall be NSF 61 certified– Lead free.			
2. Epoxy coat interior surfaces.			
3. All exposed nuts, bolts and washers shall be zinc-plated. Buries valves shall have stainless steel fasteners.			
ACCEPTABLE PRODUCTS			
Mueller Company 2361 or 2362	Clow 2639 Full Body DI		

Gate Valve - Resilient Seat

TYPE OF VALVE	**SYMBOL**
Resilient Seat Gate Valve with Spur Gearing for Vertical Installation	***GV-3***

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS** (Note 1, 3)	**Type of Service**	Liquid
Body	Ductile Iron (Note 2)	**Reference Document**	AWWA C515
Type of Disc	Full Round Port	**Size Range**	2 to 12 inches
Wedge	Ductile Iron or Cast Iron (Note 2)	**Body/Valve Ends**	FL or MJ per drawings
Trim	Mfr Standard	**Pressure Rating (psi)**	200 operating, 400 design, min.The valve shall seal at full rated pressure with flow from either direction.
Packing	Double O-Ring seal	**Temperature Rating (deg C)**	
Shaft	Mfr Standard	**Testing**	
Seats	Steel Reinforced Rubber, replaceable, or fully encapsulated Rubber	**Operator**	NRS; Handwheel (exposed) or 2-inch square nut (buried). Spurred gearing for vertical installation and AWWA maximum 250 ft-lbs closing torque with standard gearing
Bonnet	Mfr Standard	**Actuator**	

NOTES

1. For Potable Water Applications, Valve shall be NSF 61 certified– Lead free.
2. Epoxy coat interior surfaces.
3. All exposed nuts, bolts and washers shall be zinc-plated. Buries valves shall have stainless steel fasteners.

ACCEPTABLE PRODUCTS

Mueller Company 2361	Clow 2638 Full Body DI	

Globe Valve

TYPE OF VALVE		SYMBOL	
Globe Valve		***GL-1***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS**	**Type of Service**	Liquid
Body	Bronze, B62	**Reference Document**	-
Type of Disc	Polyurethane, PTFE or (mfr standard)	**Size Range**	<2 ½ inches
Disc	Bronze; composition disc	**Body/Valve Ends**	FNPT, NPT or FL; screwed ends
Trim	Bronze	**Pressure Rating (psi)**	Class 125, 300 lb WOG
Packing	Teflon Impregnated asbestos	**Temperature Rating (deg C)**	3 to 100, design 120
Shaft	Bronze Ring	**Testing**	-
Seats	-	**Operator**	Handwheel, Rising Stem
		Actuator	-
NOTES			
1.			
ACCEPTABLE PRODUCTS			
Jenkins Bros.	Apollo 120T Apollo 127T	Crane	

Needle Valve

TYPE OF VALVE		SYMBOL	
Needle		***NV-1***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS**	**Type of Service**	Liquid
Body	316 SS	**Reference Document**	-
Type of Disc	-	**Size Range**	1/8" – 1/2"
Disc	-	**Body/Valve Ends**	FNPT, NPT
Trim	-	**Pressure Rating (psi)**	5000 PSIG
Packing	316 SS Packing Nut	**Temperature Rating (deg C)**	-28 to 37
Shaft	316 SS	**Testing**	-
Seats	-	**Operator**	-
		Actuator	-
NOTES			
ACCEPTABLE PRODUCTS			
Swagelock Series 1R or 18R	Parker		

Knife Gate Valve

TYPE OF VALVE		**SYMBOL**	
Knife Gate Valve		***KGV-1***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS** (Note 1)	**Type of Service**	Liquid (Water or Sewage, Mixed Liquor)
Body/ Frame	304 Stainless Steel ASTM A351 CF8/ or Cast Iron	**Reference Document**	
Disc/ Gate	304 Stainless Steel ASTM A240	**Size Range**	4" to 24"
Yoke	304 Stainless Steel CF8	**Body/Valve Ends**	ANSI B16.1, Class 125/ANSI B16.5, Class 150 flanges; heavy duty flanged type; must provide positive seal under both seating and unseating head conditions.
Trim/ Fasteners	18-8 SS	**Pressure Rating (psi)**	150
Stem/ Stem Nut/ Seat ring	304 Stainless Steel ASTM A276	**Temperature Rating (deg C)**	
Packing	Teflon w/ PTFE anti-extrusion plate 500˚F (260˚C)	**Testing**	
Gland	304 Stainless Steel ASTM A351 CF8	**Operator**	Non-Rising Stem (Note 2); handwheel - or 2" nut
Yoke Sleeve	Aluminum Bronze or Brass	**Actuator**	
Seat	NBR or EPDM		
NOTES			
1. For Potable Water Applications, Valve shall be NSF 61 certified– Lead free.			
2. Valves shall be furnished complete with non-rising stainless-steel extension stem and indicating floor stand, or wall bracket, or 2-inch operating nut, depending on location, as shown on the Drawings. Stem guides shall be provided as recommended by the manufacturer.			
ACCEPTABLE PRODUCTS			
Dezurik KGN	Red Valve Series D Slurry KGV	Approved Equal	
Henry Pratt			

Mud Valve

TYPE OF VALVE		**SYMBOL**	
Mud Valve		***MV-1***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS** (Note 1)	**Type of Service**	Liquid (Water or Sewage, Mixed Liquor)
Body/ Frame	Cast Iron ASTM A 126 Class B	**Reference Document**	-
Disc/ Gate	Cast Iron ASTM A 126 Class B	**Size Range**	4" to 12"
Yoke	Cast Iron ASTM A 126 Class B	**Body/Valve Ends**	ANSI B16.1, Class 125/ANSI B16.5, Class 150 flanges; heavy duty flanged type; must provide positive seal under both seating and unseating head conditions.
Trim/ Fasteners	316L SS	**Pressure Rating (psi)**	150
Stem/ Stem Nut/ Seat ring	Bronze; Seat ring shall be tapered and have a machined seating face that mates with the seat to provide a drip tight seal. Stem threads shall be machined cut modified acme threads.	**Temperature Rating (deg C)**	-
Packing	Bronze to Bronze	**Testing**	-
Plug	Plug: Cast Iron; Plug Seat: Seamless Buna-N	**Operator**	Non-Rising Stem (Note 2); handwheel
Yoke	Cast Iron ASTM A 126 Class B	**Actuator**	-

NOTES
1. For Potable Water Applications, Valve shall be NSF 61 certified– Lead free.
2. Valves shall be furnished complete with non-rising stainless steel extension stem and indicating floor stand, or wall bracket, or 2-inch operating nut, depending on location, as shown on the Drawings. Stem guides shall be provided as recommended by the manufacturer.

ACCEPTABLE PRODUCTS		
Waterman Model MV-11	F-3075-T NRS Clow Valve	Trumbull

Orifice Plate

TYPE OF VALVE		SYMBOL	
Orifice Plate (Note 1)		***OP-1***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS**	**Type of Service**	Liquid
Body/ Frame	304 SS (Note 2)	**Reference Document**	ISO 5167-2 and/or ASME MFC-3M
Disc/ Gate	-	**Size Range**	2" to 24"
Yoke	-	**Body/Valve Ends**	(Note 3)
Trim/ Fasteners	-	**Pressure Rating (psi)**	200
Stem/ Stem Nut/ Seat ring	-	**Temperature Rating (deg C)**	-
Packing	-	**Testing**	-
Plug	-	**Operator**	-
Yoke	-	**Actuator**	-

NOTES

1. Manufacturer to size the orifice plate(s) to provide the necessary system pressure reduction and flow for the following conditions and piping arrangements as shown in the plans:
    a. Pressure difference across the orifice: 40 psi (75 psi upstream pressure reduced to 35 psi downstream) at a flow rate of 3,000 gpm
2. The upstream side of each orifice tab shall be stamped with:
    a. the word "UPSTREAM"
    b. the tag number
    c. ASME flange class
    d. nominal pipe size
    e. orifice diameter
    f. type of orifice plate (square, restriction, etc.)
3. Orifice plate(s) shall be located between two flanges that meet specifications of ANSI B16.1, Class 125/ANSI B16.5, Class 150 flanges.

ACCEPTABLE PRODUCTS

Kurita (Tonka)	Dwyer-Instruments	Cla-Val
Approved Equal		

Pressure Regulating Valve

TYPE OF VALVE		**SYMBOL**	
Pressure Regulating Valve (Pressure Reducing)		***PRV-1***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS**	**Type of Service**	Water
Body	Cast Bronze, Brass	**Reference Document**	CSA or ASME Certification
Spring	Stainless Steel	**Size Range**	<3”
Elastomers	-	**Body/Valve Ends**	NPT, FNPT (Note 3)
		Pressure Rating (psi)	150 PSI (Note 2)
		Temperature Rating (deg C)	-
		Testing	-
		Operator	Adjustment nut/screw
		Actuator	-

NOTES
1. Valve shall be NSF 61certified for potable water applications– Lead free.
2. Valve shall be adjustable with range suitable for the installation.
3. A strainer shall be provided ahead of all PCVs and PRVs

ACCEPTABLE PRODUCTS		
Watts	Mueller	Apollo 36ELF (1/2” – 1”)
Apollo 36H (1 ¼” – 3”)		

Pressure Regulating Valve

TYPE OF VALVE		**SYMBOL**	
Pressure Regulating Valve (Backpressure and Pressure Relief)		***PRV-2***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS**	**Type of Service**	Water, Chemical – Sodium Hypochlorite <15%, (or Chlorine Gas Solution)
Body	PVC Type 1 or Polypropylene	**Reference Document**	-
Seat Ring	-	**Size Range**	≤3”
Elastomers	PTFE seats or Viton	**Body/Valve Ends**	Union with Socket Weld (Note 1)
		Pressure Rating (psi)	150 PSI
		Temperature Rating (deg C)	140 F PVC; PP 195 F
		Testing	-
		Operator	Adjustment nut/screw
		Actuator	-
NOTES			
1. Valve shall have threaded double-union body that can be removed from the line without disengaging the end connections.			
ACCEPTABLE PRODUCTS			
Grifco G Series	Plastomatic	Asahi/America, Inc	
Hayward Flow Control			

Pressure Regulating Valve

TYPE OF VALVE		**SYMBOL**	
Pressure Regulating Valve (Backpressure and Pressure Relief)		***PRV-3***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS**	**Type of Service**	Chemical – Ferric Chloride, Sodium Bisulfite, Aluminum Sulfate, Sodium Hydroxide (Note 2), or Citric Acid
Body	PVC Type 1 or Polypropylene	**Reference Document**	-
Seat Ring	-	**Size Range**	<2”
Elastomers	PTFE Seats, EPDM or Viton (Note 2)	**Body/Valve Ends**	Union with Socket Weld (Note 1)
		Pressure Rating (psi)	150 PSI
		Temperature Rating (deg C)	140 F PVC; PP 195 F
		Testing	-
		Operator	Screw Adjust
		Actuator	-
NOTES			
1. Valve shall have threaded double-union body that can be removed from the line without disengaging the end connections.			
2. When used with sodium hydroxide, valve elastomers shall be PTFE only.			
ACCEPTABLE PRODUCTS			
Griffco G Series	Plastomatic	Hayward Flow Control	

Pressure Regulating Valve

TYPE OF VALVE		**SYMBOL**	
Pressure Regulating Valve (Backpressure and Pressure Relief)		***PRV-4***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS**	**Type of Service**	Chemical – Sodium Hydroxide (Caustic Soda)
Body	316 SS	**Reference Document**	-
Seat Ring	-	**Size Range**	<2”
Elastomers	PTFE Diaphragm	**Body/Valve Ends**	Union with Socket Weld (Note 1,2)
		Pressure Rating (psi)	150 PSI
		Temperature Rating (deg C)	300 F
		Testing	-
		Operator	Screw Adjust
		Actuator	-
NOTES			
1. Valve shall have threaded double-union body that can be removed from the line without disengaging the end connections.			
2. No threaded ends, socket weld or Flanged only.			
ACCEPTABLE PRODUCTS			
Asahi/America, Inc.	Griffco G Series	Plastomatic	

Pinch Valve

TYPE OF VALVE		**SYMBOL**	
Pinch Valve		***PIV-1***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS**	**Type of Service**	Sewage, Water, Sludge, Mixed Liquor
Body	Ductile Cast Iron. The valve face-to-face dimensions shall be as given in ASME/ANSI B16.10. Open Body designs shall not be permitted.	**Reference Document**	-
Stem/ Pinch Mechanism	The pinch mechanism shall be double acting, centerline closure. The mechanism shall be supported in the valve body. (Note 3).	**Size Range**	4" to 24"
Sleeve	Buna-N inner tube in contact with the process, a high strength nylon, polyester or Kevlar fabric as recommended by the manufacturer for the conditions. The layers shall be vulcanized together to for a tough, maintenance free sleeve. (Note 1)	**Body/Valve Ends**	ANSI B16.1, Class 125/ANSI B16.5, Class 150 flanges
Sleeve Trim	Flange bolts shall not penetrate the sleeve as to retain its position allowing for in-line tube change, without removing the entire valve from the pipeline. No recalibration should be required in sleeve replacement. All internal valve metal parts are to be completely isolated from the process fluid by the sleeve.	**Pressure Rating (psi)**	Throttling Service 150 PSI
		Temperature Rating (deg C)	-
		Testing	-
		Operator	-
		Actuator	Motorized with manual override. Electric actuators as shown on the plans and as specified in Division 16. (Note 2)

NOTES

1. The port areas shall be 100% of the full pipe area at the valve ends and have inlet and outlet cones as identified on the drawings.
2. For below-grade applications (inside vaults), a torque tube shall be fitted to the body of the valve via a mounting plate. The tube shall extend from the valve to 36" above grade level, providing protection for the operating stem and supporting the motorized actuator. Coordinate actuator mounting stem/plate with actuator mfr.
3. The pinch mechanism shall be adjustable for stroke without removing the valve from the line.

4. The pinch valve and actuator assembly shall be integrated, adjusted, tested and have start-up services performed by an authorized manufactures representative.		
ACCEPTABLE PRODUCTS		
Red Valve Series 5200E or Series 5200ED	RF Valve – Enclosed Body	

Plug Valve

TYPE OF VALVE	**SYMBOL**
Eccentric Plug Valve	***PV-1***

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS** (Note 1)	**Type of Service**	Sewage, Sludge, Scum
Body	ASTM A126 Class B cast iron	**Reference Document**	ANSI/AWWA C517 Eccentric Plug Valves
Type of Plug	Eccentric, non-lubricated	**Size Range**	3" TO 36"
Plug	Standard and 3-way plug valves shall have resilient plug facings shall be of neoprene suitable for use with sewage, sludge or scum. (Note 4)	**Body/Valve Ends**	ANSI B16.1 125/ B16.5 150# FL or MJ or screwed as shown on drawings (Note 3)
Packing/Sealing	1)4" and larger valves shall be re-packable and adjustable packing without removing the bonnet 2) Lip Seal	**Pressure Rating (psi)**	150 PSI
Trim	SS	**Temperature Rating (deg C)**	300 F
Shaft	SS	**Testing**	-
Seats	Raised seats. Seats in 3" and larger valves shall have a welded-in overlay of high nickel content on all surfaces contacting the plug face. (Note 4, 5)	**Operator**	Geared (Note 2)
Bearings	Body: 316L SS Sealed, permanently lubricated in upper and lower stem journals; Thrust: PTFE	**Actuator**	Automated pneumatic or electric motor actuator as indicated on the plans and specifications.
Bonnet	Bolted, ASTM A126 Class B cast iron		

NOTES

1. For Potable Water Applications, Valve shall be NSF 61 certified – Lead free.
2. Valves shall have gear actuators and tee wrenches, extension stems, floor stands, chain-wheels, etc., as required or indicated on the Plans. Quarter turn lever actuators required if specifically noted on the Plans. All gearing shall be enclosed in a semi-steel housing and be suitable for running in a lubricant with seals provided on all shafts to prevent entry of dirt and water into the actuator allowing for submerged or buried service. The actuator shaft and the quadrant shall be supported on permanently lubricated bronze bearings. Actuators, if required, shall clearly indicate valve position, and an adjustable stop shall be provided to set closing torque.
3. Flanges of valves through 12" shall have face-to-face dimensions of standard gate valves.
4. Port areas of valves shall be a minimum of 80% of full pipe area.
5. ***Valves installed in sludge lines shall be installed with the seat on the upstream side and shall be designed for bi-directional service.***

ACCEPTABLE PRODUCTS

Dezurik	Pratt	Milliken	Val-Matic

- All exposed nuts, bolts, springs and washers shall be zinc-plated.
- Valves and gear actuators for buried or submerged service shall have seals on all shafts and gaskets on the valve and actuator covers to prevent the entry of water. Actuator mounting brackets for buried or submerged service shall be totally enclosed and shall have gasket seals. All exposed nuts, bolts, springs and washers shall be stainless steel.

Shear Gate Valve

TYPE OF VALVE		**SYMBOL**	
Shear Gate Valve		***SGV-1***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS** (Note 1, 2)	**Type of Service**	Liquid (Water or Sewage, Mixed Liquor)
Body	Cast Iron, ASTM 126B	**Reference Document**	-
Mounts	Bronze	**Size Range**	4" to 12"
Seat Wedges/ Seal Faces	Cast Iron, ASTM 126B, replaceable. Mounted with SS hardware.	**Body/Valve Ends**	ANSI B16.1, Class 125/ANSI B16.5, Class 150 flanged end
Disc	Cast Iron, ASTM 126B	**Pressure Rating (psi)**	30 ft WC
Seat rings, disc ring, hinge bolt and hinge nut	Bronze, B62.	**Temperature Rating (deg C)**	-
Lift rods	¾" diameter carbon steel. Shall be used to manually raise and lower the Shear Gate disc from a position above the gate.	**Testing**	-
		Operator	Handle, with extensions shall be furnished to elevations shown on Plans.
		Actuator	-
NOTES			
1. For Potable Water Applications, Valve shall be NSF 61 certified– Lead free.			
2. Full opening, circular port.			
ACCEPTABLE PRODUCTS			
Clow	M&H		

Solenoid Valve

TYPE OF VALVE		**SYMBOL**	
Solenoid Valve		***SV-1***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS** (Note 1)	**Type of Service**	Water, Filtered Process Water (free chlorine <10 ppm)
Body	PVC	**Reference Document**	
Seals	FKM	**Size Range**	½" to 2"
		Body/Valve Ends	NPT/FNPT
		Pressure Rating (psi)	150
		Temperature Rating (deg C)	
		Testing	
		Operator	
		Actuator	Solenoid magnet (Note 2)
NOTES			
1. For Potable Water Applications, Valve shall be NSF 61 certified – Lead free.			
2. Valve configuration data (normally (fail) closed, or normally (fail) open) shall be submitted to Engineer prior to ordering.			
ACCEPTABLE PRODUCTS			
Plast-O-Matic Z-Cool series (voltage per electrical requirements).			

Solenoid Valve

TYPE OF VALVE		**SYMBOL**	
Solenoid Valve		***SV-2***	
VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	**MATERIALS** (Note 1)	**Type of Service**	Water, Filtered Process Water (free chlorine <10 ppm); Class I, Division I hazardous area
Body	Stainless Steel	**Reference Document**	
Diaphragm	FKM	**Size Range**	½" to 2"
O-rings	FKM	**Body/Valve Ends**	NPT/FNPT
		Pressure Rating (psi)	150
		Temperature Rating (deg C)	
		Testing	
		Operator	
		Actuator	Solenoid magnet (Note 2)

NOTES

1. For Potable Water Applications, Valve shall be NSF 61 certified – Lead free.
2. Valve configuration data (normally (fail) closed, or normally (fail) open) shall be submitted to Engineer prior to ordering.

ACCEPTABLE PRODUCTS

Burkert Type 5282 (voltage per electrical requirements).		

END OF SECTION

SECTION 16000
ELECTRICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE

A. This Section consists of the Electrical General Requirements and related items necessary to provide complete and operational electrical system(s) indicated within the Contract Documents.

1.2 APPLICABLE SECTIONS AND REQUIREMENTS

A. The General Conditions, Supplementary Conditions, Special Conditions, Alternates and Addenda, applicable drawings, and the technical specifications herein shall apply to all work under this Division 16.

B. The CONTRACTOR shall comply with the specifications and accompanying drawings which describe and provide for the furnishing, delivering, installing, testing, and placing in satisfactory and successful operation all equipment, materials, devices, and necessary appurtenances to provide a complete electrical system for power distribution, control, lighting, and auxiliary systems.

C. State Licensed Contractor - All contractors must have a current state contracting license. The CONTRACTOR shall be licensed as such in the CONTRACTOR state of origin and in the state where the work is performed.

D. The electrical contractor shall have a licensed Master Electrician assigned to direct the electrical work and to coordinate work with the General Contractor and other trades. Furthermore, a licensed journeyman electrician shall be assigned to supervise the actual performance of all electrical work under Division 16.

E. The licensed journeyman assigned to supervise the performance of Division 16 electrical work, shall be required to be on the job site at all times, while Division 16 work is being performed.

1.3 CONTRACT DOCUMENTS

A. Contract documents consist of drawings, specifications, and other documents issued by the ENGINEER. Each is complementary and requirements shown, written or reasonably inferred there from on one is considered as written, shown or implied in all. In the event work is called for in more than one place and is of conflicting requirements, the right shall be reserved to require the installation of the larger or the more expensive.

B. The drawings are diagrammatic, intended to indicate the general scope and locations of the work to be installed and are not to be considered as complete in every detail, but shall be followed as closely as actual construction and work of other contractors will permit.

C. Data given herein and on drawings are as exact as could be secured, but their extreme accuracy is not guaranteed. Drawings and specifications are for the assistance and guidance of the CONTRACTOR; but exact locations, distances, and levels will be governed by actual conditions, and the CONTRACTOR is to verify all dimensions given on the drawings, and to report any discrepancy or inconsistency to the ENGINEER before commencing with the work.

D. The CONTRACTOR shall install all work indicated and/or specified herein, complete to perform the function intended without additional cost. Raceway and conductors to panels from devices referred to as "home runs" are indicated by pointing in the general direction of panels. Construction shall continue such circuits to the panels as though the routes were completely indicated. Home runs shall be installed from devices to panels as indicated.

E. Deviations from the drawings required to make work of this contract conform to actual conditions as constructed, or as to work of other contractors, shall be made by the CONTRACTOR at his expense. The ENGINEER reserves the right to make minor changes in the location of equipment and devices without additional charges.

F. The CONTRACTOR shall familiarize himself with the architectural, structural, and civil/mechanical drawings and shall study drawings and details so that equipment will be properly located and readily accessible. If any conflicts occur necessitating departures from the contract drawings, details of departures and reasons therefore shall be submitted for prior approval.

G. In any case and at any time, a change in material or location is made necessary by CONTRACTOR's failure to take into account obstacles or the installation of other trades shown, whether on electrical drawings or other drawings, in existence at the time bids were received, such changes shall be made without charge to OWNER.

H. Drawings are not intended to be scaled for rough-in measurements nor to serve as Shop Drawings. Where drawings are required for these purposes or have to be made from field measurements, they shall be prepared by the CONTRACTOR, Shop Drawings of various contractors shall be coordinated to take into account all obstacles that will interfere with the installation.

I. Every attempt has been made to indicate the installation and wiring requirements for all equipment to be installed. However, it shall be the CONTRACTOR’s responsibility to coordinate with equipment shop drawings and make adjustments necessary including; power and control wiring sizes and counts, breaker sizes, rough-in locations, etc. for actual equipment provided. The contractor shall provide in his bid the conductors and conduits required for the equipment to be installed. The contractor shall reference the mechanical drawings, the P&ID drawings, the control diagrams, the control drawings, the power drawings, the one line diagrams and all schedules. The contractor shall at his expense provide the conduit and conductors for the equipment installation for a complete and functional system.

J. Every attempt has been made in the drawings to indicate the general installation requirements for the power and control connections for the equipment indicated. However, equipment requirements vary from manufacturer to manufacturer and from date to date for equipment. The responsibility to coordinate the exact requirements of all equipment and install the required systems for these systems shall belong to the contractor, at his expense. No additional costs to the owner shall be incurred for the contractor's failure to coordinate these equipment requirements at the time of bid.

K. Electrical drawings are diagrammatic in nature and are not intended to show shop drawing style connections, equipment installation coordination or exact conduit and conductor sizes or counts. The contractor shall at his expense coordinate and provide necessary electrical and control components for a complete and functional system. If any conduit, equipment schedule, sizing, capacities, counts, lengths are unclear at the time of bidding or if conflicts exist on the drawings or in the specifications, the owner reserves the right for the installation of the more expensive or the more involved at no additional cost to the owner.

1.4 INFORMATION FOR ENGINEER

A. Submit the required information in accordance with the General Conditions, Section 01300, and the following requirements.

1. The CONTRACTOR shall check all shop drawings for conformance with Contract Documents before submitting. The CONTRACTOR shall note on shop drawings any changes from items specified listing reasons and giving source of change such as "Approved Equal", "Addendum", or "Change Order". The CONTRACTOR shall be responsible for conformance with drawings and specifications; for dimensions to be confirmed and correlated at the job site: for information that pertains solely to the fabrication processes or the techniques for construction; and coordination of the work with other trades. Receipt or approval of shop drawings by the ENGINEER does not relieve the CONTRACTOR of the responsibility of complying with Contract Documents.

2. All shop drawings (drawings and manufacturer's data) required under each section of this Division 16 shall be submitted at the same time and be bound together in one hard back, three ring binders per copy, properly indexed for the formal submittal. Binder shall be sized to adequately contain all the materials therein and shall be labeled as to the identity of the job and the sub-contractor.

3. Shop drawings shall include functional and descriptive literature of the particular item furnished complete with dimensional drawings, wiring or schematic diagrams, rough-in and installation instructions, knock-out locations, hangers or mounting devices, etc., as required for the proper checking and installation of the equipment. Catalog sheets without any reference made to the particular item will not be acceptable. All special features called for in Contract Documents shall be noted. Where performance test results of a product design are called for in the technical sections of these specifications, test data sheets shall be provided with the shop drawing submittal.

B. Material Lists: Include manufacturer, type and model number of equipment that will be provided as called for under each section of this Division 16.

C. Other Information: As required by the ENGINEER.

1.5 CODES, LICENSES AND STANDARDS

A. Perform work in accordance with best present-day installation and manufacturing practices. Comply with all applicable laws, building and construction codes, and requirements of governmental agencies under whose jurisdiction work is being performed. Unless specifically noted to contrary, conform with and test in accordance with applicable sections of latest revisions of the following codes and standards.

1. American Society for Testing and Materials (ASTM)
2. National Fire Protection Association (NFPA)
3. National Electrical Code (NFPA 70-NEC)
4. Insulated Power Cable Engineers Association (ICEA)
5. Underwriters Laboratories Inc. (UL)
6. American Steel and Iron Institute, "Design Manual on Steel Electrical Raceways"
7. National Electrical Manufacturer's Association (NEMA)
8. National Electrical Contractor’s Association (NECA)
9. American National Standards Institute (ANSI)
10. International Building Code (IBC)
11. State of Nevada Electrical, Energy, Building and Safety Codes
12. Institute of Electrical and Electronic Engineers (IEEE)
13. Instrument Society of America
14. Wastewater Treatment Plants (NFPA-820)

B. Conflicts Between Above Codes and Standards: The code or standard establishing the more stringent requirements shall be followed.

C. Conflicts Between Codes and Standards and Specifications and/or Drawings: The one establishing the more stringent requirements shall be followed.

1.6 MATERIALS AND WORKMANSHIP

A. Each type of equipment or material shall be the same make and quality. All materials and equipment shall be installed in accordance with the recommendations of the manufacturer as approved by the ENGINEER to conform to the Contract Documents. The installation shall be accomplished by workmen skilled in the type of work involved.

B. All materials and equipment furnished and installed shall be of best quality, new, free from defects and meet the standards of NEMA, ICEA, UL, NFPA, IBC, OSHA, NEC, and shall bear their label wherever standards have been established and label service is available. Where materials and equipment are specified by manufacturer's name, the type and quality required is thereby denoted. The ENGINEER shall be afforded every facility, deemed necessary to observe and examine the materials and apparatus being installed to prove their quality.

C. Workmanship shall be the best quality of its kind for the respective industry crafts and practices, be neat and orderly throughout the project and shall be acceptable in every respect to the ENGINEER. Nothing contained herein shall relieve the CONTRACTOR from making good and perfect work in all details of construction.

D. The CONTRACTOR shall work in harmony with the ENGINEER and with other contractor's, companies or individuals working in connection with this project. Imperfections or discrepancies by other contractors shall not relieve responsibility of this CONTRACTOR. Store materials orderly and clean up without interference with other trades.

1.7 DEFECTIVE EQUIPMENT

A. If equipment fails to conform to detailed specifications or to operate satisfactorily, the OWNER will have the right to operate equipment until defects are corrected.

1. The OWNER will have the right to operate rejected equipment until it is replaced, without cost for depreciation use or wear.

2. Remove equipment from operation for examination, adjustment, alteration or change only at times approved by the OWNER.

1.8 STORAGE AND PROTECTION OF MATERIALS

A. Provide storage space for storage of materials and apparatus and assume complete responsibility for all losses due to any cause whatsoever. In no case shall storage interfere with traffic conditions in any public thoroughfare or constitute a hazard to persons in the vicinity. Protect completed work, work under way, and apparatus against loss or damage.

B. Materials and apparatus shall be stored with environmental protection and other necessary conditions as recommend or required by the manufacturers'.

1.9 RECORD DRAWINGS

A. The Contract Document drawings will be used by the CONTRACTOR who shall accurately and neatly mark in colored pencil all changes or deviations from the drawings as they are made in the work.

B. Refer to Section "Closeout Procedures and Record Drawings" for additional requirements.

1.10 COORDINATION OF CONSTRUCTION

A. Coordinate work with other contractors, the OWNER, and the ENGINEER to assure orderly and expeditious progress of work. Select order of work and establish schedule of working hours for construction. This is subject to review by the OWNER if the work involved is part of a functioning facility. If such is the case, the CONTRACTOR shall carefully coordinate any disruption of service with the OWNER. Any after hours/weekend outages shall be accommodated at no additional cost to the OWNER.

B. The electrical work shall be laid out in advance of construction to eliminate unnecessary cutting, drilling, or channeling, etc. Where such cutting and drilling, or channeling becomes necessary for proper installation; perform with care, use skilled mechanics of the trades involved. Repair damage to building and equipment at no additional cost to the OWNER. Cutting work of other trades shall be done only with the consent of the CONTRACTOR. Cutting of structural members shall be done only with the written approval of the ENGINEER.

C. Comply with the following:

1. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
2. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
3. Install systems, materials and equipment giving right-of-way priority to systems required to be installed at a specified slope.

D. Cooperate with other trades to coordinate locations of electrical devices and apparatus.

E. Perform for other trades the electrical wiring and connections, for all devices or apparatus where not specified herein or indicated on the drawings. Consult the architectural and mechanical drawings to avoid the location of switches, outlets, and other equipment from being hidden behind doors, cabinets, counters, heating equipment, etc. Hidden electrical devices and/or connections shall be relocated as directed, at no additional cost to the OWNER.

F. Where conduit, outlets or apparatus is to be cast in concrete or encased, it must be located and secured by a journeyman or foreman present at the point of installation. He shall check the locations of the electrical items before and after the concrete and masonry installation and shall relocate displaced items at no additional cost

1.11 USE OF SUBSTITUTES

A. Equipment and materials are designated by one or more manufacturer's name brands or numbers. It is not the intent of the specifications to exclude other equipment or materials that equal or exceed the standard of those specified. If the CONTRACTOR desires to use substitute equipment or materials, he must submit for written approval as outlined in the General Conditions of the Contract Documents.

1.12 SITE CONDITIONS

A. Examination Of Site: Examination of the site shall be made by the CONTRACTOR, who shall compare it with the drawings and specifications and satisfy himself as to the conditions under which the work is to be performed. He shall, at such time, ascertain and check all conditions which may affect his work. No allowance shall subsequently be made in his behalf for any extra expenses to which he may be put due to failure or neglect on his part to make such examination.

B. Review of Plans: Review all work indicated on drawings and specified herein with proper authorities responsible for interpreting applicable codes, ENGINEER, and local inspector prior to commencement with construction as listed herein, but not necessarily limited thereto:

1. Visit site prior to executing bid.
2. Verify measurements and locations of field measurements of existing conditions and those developed by construction.
3. Confirm requirements of work at off-site, publicly owned property with local authorities
4. Confirm connection requirements, sizes and layout with local public utilities.
5. Conditions discovered in conflict with intent of drawings and/or specifications must be clarified with ENGINEER prior to execution of work.

1.13 CLEAN-UP

A. As the work progresses and on a daily basis, the CONTRACTOR shall remove from the premises and surrounding streets, alleys, etc., all rubbish and debris resulting from his operations and shall leave all equipment and material furnished by him absolutely clean and ready for use.

1.14 SUPERVISION:

A. A competent foreman or superintendent initially approved by the ENGINEER shall be at the site at all times to receive instructions and shall be empowered to act. He shall verify dimensions given on the drawings and report any discrepancies or inconsistencies to the ENGINEER before commencing the work. The ENGINEER, or his representative, will interpret the meaning of the drawings and specifications where questions arise.

1.15 SAFETY REGULATIONS

A. The CONTRACTOR shall comply with OSHA and all other safety codes required by law and shall furnish and place proper protection for prevention of accidents. He/she shall provide and maintain any necessary construction required to secure safety of life or property during the performance of his/her work, including the maintenance of sufficient lights to secure such protection.

1.16 DISPOSITION OF EXISTING EQUIPMENT REMOVED FROM SERVICE

A. Existing equipment and materials such as cables, switches, conductors, etc., which are removed and not reused in the new installation shall remain the property of the OWNER. The CONTRACTOR shall deliver such equipment to storage place as directed. Items not wanted by the OWNER shall be removed from the site and disposed of by the CONTRACTOR.

1.17 PERMITS AND FEES

A. Obtain all permits and pay all fees for inspections, required by code for all the work covered under Division 16 of the specifications. All fees shall be included in the contract price. The CONTRACTOR shall furnish a certificate of approval to the ENGINEER from each inspection authority at completion of the work.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 FIELD DESIGN CHANGES

A. No field changes, additions, or change in locations shall be made without written approval from the ENGINEER.

3.2 EXCAVATION AND BACKFILLING

A. The CONTRACTOR shall perform all excavation, trenching and backfilling work, and remove all debris in connection with his work. Backfilling shall be done with materials acceptable to the ENGINEER and thoroughly tamped in place. All disturbed surfaces shall be restored to their original condition and properly installed to eliminate any settlement. Inside and outside, backfill shall be in 6-inch layers, compacted to 95% of the "standard protector test".

B. Perform excavation in a manner to protect walls, footings and other structural members, from being disturbed or damaged in any way.

3.3 ROUGH-IN REQUIREMENTS

A. Architectural, structural and mechanical drawings shall be continually consulted and referred to. Exact placement of sleeves, conduit, and equipment shall be provided for by checking building and equipment dimensions. Equipment requirements and dimensions related there to shall be determined from detailed rough-in dimensions of each piece of equipment shown on Shop Drawings furnished by manufacturer.

3.4 CUTTING AND PATCHING CHASES AND OPENINGS

A. Provide for all required cutting and patching, anchors, openings, slots, chases, etc., in construction for electrical work. Cutting and patching performed under direction of CONTRACTOR and will leave no discernable scars.

B. The CONTRACTOR shall be responsible for block-outs or demolition work pertaining to the installation of the electrical system.

C. In Remodeling and/or Addition projects, all salvageable electrical equipment and materials that cannot be integrated into the new electrical network becomes the property of the OWNER. Remove from the premises materials which the OWNER decides not to keep, as directed by the ENGINEER.

3.5 WORKMANSHIP

A. The CONTRACTOR shall be held solely responsible for the proper installation of his work. He shall arrange with the proper contractors for the building in of anchors, etc., and for the leaving of required chases, openings, etc., and shall do all cutting and patching made necessary by his failure or neglect to make such arrangements with others. Any cutting or patching done by this CONTRACTOR shall be subject to the directions of the ENGINEER and shall not be started until approval has been obtained.

B. All cutting, welding or drilling of concrete or structural members shall be properly reinforced and patched to match as nearly as possible the surrounding work. Before cutting, welding or drilling any concrete or structural member, the CONTRACTOR shall secure the approval of the ENGINEER.

C. This CONTRACTOR shall assign persons in direct charge of work who are thoroughly experienced in the class of construction work specified herein. All labor shall be performed in a workman like manner by skilled workmen under the supervision of competent foremen.

D. This CONTRACTOR shall periodically remove all debris and waste in order to maintain safe working and operating conditions, and shall dispose of the same in an approved manner. At the completion of work, he shall remove all his rubbish, tools, scaffolds and surplus materials from and about the site, leaving his work clean and the areas ready for occupancy.

3.6 SEISMIC RESTRAINT

A. The International Building Code requires that not only the structure, but also major mechanical and electrical components be designed and installed in a manner which will preclude damage during a seismic event. All electrical equipment shall be securely anchored and seismic braced in accordance with regulations contained in the most recent adopted edition of the IBC, and SMACNA "Guidelines for Seismic Restraints of Electrical Systems".

B. Units mounted and secured directly to structure shall be provided with connectors of sufficient strength to meet the restraining criteria.

C. All electrical equipment which is securely anchored (hard mounted) to the building or structure shall have supports designed to withstand lateral and vertical "G" loadings equal to or greater than IBC requirements and SMACNA guidelines.

D. Shop drawings are required for all equipment anchors, supports and seismic restraints. Submittals shall include weights, dimensions, load/deflection data, center of gravity, standard connections, manufacturer's recommendations, and behavior problems (vibration, thermal, expansion, etc.) associated with equipment so that the final design can be properly reviewed.

3.7 TESTS

A. On completion of the work, the installation shall be tested free from all grounds and short circuits.

B. Normal feeders, circuits, and service entrance conductors with wire size #2 and larger shall be tested for leakage phase-to-ground and phase-to-phase prior to energizing the electrical system. The CONTRACTOR shall submit a written report to the ENGINEER showing methods and readings taken. Voltage applied for testing shall not exceed two times normal operating voltage.

C. Submit a record of voltage readings and amp meter readings on all feeders, motor full load amps, outside lighting, and service conductors to the facility. If there are any abnormal conditions, they shall be brought to the attention of the ENGINEER in writing as a part of this submittal.

D. Refer to Section "Electrical Acceptance Tests" for additional requirements.

3.8 SUBSTANTIAL AND FINAL COMPLETION

A. Notify the ENGINEER when work is considered to be complete, in operating condition, and ready for Substantial Completion.

B. The ENGINEER, after determining that installation is ready for Substantial Completion, will make walkthrough and perform operational tests deemed necessary to determine that provisions of specifications are satisfied and prepare a list of outstanding items.

C. The OWNER will not accept work nor make final payment to CONTRACTOR until ENGINEER has certified that work of CONTRACTOR is complete and in conformance with specifications and guarantees.

D. Leave the job in complete order ready for use. All fixtures and equipment shall be tight, fully equipped and completely cleaned. All equipment shall have been operated, checked and approved by the OWNER before the project can be accepted.

E. At the time of the substantial and final walkthroughs, the project foreman shall accompany the party and remove cover plates, panel and enclosure covers, and other access panels for the ENGINEER, to allow complete observation of the entire electrical system(s).

F. Notify the ENGINEER when work is considered to be complete, including list of outstanding items, and is ready for Final Completion. Refer to Section "Closeout Procedures and Record Documents" for additional requirements.

3.9 TRAINING

A. Instruct OWNER's operating personnel in proper operation of the complete electrical system including all electrical equipment, switching, disconnects, panels, controls, etc., during a scheduled training tour for the OWNER's personnel of entire project after Substantial Completion and prior to Final Completion. Confirm complete understanding on part of OWNER's operating personnel. Utilize the Operations and Maintenance Manuals specified elsewhere during the instruction process.

3.10 GUARANTEE/WARRANTY

A. The following guarantee is a part of the specification and shall be binding on the part of the CONTRACTOR and shall be submitted by letter to the OWNER prior to acceptance.

B. The CONTRACTOR guarantees that this installation complies with the drawings and specifications in all respects, and is free from defects. He agrees to replace or repair, to the satisfaction of the ENGINEER, any part of this installation which may fail or be determined unacceptable within a period of one (1) year after Final Completion.

C. The CONTRACTOR guarantees that the installation of OWNER furnished equipment is free from defects. He agrees to provide labor to repair or replace to the satisfaction of the ENGINEER any part of his installation of the OWNER furnished equipment (the respective equipment vendor will provide all parts and labor for the equipment), which may fail or be determined to be unacceptable within a period of one (1) year after Final Completion.

D. Electrical and instrumentation systems and equipment shall not be considered acceptable for Substantial Completion until they have performed in service continuously without malfunction for at least ten (10) days.

END OF SECTION

SECTION 16060
GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SCOPE

A. Furnish all labor, materials, equipment, appliances, and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work:

1. Grounding electrodes and conductors.
2. Equipment grounding conductors.

1.2 APPLICABLE SECTIONS

A. The General Conditions, Supplementary Conditions, alternates and Addenda, applicable drawings and the technical specification including but not limited to the following:

1. Section “Electrical General Requirements”.

1.3 REFERENCES

A. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (International Electrical Testing Association).

B. NFPA 70 - National Electrical Code.

1.4 GROUNDING SYSTEM DESCRIPTION

A. Metal underground water pipe.

B. Metal frame of the building.

C. Concrete-encased electrode.

D. Rod electrode.

E. Plate electrode.

F. Active electrode.

1.5 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance: 25 ohms maximum.

1.6 SUBMITTALS FOR REVIEW

A. Section Submittals: General.

B. Section Submittals: Procedures for submittals.

C. Product Data: Provide for grounding and bonding equipment.

D. All submittals shall include a list of all items being submitted by description, manufacturer and catalog number.

1.7 SUBMITTALS FOR CLOSEOUT

A. Section “Operation and Maintenance Manuals”.

B. Project Record Documents: Record actual locations of components and grounding electrodes.

C. Certificate of Compliance: Indicate approval of installation by the authority having jurisdiction.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum 5 years documented experience.

1.9 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 ROD ELECTRODES

A. Material: Copper Clad Steel.

B. Diameter: 5/8 inch.

C. Length: 10 feet (3000 mm).

2.2 CONNECTORS

A. Manufacturers:
1. T&B
2. Burndy - Hi-Ground
3. ERICO® - Cadweld®

B. Material: Irreversible Crimp Style or Exothermic Weld.

2.3 WIRE

C. Material: Stranded copper, tinned.

D. Grounding Electrode Conductor: Size as indicated in the Drawings, or if modified or not indicated, size to meet NFPA 70 requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.2 INSTALLATION

A. Install electrodes at locations indicated and in accordance with manufacturer's instructions. Install additional rod electrodes as required to achieve specified resistance to ground.

B. Provide grounding electrode conductor (UFER) and connect to reinforcing steel in foundation footing. Bond steel together.

C. Provide bonding to meet Regulatory Requirements.

3.3 FIELD QUALITY CONTROL

A. Perform inspections and tests listed in NFPA ATS, Section 7.13.

END OF SECTION

SECTION 16100

LIGHTNING PROTECTION

PART 1 - GENERAL

1.1 SCOPE

Furnish all labor, materials, equipment, appliances and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work:

A. Air terminals and interconnecting conductors.

B. Grounding and bonding for lightning protection.

1.2 APPLICABLE SECTIONS

The General Conditions, Supplementary General Conditions, alternates and Addenda, applicable drawings and the technical specification including but not limited to the following;

A. Section “Electrical General Requirements”.

B. Section “Conductors and Cables”.

1.3 REFERENCES

A. LPI-175 - Lightning Protection Installation Standard.

B. LPI-176 - Lightning Protection System Material and Components Standard.

C. LPI-177 - Inspection Guide for LPI Certified Systems.

D. NFPA 78 - Lightning Protection Code.

E. UL 96 - Lightning Protection Components.

F. UL 96A - Installation Requirements for Lightning Protection Systems.

1.4 SYSTEM DESCRIPTION

A. Lightning Protection System: Conductor system protecting consisting of air terminals on roofs, roof-mounted mechanical equipment, chimneys and stacks, parapets, bonding of structure and other metal objects; grounding electrodes; and interconnecting conductors.

1.5 SUBMITTALS FOR REVIEW

A. Section 16 05 00 – Electrical General Requirements: Procedures for submittals.

B. Shop Drawings: Indicate layout of air terminals, grounding electrodes, and bonding connections to structure and other metal objects. Include terminal, electrode, and conductor sizes, and connection and termination details.

C. Product Data: Provide dimensions and materials of each component, and include indication of listing in accordance with UL 96.

1.6 PROJECT CLOSEOUT SUBMITTALS

A. Record actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors in project record documents.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with NFPA 70.

B. Perform Work in accordance with UL 96A

C. Perform Work in accordance with LPI-175

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in lightning protection equipment with minimum three years experience and member of the Lightning Protection Institute.

B. Installer: Authorized installer of manufacturer with minimum three years experience and certified by the Lightning Protection Institute.

1.9 REGULATORY REQUIREMENTS

A. Product Listing: UL 96 and LPI-176.

B. System shall be UL listed and certified.

1.10 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on shop drawings.

1.11 COORDINATION

A. Coordinate work with roofing and exterior and interior finish installations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS AND INSTALLERS

A. VFC Corporation. North Salt Lake, Utah.

B. Robbins Lightning, Inc.

2.2 COMPONENTS

A. Air Terminals: Copper solid with adhesive bases for single-ply roof installations.

B. Air Terminal for Chimney: Lead-coated copper.

C. Grounding Rods: Solid copper

D. Ground Plate: Copper.

E. Conductors: Copper cable

F. Connectors and Splices: Bronze

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with NFPA 78, UL 96A and LPI-175.

B. Connect conductors using exothermic welding process. Protect adjacent construction elements and finishes from damage. All welds shall be witnessed by the OWNER.

C. Bond exterior metal bodies on building to lightning protection system and provide intermediate level interconnection loops 60 feet (18 m) on center.

3.2 FIELD QUALITY CONTROL

A. Obtain the services of Underwriters Laboratories, Inc. to provide inspection and labeling of the lightning protection system in accordance with UL 96A.

B. Obtain the services of the Lightning Protection Institute to provide inspection and certification of lightning protection system in accordance with LPI-177.

END OF SECTION

SECTION 16107
ELECTRICAL POWER SYSTEM STUDIES

PART 1 - GENERAL

1.1 SUMMARY

A. The electrical equipment manufacturer shall provide electrical power system studies for the project. The studies shall be prepared by the licensed professional electrical engineer of record for the plant. The type and content of each study is specified in the following articles.

1.2 SUBMITTALS

A. Completed electrical power system studies shall be bound and submitted to the ENGINEER.
   1. Five (5) printed copies (hardcopies) of the completed study report shall be provided and one (1) copy in Microsoft Word or Adobe Acrobat format.
   2. The software database and library used to model the power system shall be submitted in native file format including all updates to the library necessary to complete the model.

B. The CONTRACTOR shall attach brochures, resumes, references and other information indicating how your firm is qualified to provide the services outlined in this document.

C. The CONTRACTOR is responsible for compliance with all performance specifications in this proposal. Any deviation from complete compliance must be noted on the performance specification submitted for review and approved before work begins.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The analysis software shall be SKM Analysis Software or equal meeting all performance specifications.

2.2 ELECTRICAL POWER SYSTEM STUDIES

A. An electrical arc flash hazard analysis, including:
   1. The development of an up-to-date electrical system one-line diagram and model to provide staff members with an accurate representation of the installed electrical system.
   2. Determination of system operating modes and conditions that can impact short circuit currents and arc flash hazard energy levels.
   3. Short circuit and equipment duty study to verify that equipment is rated to safely handle short circuit currents without creating hazardous conditions.
   4. Protective device coordination study and review to help ensure proper electrical system reliability and to determine if arc flash hazard energy levels can be reduced.
   5. Arc flash hazard analysis study to determine arc flash energy levels and Personal Protective Equipment (PPE).

6. Power System Modeling and Arc Flash Analysis software for ongoing use by the staff members maintaining and updating the system study as the plant changes.
7. Arc flash and safety program implementation software for ongoing use by the staff members for arc flash and safety program management and tracking.
8. Arc flash hazard labeling.
9. Assistance with the development of Energized Work Permits.
10. Arc flash and electrical safety training.
11. Personal Protective Equipment (PPE) training.

B. An electrical arc flash hazard analysis shall be performed to determine incident energy, arc flash protection boundaries, and required PPE for all electrical equipment in the facility. The calculations shall comply with NFPA-70E 2004, and IEEE-1584-2002. An integral part of NFPA-70E compliance is integrating work permits with arc flash assessment for all equipment in this facility. This section describes in detail the requirements for the study as well as integrating work permits in the system model for 70E compliance.

C. The purpose of this study is to provide a comprehensive software model of the electrical distribution system, which will document facility compliance with NFPA 70E mandates as described below. This model will serve as an integral part of an ongoing safety program by providing integral work permits and arc flash calculations in compliance with NFPA-70E 2004 Article 130.1(A)(2) for each electrical equipment in the facility.
   1. Article 205.3, 120.2(F)(1): Updated and verified one-line diagram for all electrical distribution voltages including all sources for lock-out and tag out procedures.
   2. Article 400.5, 400.6: Updated short circuit and equipment duty verification study showing all electrical equipment is properly rated to withstand and interrupt the available short circuit duty per ANSI Standards and NEMA/UL/NEC requirements.
   3. Article 400.6, 410.9: Updated protective device coordination study showing the system protective devices are properly set to coordinate and clear a fault without extensive equipment damage or personnel risk.
   4. Article 130.3(A)(B), 110.8: Updated arc flash study providing maximum incident energies, arc flash boundaries, and PPE requirements for each equipment in the system. In addition, these calculations shall be integrated with 70E compliant work permits as part of an ongoing safety program.
   5. Article 130.16(E), 400.11, 400.14, 400.21(C)(2), 410.8: Updated labeling displaying the worst-case arc hazard values for each equipment in the facility.

D. The analysis shall consist of the following:
   1. Field data collection by qualified personnel (as defined by NFPA 70E).
   2. Data entry and system one-line modeling in commercially available power system software.
   3. Model verification.
   4. Short Circuit and equipment verification study.
   5. Protective device coordination study.

6. Arc flash hazard study.
7. Detailed report and findings of the analysis.
8. Electronic copies of the Project Report and the System Modeling File.

E. The analysis and procedures shall comply with the following standards and recommended practices for power system studies.
1. NFPA-70E, 2004 Standard for Electrical Safety in the Workplace
2. IEEE-1584-2002
3. IEEE-242 “Buff Book” Protection and Coordination of Industrial Power Systems
4. IEEE-399 “Brown Book” Power System Analysis
5. IEEE-141 “Red Book” Electric Power Distribution for Industrial Plants

2.3 DATA COLLECTION

A. Field data collection shall be performed by qualified individuals (as defined by NFPA 70E – 2004) to ensure accurate equipment modeling.

B. Field data collection and system modeling shall be based on the system installed.

C. Equipment shall be visually inspected to collect the necessary nameplate data used in the analysis, including transformers, switchgear and breakers, relays, direct-acting trip units, etc. Data that may not be readily accessible or may not have nameplate data such as conductors, busway, etc. can be taken from drawings.

D. Data collection shall include the step down transformer from the utility service (including primary relaying) down through each 480-volt motor control center (MCC) and 240/208 volt panels for all systems served by transformers rated greater than 125 kVA as per IEEE-1584-2002.

E. The CONTRACTOR shall obtain from the utility the minimum, normal, and maximum operating service voltage levels, three-phase short circuit MVA and X/R ratio, as well as line-to-ground short circuit MVA and X/R ratio at the point of connection as shown on the drawings.

2.4 SYSTEM MODELING

A. The system model shall be developed using a commercially available, fully integrated software package that meets the performance specifications developed in this Section. To ensure compliance with NFPA-70E 2004, ANSI, and IEEE Standards, and OSHA mandates, no exceptions or substitutions to the performance specification are allowed.

B. The system model shall be laid out in one drawing/view and in a manner that provides for easy viewing of all analysis results. The one drawing/view requirement ensures that problem areas found and highlighted by the program are easily seen and not hidden or buried in multiple drawings, eliminating potential human errors where multiple drawing verification is required.

C. All one-line symbols shall be spaced properly to facilitate viewing results on the one-line.

D. Equipment names used in the modeling software shall be identical to the equipment and naming convention shown on the drawings and equipment unless conflicts exist. The CONTRACTOR shall bring all naming convention conflicts or deficiencies to the attention of the ENGINEER for clarification.

E. The facility may have multiple operating conditions, including, but not limited to, generation on/off, shutdown, bus-ties, start-up, emergency operation, etc. Each of the operating modes shall be documented and modeled in the software in order to determine the worst-case arc flash hazard and associated parameters for the electrical equipment. For the purpose, assume that up to four (4) operating modes are possible.

F. The software shall model each operating mode in a manner such that each mode is a scenario or change case from the base case. Each scenario shall be a simple differential algorithm storing only the difference from the base case and the scenario. Modifications to the base case model shall automatically update all scenarios to eliminate the necessity to store complete databases for each condition, providing for a manageable file size that can be Emailed and eliminating the associated time, man hours, and errors with updating each database individually.

G. Project files created by the software shall be single files and not project directories containing multiple files. The file shall be self-contained and have all necessary information to describe the one-line, system data, settings, and analysis information. Files shall be easily transferable to any site via Email or disk and operable with no setting changes to the database file to eliminate the maintenance and administrative problems associated with multi-file project directories, and to provide an easy method to transfer the file for engineering review.

H. The software shall accurately model daisy-chained MCC's, panels, and sub-transformers without the use of intermediate buses, nodes or fake impedances.

I. Lumped motor groups for MCC's shall be modeled per IEEE standards using groups >50 Hp, and <50 Hp. Where motor list data is not available, single lumped groups may be modeled per IEEE-141 "Red Book".

J. Medium voltage motors greater than 1.0 kV shall be modeled individually on their respective buses including all protective phase and ground overcurrent relays and fuses. This model will provide individual work permits for each starter/motor on the one-line.

K. All low voltage power circuit breaker (LVPCB), insulated case (ICCB), molded case (MCCB) and fuse data shall be modeled based on the actual nameplate data including manufacturer, type, style, trip device, and actual settings. Generic substitutions or assumptions shall not be allowed unless data cannot be field verified. All assumptions shall be documented in the report.

L. All relay data shall be modeled based on the actual nameplate data including manufacturer, type, style, trip device, and actual settings. Generic substitutions or assumptions shall not be allowed unless data cannot be field verified. All assumptions shall be documented in the report.

M. All overcurrent relay types for the distribution system shall be modeled on the one-line diagram (and database) including phase and ground overcurrent, differential, residual, ground neutral, etc. to establish a complete and detailed system model where protective device data can be easily modified and updated by the facility and all data is available for a comprehensive protective device coordination study if required in the future.

N. Relay models shall depict the actual connection requirements. See Figure-1.3M. Programs using symbols as shown in Figure-1.3M(na) are not acceptable since they do not depict the actual system and can lead to confusion in determining arc flash results and proper protective device modeling.

O. Multi-function relays shall have all their overcurrent devices modeled in a single device and shall be able to accept multiple CT's.

P. All equipment modeling must have a corresponding one-line diagram symbol. This means that there can be no hidden database models. The purpose is for the facility to easily see all equipment, its associated data, to be able to link documents to the equipment as a data repository, etc. and to see problems right on the one-line.

Q. All system modeling shall conform to accepted modeling practices as outlined in IEEE-399 "Brown Book". Contractor/consultant may provide more advanced modeling techniques where compliance with the specification is maintained.

2.5 MODEL VERIFICATION

A. The system model shall be verified by reviewing the results of short circuit current flows for all buses/equipment in the system. The results shall be viewed on each branch and total flow into a bus/equipment on the system one-line diagram. The purpose is to visually spot check values with recognized industry benchmarks as to the expected amount of short circuit current, and correct any problem areas.

2.6 SHORT CIRCUIT STUDY

A. A short circuit study shall be performed to verify all equipment duties in the system. The calculations shall comply with ANSI C37.010, C37.13, C37.5, IEEE-141, and IEEE-399. The short circuit study shall verify the system electrical equipment is properly rated to withstand and interrupt the expected bolted and arcing faults in the system. Improperly rated and applied equipment may not protect personnel against arc flash hazards even if properly applied PPE is used. The software program must comply with the above standards in order to properly verify equipment installed in North America. No substitutions will be allowed.

B. The equipment duty verification shall determine both the line side and load side fault current through each equipment and use the highest current to verify equipment ratings. Standard bus faults are not acceptable for protective devices in that they do not accurately model the current through the device and consequently they provide erroneous results. For solidly grounded systems, both three-phase and single-line-to-ground faults should be modeled. For other grounding configurations only a three-phase fault is required.

C. Equipment duty results shall be graphically displayed on the electrical one-line as well as tabular report format.

D. The results of the equipment duty verification tabular format report shall provide the following data:

1. Equipment name and kV
2. Manufacture, type, style, and ratings of the device
3. Actual line or load side currents through the device and percent over/under duty
4. Flag for the device showing VIOLATION or WARNING level for visual identification

E. A report of all problem areas shall be provided. Consultant/contractor shall notify XYZ Corporation – Abc Facility personnel immediately of all problems found in this system before proceeding in the study. A recommended action list shall be provided for all underrated equipment in the system.

2.7 PROTECTIVE DEVICE COORDINATION (PDC) STUDY

A. A PDC study shall be performed in order to determine if the system protection characteristics are sufficient to provide reliable power to the facility. The PDC study will also determine if the settings entered in the software will provide proper personnel protection in the arc flash portion of this study. For facilities where the main distribution is low voltage (under 600 volts) and only instantaneous breakers or fuses are used, this section may not apply.

B. The PDC study shall consist of system feeders and branch circuits 100amps and larger, and plotting the time-current curves (TCC's) to verify proper selective operation of the protective devices. The study should also determine if the settings can be enhanced to provide increased personnel/equipment protection without sacrificing selective coordination.

C. The CONTRACTOR shall notify the ENGINEER of any potential problems in the protective device settings that affect either selective operation and reliability or personnel protection and shall provide recommendations for changes in writing before continuing with the study.

D. As specified in the data collection and modeling sections, all PDC data shall be modeled on the one-line diagram and in the equipment database.

E. The CONTRACTOR shall contact the serving utility and obtain protective device settings for all service entrance over current devices in series with the facility and affecting coordination with facilities distribution system.

F. TCC Specifics: The TCC's shall graphically illustrate on log-log paper that adequate time separation exists between series devices. The specific time - current characteristics of each protective device shall be plotted in such a manner that sufficient upstream devices will be clearly depicted on one sheet to prove selective coordination.

1. TCC's shall include a system one-line diagram and protective device coordination curves for each device in the selected area. The TCC shall be printed in color on 8 ½ x 11" paper – full size portrait mode, using a log-log scale. The one-line diagram shall be part of the TCC and include all protective devices, equipment names, and short circuit currents calculated from the main one-line. The purpose of this requirement is to provide all necessary information on one sheet, in a format easily readable and standard to the industry.

2. For low voltage systems, TCC's shall be developed for both phase and ground protective devices. One phase and one ground TCC should be developed for each unit substation. The TCC should show the largest feeder/motor protective device in the MCC or panel up through the switchgear/switchboard feeder breaker, transformer secondary main, unit substation primary fuse, and medium voltage feeder breaker. For secondary switchboards serving large loads or a wide variety of loads that may affect upstream coordination, additional TCC's may be required.
3. For medium voltage systems, TCC's shall be developed for both phase and ground protective devices. The TCC should show the largest feeder/motor protective device in the lineup up through the switchgear/transformer secondary main, unit substation primary fuse, and medium voltage feeder breaker.

4. The following specific information shall also be shown on the coordination curves:
    a. Device identification.
    b. Voltage and current ratio for curves.
    c. Transformer three - phase and single-line-to-ground ANSI damage curves.
    d. Transformer inrush points.
    e. Minimum melting, and clearing curves for fuses, and if available the no-damage curve.
    f. Cable damage curves.
    g. Motor starting locked rotor curves, and if available the motor locked rotor damage point.
    h. Maximum short circuit cut-off point.
    i. Clearly marked short circuit current levels through each protective device/branch, which should be based on the appropriate current through the device, i.e. Momentary, Interrupting or 30 Cycle current.
    j. Protective device one-line diagram clearly showing all protective devices on the time-current curve, labels for each device, open breakers, faulted buses, and the short circuit current flowing in each branch.
    k. Each TCC sheet shall have appropriate identification and a one-line diagram that applies to the specific portion of the system associated with time-current curves on that sheet.
    l. Each protective device curve shall be terminated at a point reflecting maximum symmetrical or asymmetrical fault current through the device.
    m. Identify the device associated with each curve by manufacturer type, function, and setting – i.e. tap, time delay, and instantaneous, pickup, etc.
    n. Primary Protective Device Settings for Delta-Wye Connected Transformer:
        1) Secondary Line-To-Ground Fault Protection: Provide primary protective device operating band within the transformer's characteristics curve, including a point equal to 58 percent of ANSI C57.12.00 withstand point.
        2) Secondary Line-To-Line Faults: Provide 16 percent current margin between primary protective device and associated secondary device characteristic curves.

o. Typical time separations for curves:

1) Consultant/contractor shall discuss the advantages and disadvantages of various time separation settings between device curves with XYZ Corporation – Abc Facility personnel to help determine how the system settings shall be optimized for selectivity and arc flash hazard reduction.

G. A setting table shall be developed to summarize the settings selected/existing for the protective devices. The table shall include the following:

1. Device identification.
2. For low voltage breakers, the circuit breaker manufacturer, type, and style, sensor rating, long-time, short-time, instantaneous settings, and time bands. For breakers with ground fault capability, the pickup and time delay.
3. Fuse manufacturer, type, style, and rating.
4. Protective relay manufacturer, type, style, function (51, 50, 67, etc.) pickup, current multiplier, time dial, and delay. For multi-function units, list all devices being used. Include the CT and/or PT ratios for each function.

H. The software shall provide complete integration of the one-line, database, short circuit, protective device coordination and arc flash analysis functions to provide accurate calculations and avoid errors and inefficiencies associated with multiple data entry programs. Programs using separate PDC or TCC plotting packages are not allowed. Complete PDC integration is defined as the following:

1. TCC's shall be developed by simply selecting (highlighting) with the mouse the one-line area to be coordinated. The TCC shall automatically be plotted for the selected area including all short circuit levels. The TCC plot shall automatically include the selected one-line area in a drag and drop window on the TCC showing all one-line attributes without user additions required. These attributes shall automatically include all short circuit currents and voltages displayed on the main one-line, equipment names, etc. and update automatically without additional user input.
2. Programs requiring the user to build a separate TCC one-line are not integral with system short circuit calculations and do not automatically update as the system one-line changes, requiring additional man-hours for one-line development and are consequently prone to errors as the system changes. These types of programs shall not be considered for the study.
3. Each TCC shall have momentary (1/2 cycle), interrupting (1-4 cycle), and 30 cycle short circuit currents (tick marks) displayed on the TCC plot for each protective device or as required to properly model the tripping characteristics of the device. The tick marks shall be user adjustable for visual appearance. The purpose is to provide accurate tripping currents for each device.
4. The software model shall allow each protective device to model momentary (1/2 cycle), interrupting (1-4 cycle), and 30 cycle short circuit currents simultaneously depending on the characteristics of the device.

5. The software shall model remote voltages and currents for any single fault and display them on the TCC showing all trip cutoffs based on the remote currents. The purpose is to accurately model and verify backup relaying to ensure selective operation under all fault conditions. PDC programs that perform only batch faults, or fail to model remote voltages and currents for all fault types shall not be considered.
6. The software shall model and display time difference calculations for any selected pair of protective devices. The difference calculator shall include bracketing bars with the calculated difference to clearly show the selective time between the devices. The calculated time shall update dynamically for instant visual setting as the devices are dragged (settings modified). In addition, Windows tool tips shall clearly show the time difference and the protective device settings for all devices as they are dynamically changed or set to allow the user to accurately determine the proper setting between devices in the most efficient manner, reducing coordination time and providing more accurate results.
7. The software model shall provide for WYSIWYG drag and drop modeling of all protective devices and provide for tool tips and notes to display all settings dynamically. The purpose is to provide accurate adjustments and settings in the most time efficient and accurate manner.
8. TCC's shall have the ability to display short circuit currents and arc flash hazard results within the fully integrated system one-line in the PDC focus. Short circuit currents are available at any equipment with a single mouse click. Short circuit currents and arc flash hazard values shall change on the fly as the protective device settings change, allowing the user to instantly see the results of PDC changes and the associated impact to short circuit currents and arc flash hazard values.
9. The software model shall provide a detailed library for the most common protective devices available in North America. The library shall be user definable.

2.8 ARC FLASH STUDY

A. A detailed arc flash study shall be performed to determine potential arc flash incident energies, arc flash boundaries, shock hazard boundaries and proper personal protective equipment (PPE) for all energized electrical system equipment tasks for the electrical system studied. The calculations shall comply with NFPA-70E 2004, and IEEE-1584. Bolted short circuit calculations used in the above standards shall comply with ANSI C37.010, C37.13, C37.5, IEEE-141, and IEEE-399. The purpose of this study is to determine arc flash hazards in conformance with NFPA-70E and to facilitate a safety program for the OWNER, and to provide a comprehensive software model of the electrical distribution system, which provides integral work permits and arc flash calculations in compliance with NFPA 70E Article 130.1(A)(2) for all equipment in the facility. The software program used in this study shall comply with the above standards. No substitutions in calculation methods will be allowed.

B. The arc flash study shall determine the following results for each system mode of operation. The results shall be provided in spreadsheet format for each mode and electrical system location to provide easy viewing and comparison. Worst-case arc flash energy levels shall be flagged and the spreadsheet comparison table shall be capable of providing its output directly to high quality vinyl label printers. The calculations shall, as a minimum, include a comparison of both 100% and 85% arcing currents for low voltage equipment for each electrical system configuration or operating mode, indicating worst-case arc flash hazards. The spreadsheet results shall include:

1. Equipment name and voltage.
2. Upstream equipment device name and ANSI function, i.e. 51/50, etc.
3. Equipment type, i.e. switchgear, MCC, Panel, VFD, etc.
4. Equipment arc gap.
5. Bolted and estimated arcing fault current at the fault point (equipment) in symmetrical amperes. The estimated arcing current should be based on the arcing current equations used.
6. Trip time, opening time, and total clearing time (total Arc time) of the protective device.
7. Worst-case arc flash boundary for each bus/equipment in the model.
8. Worst-case arc flash hazard incident energy in cal/cm^2 for each bus/equipment in the model.
9. Worst-case personal protective equipment (PPE) for each bus/equipment in the model.
10. Working distances for up to five different distances showing items 7, 8, and 9 for each distance.
11. Indicate “Danger/Hazardous” areas where incident energy is greater than 40 cal/cm^2 and provide recommendations to reduced arc flash energy levels for these areas.
12. Flag results where 85% arcing current provided worst-case results.

C. Each mode of operation shall include a detailed write-up indicating areas where incident energy calculations and PPE requirements are higher than calculated in the normal operating mode.

D. Consultant/contractor shall provide a detailed arc flash analysis report including as a minimum:

1. Introduction.
2. Methodology.
3. Information Sources.
4. Key Assumptions.
5. Arc Flash Energy and other consideration for various System Modes of Operation (maintenance mode, bus-tie, co-gen on/off, etc.).
6. Arc Energy at 100% and reduced currents.
7. IEEE 1584-2002 Considerations.

8. Overcurrent Protective Device Changes, Replacements or Setting Changes implemented in study to reduce arc flash hazard exposure.
9. Explanation of Data in Arc Flash Hazard Report Tables.
10. NFPA 70E Information.
    a. Shock Hazards with covers removed.
    b. Shock Hazard Approach Boundaries.
        1) Limited Approach Boundary.
        2) Restricted Approach Boundary.
        3) Prohibited Approach Boundary.
    c. Arc Flash Hazard Boundaries.
11. Results of Arc flash Hazard Analysis for high voltage, medium voltage and low voltage systems, including:
    a. Working distances.
    b. Energy Levels.
    c. PPE Requirements.
    d. Recommendations to reduce arc flash hazard energy and exposure.
12. Arc Flash Hazard Report.
    a. 5 Hard Copies.
    b. 1 Electronic Copy in Adobe Acrobat format (5.0 or later).
13. Electronic file for Power System Modeling Software as developed and utilized for this analysis.

E. The CONTRACTOR shall provide printed labels for labels for all equipment in the system from the project study file. Assume three (3) labels per equipment/bus in your estimate using 4" x 6" labels or one (1) 6" x 8" label per equipment bus. The labels shall be UV resistant vinyl labels (white with orange warning strip and black letters) conforming to ANSI-Z535. The labels shall be printable directly from the power system software utilized for the study with a Duralabel, Brady PowerMark or GlobalMark printer to ensure that the OWNER's personnel have the option of printing the labels without the extra expense of going to an outside printing service, converting arc flash results to spreadsheet format or performing tedious manual data entry.

F. Software Requirements: The software shall provide complete integration of the one-line, database, short circuit, PDC and Arc flash functions. Software using separate short circuit, PDC, TCC or arc flash programs is not allowed. Spreadsheet calculations are not allowed. The purpose of this section is to ensure that the arc flash hazard calculations comply with NFPA-70E and IEEE-1584, and that the calculations are programmed with necessary requirements to help eliminate possible errors in the arc flash calculations. The additional purpose is to establish a detailed software model of the XYZ Corporation – Abc Facility electrical distribution system, which will document compliance with the OSHA requirements and NFPA 70E mandates. This model will serve as an integral part of the OWNER's safety program by providing integral work permits and arc flash calculations in compliance with NFPA-70E Article 130.1(A)(2) for each electrical equipment in the facility.

1. Arc flash calculations shall be performed with enhanced IEEE-1584 equations, which eliminate voltage discontinuities and the non-conservative/average results of the standard equations. The purpose of this requirement is to ensure that the calculated incident energies are closer to actual test results insuring a conservative calculation minimizing personnel risk.
2. Arc flash calculations shall be based on the fastest clearing upstream protective device protecting the equipment for single sources and the slowest upstream protective device for multiple sources. The calculations shall automatically compare all series and parallel upstream protective devices in the system to determine the fastest series device or a conservative parallel clearing time. The algorithm shall incorporate a traversing routine that can search back an unlimited number of buses/nodes and consider all series and parallel branches in the comparison to ensure accurate answers and to prevent hazards associated with incorrect results. Software shall not have trace back limits (5-10 buses) that can provide incorrect answers for low voltage faults that require high voltage protective device clearing to prevent potential errors.
3. The arc flash calculations including arc flash boundary, incident energy, PPE requirements, and working distance shall be displayed on the software one-line diagram and TCC simultaneously. The software must show visually the arc flash values as the settings are incrementally changed (dragging curves) so the protection can be optimized in the most efficient manner, allowing the protection engineer to visually balance the competing objectives of personnel protection with that of system selectivity.
4. The arc flash calculations shall include four (4) calculation options to ensure that the software provides the flexibility required to meet any system configuration or training requirement that may be considered. Each calculation option shall comply with the graphic and spreadsheet display requirements of this section. Each option is more specifically described below.
    a. The detailed option shall provide the let-through energy for each protective device in the system. This is the energy on the load side of the protective device. The equipment shall be highlighted when the let-through energy exceeds a user defined threshold-clothing limit.

b. Worst-case including main protective device. This option shall provide the worst-case arc-hazard energy for the equipment based on the let-through energy of the equipment's main protective device. If the equipment is not equipped with a main device, the program must traverse back the entire system to determine the fastest series upstream protective device. The equipment shall be highlighted when the let-through energy exceeds a user defined threshold-clothing limit.

c. Worst-case excluding main protective device. This option shall provide the worst-case arc-hazard energy for the equipment based on the let-through energy of the fastest upstream series protective device in the system. The program shall traverse back the entire system to determine the fastest upstream protective device. The equipment shall be highlighted when the let-through energy exceeds a user defined threshold-clothing limit.

d. Worst-case excluding and including the main protective device. A combination of options 'b' and 'c' as stated above.

5. The arc flash calculations shall provide integral "Work Tasks" for the listed equipment types. The tasks shall be derived from 70E Table 130.7(C)(9)(a) and be specific to the equipment type. Work tasks shall be user definable in the software to allow customization and integral with the "Work Permit" feature of the software. Listed equipment types shall include:

   a. Switchgear, Switchboards, Panelboards, MCC, VFD, UPS, ATS, Interrupting Switch, NEMA E2 Contactor, Conductor, Open Air for 100-200 volt equipment.

   b. Switchgear, Switchboards, Panelboards, MCC, VFD, UPS, ATS, Interrupting Switch, NEMA E2 Contactor, Conductor, Open Air for 200-1000 volt equipment.

   c. Switchgear, MCC, VFD, UPS, ATS, Interrupting Switch, NEMA E2 Contactor, Conductor, Open Air for 1.0-5.0 kV equipment.

   d. Switchgear, MCC, VFD, ATS, Interrupting Switch, NEMA E2 Contactor, Conductor, Open Air for 5.0-15.0 kV equipment.

   e. Switchgear, Interrupting Switch, Conductor, Open Air for 15.0-38.0 kV equipment.

   f. Interrupting Switch, Conductor, and Open Air for 38.0-1500 kV equipment.

6. Work Tasks shall have a user-defined library that provides the following customizable features for each work task:

   a. Work Tasks for each specific equipment type and voltage range.

   b. Working distance units English or Metric.

   c. Work distance for each task.

   d. V-rated gloves and tool requirements.

   e. Job description and procedures.

   f. Safe work practices description.

   g. Hazard Risk Category (HRC) reduction. *Note: HRC reduction can only be used based on a documented risk assessment as an integral part of a safety program.

7. Work tasks shall be accessible from the one-line diagram for any equipment through a mouse click on the equipment in the electrical system model one-line. A dialog box shall appear listing all 70E and user definable work tasks for the specific equipment selected. The work task dialog shall include a user definable working distance for each work task and allow the user to select tasks specific to any equipment feeder or the incoming main. Work tasks for each equipment type shall be voltage specific and user definable in the library. The purpose of these requirements is to integrate 70E work tasks to the one-line diagram for specific equipment types. This will provide the basis for a customized safety program and work permit process compliant with 70E mandates. The level of detailed requirements for the "work task" software is necessary to ensure that any variation of equipment type, equipment layout, or work procedure can be handled and documented in the software.
    a. The software interface shall allow the user to select any breaker fuse or switch on the one-line, and get a specific work task generated for that device showing the load side arc flash hazard (let-through energy) for that device. The purpose of this requirement is to detail specific feeder hazards when work tasks dictate working downstream from a feeder protective device.
    b. The arc flash calculations shall provide integral work permits for compliance with NFPA-70E, 2004 Article 130.1 (A). The work permits shall be integral with the system one-line diagram and the arc flash calculations and shall detect and account for work between feeder and main breaker.
8. Work permits shall be activated by mouse click, for all equipment types listed in K5. Work permits shall have the following calculated values and provide the following information specific to the "work task" and equipment selected:
    a. Shock hazard.
    b. Shock hazard boundaries.
    c. Arc flash boundary – worst-case for each equipment.
    d. Arc flash hazard incident energy in cal/cm2 for the equipment.
    e. Hazard Risk Category (HRC) and any applicable risk reduction.
    f. Required PPE category based on calculated energy level and optional risk reduction.
    g. Required PPE description based on PPE category.
    h. Determination of V-rated gloves and tools.
    i. Auto fill job description and procedures for each work task.
    j. Auto fill safe work practices description for each work task.
    k. Job briefing and planning check list.
    l. Approval sign off section.
    m. Working distance measurements in English or Metric units.
    n. Required work distance for each task.
    o. Documentation for safety program in compliance with 70E 130.1(A).
9. The work permits shall be created by the software in MS Word and have the following user customizable features:

a. Work Tasks for each specific equipment type and voltage range.
b. Restricted shock boundary.
c. Arc flash boundary – worst-case for each equipment.
d. Arc flash hazard incident energy in cal/cm2 for the equipment.
e. Hazard Risk Category (HRC) reduction for low risk tasks.
f. Required PPE category based on risk reduction.
g. Working distance in English or Metric units.
h. Working distance for each task.
i. V-rated gloves and tool requirements.
j. Flame Resistant clothing requirements.
k. Job description and procedures for each work task.
l. Safe work practices description for each work task.
m. Job briefing and planning check list.
n. Approval sign off section.

10. The power system software shall allow the created work permits to be linked via Windows "hyperlinks" to each equipment on the one-line diagram. The purpose is to provide a data repository of work permits performed on each equipment for 70E review, as well as providing a one-stop location where documents pertaining to the equipment can be accessed by maintenance and job planning.
11. The power system software shall be fully compatible with facility arc flash hazard and electrical safety implementation software that provides the following capabilities:
    a. Calculates shock hazards, shock hazard boundaries, arc flash boundaries, incident energies, PPE requirements, etc. for power systems modeled in EasyPower or EasyPower EasySolv.
    b. Built in Work Permit Feature for creation of custom Energized Work Permits complying with the NFPA-70E requirements. Work permit feature shall include NFPA risk assessment categories based on the task performed for all types of electrical equipment and voltage ranges. The work permit feature shall include an extensive library of user definable work tasks, safety procedures and safe work practices, saving XYZ Corporation – Abc Facility plant engineering staff, maintenance staff and contractors hours of productive time.
    c. Energized work permits, safety procedures, equipment instruction manuals, etc., shall be capable of being directly linked to the equipment one-line through a Hyperlinks feature, providing a one-stop data repository easily accessible to all plant and safety personnel, saving plant personnel and contractors significant productive time in locating the right instruction manual, equipment safety procedure, drawing, pictures and maps for the equipment. This feature shall also help XYZ Corporation – Abc Facility comply with OSHA and NFPA 70E record keeping requirements.
    d. Additional equipment information and records such as Maintenance Records, Maintenance Manuals, Operations Manuals, Lock out / Tag out procedures, etc. shall also be capable of being Hyperlinked to the equipment on the graphical one-line.

e. Program shall support creation of arc flash labels with direct output to high quality UV resistant vinyl label printers.

f. Program shall also have customizable output. Includes one-line printing, text report creation, export to AutoCAD, etc.

g. Program shall be a Windows based operating system and shall use Windows conventions.

h. Program shall be capable of being installed on stand alone personal computers or on networked systems and shall be compatible with all systems operating on Windows 2000 or higher operating systems.

i. Program shall be easily operable by the OWNER's staff without any specialized training.

12. The software shall be licensed to the OWNER and the original software package will be delivered at project completion.

2.9 REPORTING AND ANALYSIS SUMMARY

A. Executive Summary: The executive summary shall be brief 1-2 pages maximum and cover at an executive level the findings of the study, recommendations, and requirements for maintaining NFPA-70E compliance.

B. Scope of studies performed: The scope shall provide details of what actions were intended to be performed for each aspect of the study, including short circuit, protective device coordination, and arc flash.

C. Description of system and explanation of bus and branch numbering system.

D. Modes of operation studied: Each scenario/plant operating condition shall be thoroughly documented.

E. Detailed report and results of short circuit, coordination, and arc flash studies including:

1. Recommendations and additions to equipment rating and/or PDC characteristics.

2. Recommendations to reduce arc flash hazards for equipment with incident energies over 40 cal/cm^2.

F. Prioritized recommendations for all studies.

G. Action list and check off column for all recommendations.

2.10 QUALITY ASSURANCE

A. The studies shall be in conformance with the NFPA and ANSI Standards, and IEEE recommended practices detailed in this section. No substitutions in study methods or software conformance will be allowed.

END OF SECTION

SECTION 16108
ELECTRICAL ACCEPTANCE TESTS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section covers the work necessary to provide the inspection and testing services required to place the electrical system into operation.

1.2 GENERAL

A. See General Conditions and Division 1, GENERAL REQUIREMENTS, which contain information and requirements that apply to the work specified herein and are mandatory for this project.

B. This work may be conducted by the electrical subcontractors and/or independent testing laboratory but shall be performed by qualified personnel. The decision concerning acceptability of the qualifications of the individual and/or firm conducting the tests shall be determined during submittal review in accordance with Section “Quality Control”. The term "testing laboratory" shall unilaterally refer to the firm, subcontractor, etc., approved to conduct the tests.

1. For the purposes of the section the individual performing the testing, whether the electrical subcontractor, manufacturer's representatives or independent testing laboratory, shall be referred to as "testing laboratory."
2. The Contractor shall submit a division of responsibilities that shall detail who is responsible for performing each test.
3. All visual and mechanical inspections shall be conducted by the Contractor and Engineer.

C. The testing laboratory shall provide all material, equipment power, labor and technical supervision to perform such tests and inspections.

D. It is the intent of these tests to assure that all electrical equipment is operational within industry and manufacturer's tolerances.

E. Upon completion of the tests and inspections noted in these specifications, a label shall be attached to all serviced devices. These labels will indicate date serviced and the service company responsible.

F. The tests and inspections shall determine suitability for continued reliable operation.

G. All tests shall be conducted in the presence of the Engineer.

H. Electrical testing specified herein, and functional testing of all power and controls not tested under the Section “Process Control and Instrumentation Systems”, shall be completed before commencement of the 7-day test specified in Section “Electrical Acceptance Tests”.

I. The work may require the Contractor to activate circuits, shutdown circuits and run equipment, make electrical measurements, replace blown fuses, install temporary jumpers, etc.

J. Specific scope of work:

1. The following items of equipment shall be tested:
    a. Low voltage switchgear
    b. Motor control centers
    c. Transformers
    d. All wires and cables
    e. Motors
    f. Regulators
    g. Grounding system
    h. Entire control system and all process interfaces
    i. Adjustable speed drive (ASD) systems
    j. Reclosers
    k. Switches
    l. Lighting
2. All inspections and tests shall utilize the following references:
    a. Project design specifications
    b. Project design drawings
    c. Manufacturer's instruction manuals applicable to each particular apparatus.

K. Division of responsibility:

1. The Contractor shall perform routing insulation resistance, continuity and rotation tests for all distribution and utilization equipment prior and in addition to tests performed by the testing laboratory specified herein.
2. The Contractor shall supply a suitable and stable source of test power to the test laboratory at each test site. The testing laboratory shall specify requirements.
3. The Contractor shall notify the testing laboratory and schedule with the Engineer when equipment becomes available for acceptance tests.
4. The Contractor shall notify the Engineer prior to commencement of any testing.
5. The testing laboratory shall be responsible for implementing all final settings and adjustments on protective devices and tap changes in accordance with Owner's specified values.
6. Any system material or workmanship which is found defective on the basis of acceptance tests shall be reported directly to the Engineer.
7. The testing laboratory shall maintain a written record of all tests and upon completion of project, assemble and certify a final test report.

1.3 REFERENCED STANDARDS

A. See Section “General Electrical Requirements”, which lists the standards that apply to the work specified herein.

B. In addition, the following shall apply:

1. Manufacturer's recommended tests
2. ANSI C2, C37.20.1
3. NEMA WC 7, WC 8
4. IEEE 43,48,81,118
5. NETA ATS
6. NFPA 70

1.4 SUBMITTALS DURING CONSTRUCTION

A. Submittals during construction shall be made in accordance with Division 1, GENERAL REQUIREMENTS and Section “General Electrical Requirements”.

B. In addition, the following information shall be provided:

1. Shop drawings:
    a. The testing laboratory shall submit, in conformance with Section “Contractor Submittals”, a complete resume and statement of qualifications detailing their experiences in performing the test specified. This statement shall include:
        1) Corporate history and references.
        2) Resume of individual performing test.
        3) Equipment list and test calibration data.
    b. The Contractor shall submit to the Engineer and the testing laboratory, in conformance with Section “Contractor Submittals”, complete manufacturer's field testing acceptance testing procedures, as well as expected test results and tolerances for all equipment to be tested.
        1) Administrative Submittals: Submit 30 days prior to performing inspection or tests:
        2) Schedule for performing inspection and tests.
        3) List of references to be used for each test.
        4) Sample copy of equipment and materials inspection form(s).
        5) Sample copy of individual device test form.
        6) Sample copy of individual system test form.
        7) Quality Control Submittals: Submit within 15 days after completion of test: Test or inspection reports and certificates for each electrical item tested.
        8) Contract Closeout Submittals:

a) Operation and Maintenance Data:

b) In accordance with Section “Operation and Maintenance Data”.

c) After test or inspection reports have been reviewed by Engineer and returned, insert a copy of each in Operation and Maintenance Manual.

2. Test Report:

a. The test report shall include the following:

1) Summary of project.

2) Description of equipment tested.

3) Description of test.

4) Test results.

5) Conclusions and recommendations.

6) Appendix, including appropriate test forms.

7) List of test equipment used and calibration date.

b. Furnish six (6) copies of the completed report to the Engineer in conformance with Section “Contractor Submittals”.

PART 2 - PRODUCTS

2.1 TEST INSTRUMENT TRACEABILITY

A. The testing laboratory shall have a calibration program which maintains all applicable test instrumentation within rated accuracy.

B. The accuracy shall be traceable to the National Bureau of Standards in an unbroken chain.

C. Instruments shall be calibrated in accordance with the following frequency schedule.

1. Field instruments - 6 months maximum.

2. Laboratory instruments - 12 months.

3. Leased specialty equipment - 12 months. (Where accuracy is guaranteed by lessor).

D. Dated calibration labels shall be visible on all test equipment.

E. Records must be kept up-to-date which show date and results of all instruments calibrated or tested.

F. An up-to-date instrument calibration instruction and procedure will be maintained for each test instrument.

PART 3 - EXECUTION

3.1 PREPARATION

A. Safety and Precautions:

1. Safety practices shall include, but are not limited to the following requirements:
    a. Occupational Safety and Health Act - OSHA
    b. Accident Prevention Manual for Industrial Operations, Seventh Edition, National Safety Council, Chapter 4.
    c. Applicable State and Local safety operating procedures.
    d. NETA Safety/Accident Prevention Program.
    e. National Fire Protection Association - NFPA 70E.
2. The testing laboratory shall be solely responsible for safety during all tests.
3. In all cases, work shall not proceed until the testing laboratory, Contractor, and Engineer determine that it is safe to do so.
4. The testing laboratory shall have available sufficient protective barriers and warning signs to conduct specified tests safety.

B. Testing requirements prior to commencing the work:
1. All instruments required must be available and in proper operating conditions.
2. All dispensable materials such as solvents, rags and brushes required must be provided.
3. All equipment handling devices such as cranes, vehicles, chain falls and other lifting equipment must be available or scheduled.
4. All instruction books, calibration curves or other printed material to cover the electrical devices must be available.
5. Data sheets to record all test results must be available before the work is started.

C. Tests and inspection shall establish that:
1. Electrical equipment is operational within industry and manufacturer's tolerances.
2. Installation operates properly.
3. Equipment is suitable to be energized.
4. Installation conforms to requirements of these specifications and NFPA 70, NFPA 70E, and ANSI C2.

D. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.

E. Adjust all mechanisms and moving parts for free mechanical movement.

F. Adjust all adjustable relays and sensors to correspond to operating conditions, or as recommended by manufacturer.

G. Verify nameplate data for conformance with these specifications.

H. Realign equipment not properly aligned and correct any unevenness.

I. Properly anchor electrical equipment found to be inadequately anchored.

J. Tighten all accessible bolted connections, including wiring connections, with calibrated torque wrench to manufacturer's recommendations, or otherwise specified.

K. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

L. Provide proper lubrication of all applicable moving parts.

M. Inform Engineer of any working clearances not in accordance with NFPA 70.

N. Investigate and repair or replace:

1. Electrical items that fail tests.
2. Active components not operating in accordance with manufacturer's instructions.
3. Damaged electrical equipment.

O. Electrical enclosures:

1. Remove foreign material and moisture from enclosure interior.
2. Vacuum and wipe clean enclosure interior.
3. Remove corrosion found on metal surfaces.
4. Repair or replace, as determined by the Engineer, door and/or panel sections having dented surfaces.
5. Repair or replace, as determined by the Engineer, poor-fitting doors and/or panel sections.
6. Repair or replace improperly operating latching, locking, or interlocking devices.
7. Replace missing or damaged hardware.
8. Finish:
   a. Provide matching paint and touch-up scratches and mars.
   b. If required due to extensive damage, as determined by the Engineer, refinish the entire assembly.

P. Replace fuses and circuit breakers that do not conform to size and type required by these specifications.

Q. Replace transformer insulating oil not in compliance with ASTM D923.

3.2 QUALITY ASSURANCE

A. Testing Firm's Qualifications:

1. Corporately and financially independent organization which can function as an unbiased testing authority.
2. Professionally independent of manufacturers, suppliers, and installers of electrical equipment and systems being tested.
3. Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.
4. Supervising engineer accredited as Certified Electrical Test Technologist by National Institute for Certification of Engineering Technologies (NICET), or International electrical Testing Association and having a minimum of five (5) years testing experience on similar projects.
5. Technicians certified by NICET or NETA.
6. Assistants and apprentices assigned to project at ratio not to exceed two (2) certified to one (1) noncertified assistant or apprentice.

7. Registered Professional Engineer to provide comprehensive project report outlining services performed, results of such services, recommendations, actions taken, and opinions.
8. In compliance with OSHA 29 CFR Part 1907, "Criteria for Accreditation of Testing Laboratories," or a full-member company of the International Electrical Testing Association.
9. Test equipment shall have an operating accuracy equal to, or greater than, requirements established by NETA ATS.

B. Test instrument calibration shall be in accordance with NETA ATS.

3.3 SEQUENCING AND SCHEDULING

A. Perform inspection and electrical tests after equipment has been installed.

B. Perform tests with apparatus de-energized whenever feasible.

C. Inspection and electrical tests on energized equipment are to be:

1. Scheduled with Engineer prior to de-energization.
2. Minimized to avoid extended period of interruption to the operating plant equipment.

D. Notify Engineer at least 24 hours prior to performing any tests on energized electrical equipment.

3.4 INSPECTION AND TEST PROCEDURES

A. Switchgear Assembly:

1. Visual and mechanical inspection for:
    a. Physical damage
    b. Equipment nameplate information conformance with latest single line diagram and report discrepancies.
    c. Proper alignment, anchorage and grounding.
    d. Tightness of accessible bolted bus joints by calibrated torque wrench method. Refer to manufacturer's instruction for proper foot pound levels.
    e. Paint chips, dents, scratches, etc.
    f. Insulator damage and contaminated surfaces.
    g. Proper barrier and shutter installation and operation.
    h. Proper operation of indicating devices.
    i. Improper blockage of air cooling passages.
    j. Integrity and contamination of bus insulation system.
    k. Check nameplates for proper identification of:
        1) Equipment title and tag number with latest one-line diagram.
        2) Pushbuttons.
        3) Control switches.
        4) Pilot lights.

5) Control relays.

6) Circuit breakers.

7) Indicating meters.

l. Verify that fuse and/or circuit breaker ratings, sizes, and types conform to those specified.

m. Check bus and cable connections for high resistance by low resistance ohmmeter and calibrated torque wrench applied to bolted joints.

1) Ohmic value to be zero.

2) Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.

n. Check operation and sequencing of electrical and mechanical interlock systems by:

1) Closure attempt for locked open devices.

2) Opening attempt for locked closed devices.

3) Key exchange to operate devices in off-normal positions.

o. Verify performance of each control device and feature.

p. Control wiring:

1) Compare wiring to local and remote control and protective devices with elementary diagrams.

2) Proper conductor lacing and bundling.

3) Proper conductor identification.

4) Proper conductor logs and connections.

q. Exercise all active components.

r. Perform phasing check on double-ended equipment to ensure proper bus phasing from each source.

2. Electrical tests:

a. Insulation resistance test:

1) Applied megohmmeter dc voltage in accordance with NETA ATS, Table 7. 1. 1.

2) Each phase of each bus section.

3) Phase-to-phase and phase-to-ground for I minute.

4) With switches and breakers open.

5) With switches and breakers closed.

6) Control wiring except that connected to solid state components.

7) Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.

b. Overpotential test:

1) Applied voltage and test procedure in accordance with ANSIC37.20.1.

2) Each phase of each bus section.

3) Phase-to-phase and phase-to-ground for I minute.

4) Test results evaluated on a pass-fail basis.

c. Current injection tests:

1) For entire current circuit in each section.

2) Secondary injection for current flow of I ampere.

3) Test current at each device.

d. Control wiring:

1) Apply secondary voltage to all control power and potential circuits.

2) Check voltage levels at each point on terminal boards and each device terminal.

e. Operational test:

1) Initiate all control devices.

2) Check proper operation of control system in each section.

3. Test values:

a. Bolt torque levels shall be in accordance with values specified by manufacturer.

b. Insulation resistance test to be performed in accordance with manufacturer's specified values.

B. Grounding Systems:

1. Visual and mechanical inspection for:

a. Compliance with plans and specifications.

b. Equipment and circuit grounds in motor control centers, panelboards, switchgear, and motors for proper connection and tightness.

c. Ground bus connections in motor control centers, panelboards, switchgear, and control panels for proper termination and tightness.

d. Effective transformer core and equipment grounding.

e. Accessible connections to grounding electrodes for proper fit and tightness.

f. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.

2. Electrical tests:

a. Perform fall of potential test per IEEE Standard No. 81, Section 9.04 on the main grounding electrode or system.

b. Perform the two (2) point method test per IEEE No. 8 1, Section 9.03 to determine the ground resistance between the main grounding system and all major electrical equipment frames, system neutral and/or derived neutral points. Equipment ground resistance shall not exceed main ground system resistance by 0.25 ohms.

c. Alternate method: Perform ground continuity test between main ground system and equipment frame, system neutral and/or derived neutral point. This test shall be made by passing a minimum of test (IO) amperes D.C. current between ground reference system and the ground point to be tested. Voltage drop shall be measured and resistance calculated by voltage drop method.

3. Test values: The main ground electrode system resistance to ground should be no greater than one (1) ohm.

C. Low Voltage Cables - 600 Volts and Below:

1. Visual and mechanical inspection for:

a. Physical damage and proper connection in accordance with single line diagram.

b. Equipment nameplate data compliance with design plans or starter schedule.

c. Overload heaters compliance with motor full load current for proper size.

d. Tightness of bolted connections.

e. Proper barrier and shutter installation and operation.

f. Proper operation of indicating and monitoring devices.

g. Proper overload protection for each motor.

h. Improper blockage of air cooling passages.

i. Proper operation of any draw out elements.

j. Integrity and contamination of bus insulation system.

k. Check door and device interlocking system by:

1) Closure attempt of device when door is in OPEN position.

2) Opening attempt of door when device is in ON or CLOSED position.

l. Check nameplates for proper identification of:

1) Equipment title and tag number with latest one-line diagram.

2) Pushbuttons.

3) Control switches.

4) Pilot lights.

5) Control relays.

6) Circuit breakers.

7) Indicating meters.

m. Verify that fuse and/or circuit breaker sizes and types conform to these specifications.

n. Verify that current and potential transformer ratios conform to these specifications.

o. Check bus connections for high resistance by low resistance ohmmeter and calibrated torque wrench applied to bolted joints.

1) Ohmic value to be zero.

2) Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.

p. Check operation and sequencing of electrical and mechanical interlock systems by:

1) Closure attempt for locked open devices.

2) Opening attempt for locked open devices.

3) Key exchange to operate devices in off-normal positions.

q. Verify performance of each control device and feature furnished as part of the motor control center.

r. Control wiring:

1) Compare wiring to local and remote control, and protective devices with elementary diagrams.

2) Check for proper conductor lacing and bundling.

3) Check for proper conductor identification.

4) Check for proper conductor lugs and connections.

s. Exercise all active components.

t. Inspect contactors for:

1) Correct mechanical operations.

2) Correct contact gap, wipe, alignment, and pressure.

3) Correct torque of all connections.

u. Compare overload heater rating with full-load current for proper size.

v. Compare fuse, motor protector, and circuit breaker with motor characteristics for proper

w. Perform phasing check on double-ended motor control centers to ensure proper bus phasing from each source.

x. Cable connections torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by the manufacturer.

y. Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.

z. Color coding conformance with specifications.

aa. Proper circuit identification.

bb. Proper lug type for conductor material.

cc. Proper lug installation.

dd. Proper shield grounding on shielded instrumentation cable.

ee. Proper terminations.

ff. Proper circuit identification.

gg. Proper termination of neutrals and grounds for correct operation of protective

devices.

2. Electrical tests:

   a. Insulation resistance tests:

      1) Utilize 1,000-volt dc megohmmeter for 600-volt insulated conductors and 500-volt dc megohmmeter for 300-volt insulated conductors.

      2) Test each conductor with respect to ground and to adjacent conductors per IEEE I 1 8 procedures for I minute.

      3) Evaluate ohmic values by comparison with conductors of same length and type.

      4) Investigate any values less than 50 megohms.

      5) Measure insulation resistance of each control circuit with respect to ground.

      6) Applied megohmmeter dc voltage in accordance with NETA ATS, Table 10.2.

      7) Bus section phase-to-phase and phase-to-ground for I minute on each phase.

      8) Contactor phase-to-ground and across open contacts for I minute on each phase.

      9) Starter section phase-to-phase and phase-to-ground on each phase with starter with starter contacts closed and protective devices open.

      10) Test values to comply with NETA ATS, Table 10.2.

   b. Overpotential tests:

      1) Maximum applied voltage in accordance with NETA ATS, Table 7.1.2.

      2) Phase-to-phase and phase-to-ground for I minute for each phase of each bus section.

      3) Test results evaluated on pass/fail basis.

   c. Current injection through overload unit at 300 percent of motor full-load current and monitor trip time:

      1) Trip time in accordance with manufacturer's published data.

      2) Investigate values in excess of 120 seconds.

   d. Control wiring tests:

      1) Apply secondary voltage to all control power and potential circuits.

      2) Check voltage levels at each point on terminal boards and each device terminal.

      3) Insulation resistance test at 1,000 volts dc on all control wiring except that connected to solid state components.

      4) Insulation resistance to be I megohm minimum.

3. Test values:
    a. Insulation resistance tests shall be performed at 1,000 volts D.C. for one-half (1/2) minute.
    b. Bolt torque levels shall be in accordance with manufacturer's specifications unless otherwise specified by manufacturer.
    c. Control wiring insulation test voltage shall be 500 V D.C. Manufacturer shall be consulted for test voltage where solid state control devices are utilized.
    d. Overload tests shall be made at three hundred percent (300%) of motor full load current. Trip times shall be in accordance with manufacturers tolerances. Values in excess of one hundred twenty (120) seconds shall be investigated.
    e. Insulation tests shall be made prior to termination.

D. Transformers:
1. General: Inspection and testing limited to motors rated 1/2HP and larger.
2. Visual and mechanical inspection for:
    a. Physical and insulator damage.
    b. Equipment nameplate information compliance with latest single line diagram and report discrepancies.
    c. Perform specific inspections and mechanical tests as recommended by manufacturer.
    d. Proper winding connections.
    e. Bolt torque level in accordance with NETA ATS, Table 1O. 1, unless otherwise specified by manufacturer.
    f. Defective wiring.
    g. Proper operation of fans, indicators, and auxiliary devices.
    h. Removal of shipping brackets, fixtures, or bracing.
    i. Free and properly installed resilient mounts.
    j. Cleanliness and improper blockage of ventilation passages.
    k. Correct tap-changer ratio setting for rated output voltage under normal operating conditions.
    l. Proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.
    m. Dissolved Gas Analysis (DGA Di-electric test, and moisture content test of oil.
3. Electrical tests:
    a. A dielectric absorption test shall be made on motor and starter circuit. Polarization index shall be determined for motor winding.
    b. A dielectric absorption test shall be made on motor winding. The thirty-sixty (30/60) second ratio shall be determined.
    c. Insulation resistance tests:

1) Applied megohmmeter dc voltage in accordance with NETA ATS, Table 7.2.3 for each:

a) Winding-to-winding.

b) Winding-to-ground.

2) 10-minute test duration with resistances tabulated at 30 seconds, I minute, and IO minutes.

3) Results temperature corrected in accordance with NETA ATS, Table 7.2.4.

4) Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.

5) Insulation resistance test results to compare within I percent of adjacent windings.

d. Perform tests and adjustments for any fans, controls, and alarm functions as suggested by manufacturer.

e. Measure secondary voltages and adjust taps as directed by Engineer.

f. Turn to turn electrical testing for transformer integrity.

g. Measure no load and full load running current and voltage and compare to nameplate.

h. Observe proper operation and sequence of any reduced voltage starters.

i. Perform vibration base line test on motors greater than 50 HP. Amplitude to be plotted vs. frequency.

j. Perform vibration amplitude test on motors greater than 50 HP.

k. Check all protective devices in accordance with other sections of these specifications.

l. Perform over potential test on winding to ground.

m. The measurement shall be made with a 1,000 volt megohmmeter; however, the precautions noted in the tests for conductor test shall also be applied to the motors.

n. Insulation with resistance less than 10 megohms is not acceptable.

o. Measurements shall be recorded in a format similar to Form 16 05 08 - B, contained in this section.

p. After start-up of each motor, the current on each phase shall be measured.

1) At no load.

2) At defined load.

3) In-rush current.

4) Use Form 16 05 08 - B.

4. Test Values:

a. Dielectric absorption tests shall be made in accordance with test voltage listed

as specified by manufacturer. Polarization tests shall before a ten (IO) minute duration. Sixty/thirty (60/30) second ratio tests shall be for a one (1) minute duration. Polarization index readings less than threes hall be investigated. Sixty/thirty(60/30)second ratio readings less than 1.4 shall be investigated.

b. Motor measured full load current shall not exceed nameplate value.

c. Over potential test shall be made an eighty percent (80%) of twice rated voltage plus one thousand (1,000) volts.

d. Vibration amplitudes shall not exceed values furnished by manufacturer.

E. Lighting:

1. Verify that the switching, including remote control is as shown.
2. Verify that the circuitry is in accordance with the panel schedules.
3. Verify that load is balanced as closely as possible.
4. Verify that the lighting fixtures are located to minimize obstruction of illumination by liquid-filled mechanical equipment or building structural elements.
5. Verify that photocell operates properly.
6. Replace all lamps that do not operate properly.

F. Switches:

1. Visual and mechanical inspection for:
   a. Proper blade pressure and alignment.
   b. Proper operation of switch operating handle.
   c. Adequate mechanical support for each fuse.
   d. Proper contact-to-contact tightness between fuse clip and fuse.
   e. Cable connection bolt torque level in accordance with NETA ATS, Table 10.1.
   f. Proper phase barrier material and installation.
   g. Proper fuse sizes and types as shown on single line diagram.
   h. Perform mechanical operational test and verify electrical and mechanical interlocking system operation and sequencing.
2. Electrical tests:
   a. Insulation resistance tests:
      1) Applied megohmmeter dc voltage in accordance with NETA ATS, Table 10.2.
      2) Phase-to-phase and phase-to-ground for I minute on each pole.
      3) Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
   b. Contact resistance tests:
      1) Contact resistance in microhms across each switch blade and fuse holder.

2) Investigate deviation of 50 percent or more from adjacent poles or similar switches.

G. Low Voltage Cables - 600 Volts and Below:

1. Visual and mechanical inspection for:

a. Physical damage and proper connection in accordance with single line diagram.

b. Cable connections torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by the manufacturer.

c. Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.

d. Color coding conformance with specifications.

e. Proper circuit identification.

f. Proper lug type for conductor material.

g. Proper lug installation.

h. Proper shield grounding on shielded instrumentation cable.

i. Proper terminations.

j. Proper circuit identification.

k. Proper termination of neutrals and grounds for correct operation of protective devices.

2. Electrical tests:

a. Insulation resistance tests:

1) Utilize 1,000-volt dc megohmmeter for 600-volt insulated conductors and 500-volt dc megohmmeter for 300-volt insulated conductors.

2) Test each conductor with respect to ground and to adjacent conductors per IEEE I 1 8 procedures for I minute.

3) Evaluate ohmic values by comparison with conductors of same length and type.

4) Investigate any values less than 50 megohms.

b. Perform continuity test to insure proper cable connection.

c. Measurements shall be made prior to connection of wires to any equipment. Ends of wires are to be taped with Scotch 33+ and be physically remote from all grounded surfaces by a minimum of 2".

d. Insulation resistance measurements shall be recorded using Form 16960 - A contained in this section.

e. Insulation with resistance of less than 10 megohms is typically not acceptable.

f. Insulation resistance test shall be performed at 1,000 volts dc for one-half (1/2) minute. Insulation resistance readings shall be recorded after the one-half minute time interval has elapsed.

g. If in the opinion of the Engineer the test results are unacceptable, the

Contractor will correct the installation, material or labor at no additional cost to, and to the satisfaction of, the Engineer.

3. Test values:
   a. Insulation resistance tests shall be performed at 1,000 volts D.C. for one-half (1/2) minute.
   b. Insulation tests shall be made prior to termination.

H. Dry type Transformers:

1. Visual and mechanical inspection for:
   a. Physical and insulator damage.
   b. Equipment nameplate information compliance with latest single line diagram and report discrepancies.
   c. Perform specific inspections and mechanical tests as recommended by manufacturer.
   d. Proper winding connections.
   e. Bolt torque level in accordance with NETA ATS, Table IO. 1, unless otherwise specified by manufacturer.
   f. Defective wiring.
   g. Proper operation of fans, indicators, and auxiliary devices.
   h. Removal of shipping brackets, fixtures, or bracing.
   i. Free and properly installed resilient mounts.
   j. Cleanliness and improper blockage of ventilation passages.
   k. Correct tap-changer ratio setting for rated output voltage under normal operating conditions.
   l. Proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.

2. Electrical tests:
   a. Insulation resistance tests:
      1) Applied megohmmeter dc voltage in accordance with NETA ATS, Table 7.2.3 for each:
         a) Winding-to-winding.
         b) Winding-to-ground.
      2) 10-minute test duration with resistances tabulated at 30 seconds, I minute, and IO minutes.
      3) Results temperature corrected in accordance with NETA ATS, Table 7.2.4.
      4) Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
      5) Insulation resistance test results to compare within I percent of adjacent

windings.

b. Perform tests and adjustments for any fans, controls, and alarm functions as suggested by manufacturer.

c. Measure secondary voltages and adjust taps as directed by Engineer.

I. Lighting:

1. Verify that the switching, including remote control is as shown.
2. Verify that the circuitry is in accordance with the panel schedules.
3. Verify that load is balanced as closely as possible.
4. Verify that the lighting fixtures are located to minimize obstruction of illumination by liquid-filled mechanical equipment or building structural elements.
5. Verify that photocell operates properly.
6. Replace all lamps that do not operate properly.

J. Safety Switches, 600 volts maximum.

1. Visual and mechanical inspection for:
   a. Proper blade pressure and alignment.
   b. Proper operation of switch operating handle.
   c. Adequate mechanical support for each fuse.
   d. Proper contact-to-contact tightness between fuse clip and fuse.
   e. Cable connection bolt torque level in accordance with NETA ATS, Table 10.1.
   f. Proper phase barrier material and installation.
   g. Proper fuse sizes and types as shown on single line diagram.
   h. Perform mechanical operational test and verify electrical and mechanical interlocking system operation and sequencing.
2. Electrical tests:
   a. Insulation resistance tests:
      1) Applied megohmmeter dc voltage in accordance with NETA ATS, Table 10.2.
      2) Phase-to-phase and phase-to-ground for I minute on each pole.
      3) Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
   b. Contact resistance tests:
      1) Contact resistance in microhms across each switch blade and fuse holder.
      2) Investigate deviation of 50 percent or more from adjacent poles or similar switches.

K. Control Stations:

1. Visual and mechanical inspection for:
    a. Physical damage.
    b. Proper installation.
    c. Proper type and gasketing.
    d. Proper operation of pushbutton(s) and/or selector switch(es).
    e. Proper identification on nameplate.
    f. Proper control wiring:
        1) Compare to elementary diagram.
        2) Check for proper termination.
        3) Check for proper conductor identification.
2. Electrical tests:
    a. Control wiring tests:
        1) Apply proper voltage to all circuits.
        2) Check voltage levels at each termination.
        3) Insulation resistance test at 1,000 volts dc on all control wiring except that which is connected to solid state components. Insulation resistance to be one (1) megohm minimum.
    b. Operational test by initiating control devices to affect proper operation.

L. Local Control Panel(s) – LCP

1. Visual and mechanical inspection for:
    a. Physical damage.
    b. Proper type and installation of cabinet.
    c. Proper door closure and gasketing.
    d. Proper operation of pushbutton(s) and/or selector switch(es).
    e. Compliance with elementary diagrams and manufacturer's drawings.
    f. Proper identification on nameplates.
    g. Proper labeling of all devices both inside and outside.
    h. Proper control wiring:
        1) Compare to elementary diagram.
        2) Check for proper termination.
        3) Check for proper conductor identification.
    i. Proper overload protection for motor(s) when its starter is included in the panel.
    j. Proper breaker size and type.
    k. Proper CT when required.
    l. Proper terminal blocks.

2. Electrical tests:
    a. Control wiring tests:
        1) Apply proper voltage to all circuits.
        2) Check voltage levels at each termination.
        3) Insulation resistance test at 1,000 volts dc on all control wiring except that connected to solid state components. Insulation resistance to be one (1) megohm minimum.
    b. Operational test by initiating control devices to affect proper operation of each control signal and discrete signal loop.

M. Operating and Control System

1. Visual and mechanical inspection for:
    a. Physical damage.
    b. Proper type and installation of cabinet.
    c. Proper door closure and gasketing.
    d. Proper operation of pushbutton(s) and/or selector switch(es).
    e. Compliance with P&IDs and manufacturer's drawings.
    f. Proper identification on nameplates.
    g. Proper labeling of all devices both inside and outside.
    h. Proper control wiring:
        1) Compare to elementary diagram.
        2) Check for proper termination.
        3) Check for proper conductor identification.
    i. Proper terminal blocks.
    j. Equipment in compliance with these specifications.
    k. Operating equipment in compliance with these specifications.
    l. Operating screens in compliance with approved manufacturer's drawings.
    m. Annunciator screens in compliance with approved manufacturer's drawings.
    n. Alarm logs in compliance with approved manufacturers drawings.
2. Electrical tests:
    a. Control wiring tests:
        1) Apply proper voltage to all circuits.
        2) Check voltage levels at each termination.
        3) Insulation resistance test at 1,000 volts dc on all control wiring except that which is connected to solid state components. Insulation resistance to be one (1) megohm minimum.
    b. Operational test by initiating control devices to affect proper operation.

3.5 ADJUSTING

A. Subsystem Testing:

1. Shall occur after the proper operation of alarm and status contacts has been demonstrated and observed by the Engineer.
2. Shall occur after the process and control devices have been adjusted as accurately as possible.
3. It is intended that the Contractor shall adjust limit switches and level switches to their operating points prior to testing and will set pressure switches, flow switches, and timing relays as dictated by operating results.
4. After initial settings have been completed:
    a. Each subsystem shall be operated in the manual mode and it shall be demonstrated that operation is in compliance with the Contract documents.
    b. After the manual mode of operation has been proven, automatic operation shall be demonstrated to verify such items as proper start and stop sequence of pumps, proper operation of valves, proper speed control, etc.
5. Subsystems, in the context discussed here, shall mean individual and groups of pumps, conveyor systems, chemical feeders, air conditioning units, ventilation fans, air compressors, blowers, etc.

3.6 DEMONSTRATION

A. Commissioning:

1. Commissioning during the 7-day test as specified in Section “Facility Testing and Plant Start-up”, shall not be attempted until all subsystems have been found to operate satisfactorily.
2. Commissioning shall only be attempted as a function of normal plant operation in which plant process flows and levels are routine and equipment operates automatically in response to flow and level parameters or computer command, as applicable.
3. Simulation of process parameters shall be considered only upon receipt of a written request by the Contractor.

B. Motor current tabulation report shall reflect the values occurring during commissioning.

C. The indications of all switchgear ammeters and kilowatt meters, shall be recorded every half-hour during commissioning.

END OF SECTION

SECTION 16109
ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SCOPE

A. Furnish all labor, materials, equipment, appliances, and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work:

1. Nameplates.
2. Labels.
3. Wire and cable markers.
4. Conduit markers.

1.2 APPLICABLE SECTIONS:

A. Section “Electrical General Requirements”.

1.3 SUBMITTALS:

A. Submit product literature including manufacturer name, model number, material, size, and specifications. Material shall not be installed until the Engineer has reviewed the submittal data.

PART 2 - PRODUCTS

2.1 NAMEPLATES:

A. Nameplates: Engraved three-layer laminated plastic, black letters on white background.

B. Locations:

1. Each electrical distribution and control equipment enclosure.
2. Communication cabinets.
3. Each junction box.

C. Letter Size:

1. 1/8" letters for identifying individual equipment and loads.
2. 1/4" letters for identifying grouped equipment and loads.

D. Identify control device stations, motor control equipment, process equipment and instrumentation equipment. All such devices shall be labeled with equipment served, identifying name, and circuit number with panel.

2.2 WIRE MARKERS:

A. Manufacturers:

1. 3M
2. Thomas & Betts
3. Panduit

B. Description: Heat shrink tubing, imprinted, type wire markers.

C. Locations: Each conductor at panel-board gutters, pull boxes, outlet and junction boxes, and each load connection, PLC panels, instrument panels, instruments, MCC's, etc.

D. Legend:

1. Power and Lighting Circuits: Branch circuit or feeder number shall be indicated on project Record Drawings.

E. Control Circuits: Control wire number shall be indicated on schematic and interconnection diagrams.

F. Data Wiring: Address number shall be indicated on each end of conductor on the face of the outlet cover, and on the space of the patch panel.

G. All conductor numbers and terminal block numbers shall be reflected on the CONTRACTOR submitted Record Drawings.

2.3 CONDUIT MARKERS:

A. Manufacturers:

1. Tech Products
2. Thomas & Betts
3. Panduit

B. Description: 3/16" poly tag in poly tag holder. Tie wrapped to conduit.

C. Location: Furnish markers for each conduit longer than 6 feet.

D. Spacing: Label at each junction and terminal end.

E. Legend: Number as indicated in contractor prepared Record Drawings.

2.4 UNDERGROUND WARNING TAPE:

A. Description: 4" wide detectable plastic tape, colored red with suitable warning legend describing buried electrical lines.

B. Location: Along length of each underground conduit, 12" above conduit.

2.5 LABELS:

A. Self adhesive, plastic coated, machine printed.

B. Manufacturer: Brother or equal.

C. Locations:

1. Convenience outlet circuit adhered to outlet faceplate showing panel and circuit number.
2. Data address number to outlet faceplate and patch panel face plate.
3. Light switches, indicating lighting switched panel and circuit number.
4. Process wiring indicating connection point terminal block and cabinet.

PART 3 - EXECUTION

3.1 PREPARATION:

A. De-grease and clean surfaces to receive nameplates and labels.

3.2 INSTALLATION:

A. Install nameplate and label parallel to equipment lines.

B. Secure nameplate to equipment front using screws.

C. Secure nameplate to inside surface of door on panel-board that is recessed in finished locations.

D. Identify each conduit at each end.

E. Identify underground conduits using one underground warning tape per trench at 12" above conduit.

END OF SECTION

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SECTION 16116

PANELS AND CONSOLES

PART 1 - GENERAL

1.1 SUMMARY

A. General: This section sets forth the general specifications and requirements for all the control panels and enclosures being provided under this contract.

1. Including but not limited to all:

   a. All custom built and designed control panels.

2. The CONTRACTOR shall furnish, supply and install all custom panels for this project in accordance Contract documents.

3. This section also covers requirements for local control panels being supplied by the Equipment Manufacturers as part of the packaged equipment.

   a. The CONTRACTOR shall design all interfaces between these control panels and the SCADA/PLC System.

4. This specification covers the requirements for the fabrication of instrument panel boards or enclosures, mounting, finishing, piping and wiring of instrument equipment.

B. Related Sections:

1. The Contract Documents are a single integrated document, and as such all Divisions and Section apply. It is the responsibility of the CONTRACTOR and its Sub-Contracts to review all sections to insure a complete and coordinated project.

1.2 PANEL FABRICATION

A. The following paragraphs describe general fabrication requirements for the instrument panels, enclosures, and subpanels:

1. All internal instrument and component device wiring shall be as normally furnished by the manufacturer. With the exception of electronic circuits, all interconnecting wiring and wiring to terminals for external connection shall be stranded copper, insulated for not less than 600 volts, with a moisture-resistant and flame-retardant covering rated for not less than 90 C.

2. Power distribution wiring on the line side of panel fuses shall be minimum 12 AWG. Secondary power distribution wiring and wiring for control circuits shall be minimum 14 AWG. Annunciator and indicating light circuits shall be minimum 16 AWG. Electronic analog circuits shall be 16 AWG twisted and shielded pairs rated not less than 300 volts. Analog circuits shall be separated from ac power circuits. Wiring for ac power distribution, dc power distribution, and control circuits shall have different colors and shall agree with the color coding legend on the system supplier's panel wiring diagrams.

3. The power entrance to each panel shall be provided with a surge protection device. Surge protectors shall be nominal 120 volts ac with a nominal clamping voltage of 200 volts. Surge protectors shall be a non-faulting and non-interrupting design with a response time of not more than 5 nanoseconds. Surge protectors shall be Transtector "ACP-I00BW", Power Integrity Corporation "ZTAS", or equal.

4. Terminal blocks for external connections shall be suitable for No. 12 AWG wire, and shall be rated 30 amperes at not less than 300 volts. Terminal blocks shall be fabricated complete with marking strip, covers, and pressure connectors. Terminals shall be labeled to agree with identification shown on the Supplier's submittal drawings. A terminal shall be provided for each conductor of external circuits plus one ground for each shielded cable. All wiring shall be grouped or cabled and firmly supported to the panel. Not less than 8 inches of clearance shall be provided between the terminal strips and the base of vertical panels for conduit and wiring space. Not less than 25 percent spare terminals shall be provided. Each control loop or system shall be individually fused, and all fuses or circuit breakers shall be clearly labeled and located for easy maintenance.

5. The panel fabricator shall provide such additional circuits as may be indicated on the electrical schematic drawings.

6. Nameplates shall be provided on the face of the panel or on the individual device as required. Panel nameplates shall have approximate dimensions and legends as indicated on the drawings and shall be made of laminated phenolic material having engraved letters approximately 3/16 inch high extending through the black face into the white layer. Nameplates shall be secured firmly to the panel.

7. All panels shall be thoroughly cleaned, sanded, and given not less than one coat of rust-inhibiting primer both inside and out. The panel interior shall be given not less than one coat of white enamel or lacquer. All pits and blemishes in the exterior surface shall be filled. Exterior surfaces shall be smoothed and given not less than two coats of enamel, polyurethane, or lacquer finish. Color samples shall be submitted to the Engineer for color selection. One quart of finish color paint shall be furnished with the panels to cover future scratches.

B. FACTORY TEST

1. Panels shall be factory-tested electrically and pneumatically by the panel fabricator in the presence of the ENGINEER before shipment.

1.3 SUBMITTALS

A. Control Panel Engineering Submittals: Submit a two phase control panel engineering submittal for each and every control panel and enclosure being provided for this project.

1. Phase I shall be the Control Panel Hardware submittal which shall include but not be limited to:

a. Enclosure construction details and NEMA type.

b. Finish, including color chart for ENGINEER selection of color.

c. Layout.

d. Power circuits.

e. Signal and safety grounding circuits.

f. Fuses.

g. Circuit breakers.

h. Signal circuits.

i. Internally mounted instrumentation.

j. PLCs.

k. SCADA system components.

l. Face plate mounted instrumentation components.

m. Internal panel arrangements.

n. External panel arrangements.

o. Construction drawings drawn to scale which define and quantity.

    1) The type and gage of fabrication steel to be used for panel fabrication.

    2) The ASTM grade to be used for structural shapes and straps.

    3) Panel door locks and hinge mechanisms.

    4) Type bolts and bolt locations for section joining and anchoring.

    5) Details on the utilization of “UNISTRUT” and proposed locations.

    6) Stiffener materials and locations.

    7) Electrical terminal box and outlet locations.

    8) Electrical access locations.

    9) Print pocket locations.

    10) Writing board locations.

    11) Lifting lug material and locations.

p. Physical arrangement drawing drawn to scale which define and quantity the physical groupings comprising:

    1) Control panel sections.

    2) Auxiliary panels.

    3) Subpanels.

    4) Racks.

    5) Cutout locations with nameplate identifications shall be provided.

q. A bill of material which enumerates all devices associated with the control panel.

2. Phase II shall be the Control Panel Wiring Diagram submittal which shall include but not be limited to:

a. Schematic/Elementary diagrams shall depict all control devices and circuits and their functions.

b. Wiring/Connection diagrams shall locate and identify:

1) Electrical devices.

2) Terminals.

3) Interconnecting wiring.

4) These diagrams shall show interconnecting wiring by lines, designate terminal assignments, and show the physical location of all electrical and control devices.

c. Interconnection diagrams shall locate and identify all external connections between the control panel/control panel devices and associated equipment.

1) These diagrams shall show interconnecting wiring by lines, designate terminal assignments, and show the physical location of all panel ingress and egress points.

d. Control sequence diagrams shall be submitted to portray the contact positions or connections required to be made for each successive step of the control action.

3. All panel drawings shall be 22” x 34” reduced to and fully legible at 11” x 17”, and submitted at 11” x 17” format size, with all data sheets and manufacturer specification sheets being 8.5” x 11”.

4. The submittal shall be in conformance with NEMA Standard ICS-1-1.01, and each phase shall be submitted as a singular complete bound volume or multi-volume package and shall have the following contents.

a. A complete index shall appear in front of each bound volume.

1) All drawings and data sheets associated with a panel shall be grouped.

2) All panel tagging and nameplate nomenclature shall be consistent with the requirements of the Contract Documents.

b. Completed ISA-S20 data sheets for all instrumentation devices associated with each control panel supplemented with manufacturer specification sheets which verify the products conformance to the requirements of the Contract Documents.

c. A listing of spare parts in conformance with each equipment specification section.

1.4 QUALITY ASSURANCE

A. Environmental Suitability:

1. All indoor and outdoor control panels and instrument enclosures shall be suitable for operation in the ambient conditions associated with the locations designed in the Contract Documents.

2. Heating, cooling, and dehumidifying devices shall be provided in order to maintain all instrumentation devices to within a range equal to 20% above the minimum and 20% below the maximum of the rated environmental operating ranges.
3. Provide all power wiring for these devices.
4. Enclosures suitable for the environment shall be furnished.
5. All instrumentation in hazardous areas shall be suitable for use in the particular hazardous or classified location in which it is to be installed.

B. All control panels and assemblies shall be labeled and listed by a nationally recognized testing laboratory.
1. Underwriters Laboratory, Inc.
2. Or equal.

1.5 DELIVERY, STORAGE AND HANDLING

A. All panels are to be crated for shipment using a heavy framework and skids.
1. The panel sections shall further be cushioned satisfactorily to protect the finish of the instruments and panel during shipment.
2. All equipment which is shipped with the panel shall further have suitable shipping stops and cushioning material installed in a manner to protect instrument parts which could be damaged due to mechanical shock during shipment.

PART 2 - PRODUCTS

2.1 CONTROL PANELS

A. The following paragraphs describe specific requirements for the control panels:

B. CONSTRUCTION - NEMA 12 by Hoffman or equal in control room locations. NEMA 4X by Hoffman or equal in process or humid areas or outside.
1. NEMA 12
a. Seams continuously welded and ground smooth.
b. Door and body stiffeners as needed to make a rigid enclosure.
c. Heavy gauge continuous hinge.
d. Oil-resistant gasket attached to door with oil-resistant adhesive. Gasket to seal against roll lip on the enclosure opening.
e. Internal mounting panel held in place by collar studs welded to enclosure.
f. Lockable door latching and handle mechanism to allow easy access to interior of enclosure and keyboard.
g. Panel cut-outs for instruments, devices, and windows shall be cut, punched, or drilled and smoothly finished with rounded edges.
1) Reinforce around cut-outs with steel angles or flat bars.
2. Large panel cutouts such as for HMIs.

3. Pilot device groupings where the removed metal exceeds 50% of the available metal in an area bound by a 3” envelope around said pilot devices.

   a. Finish.

      1) Interior, smooth, polyester power coating.

      2) Exterior polyester powder coating gray in color.

         a) Panels that re in the same room as, motor control centers, switchboards, etc shall be of the same color as the motor control center or switchboards so that the control panel blends into the line up.

   b. Manufacturer’s standard gauge steel.

   c. Each door to have a three-point latching mechanism and padlocking handle with rollers on the ends of the latch rods.

   d. With heavy duty lifting eyes.

   e. With flange mounted disconnect.

   f. Mounting panel

      1) 10 gauge steel

      2) With stiffeners

4. Water tight corrosion resistant stainless steel

   a. NEMA 4X in design, dust tight, water tight, and corrosion-resistant.

   b. 14 gauge, Type 304 Stainless Steel.

   c. Captive stainless steel cover screws threaded into sealed wells.

   d. Oil resistant neoprene sealing gasket and adhesive to seal cover to enclosure.

   e. Finish

      1) Cover surface and sides, unpainted, brushed finish.

   f. Door fronts ground smooth.

   g. Specifically designed for use with flange mounted disconnect switches.

C. SIZE AND ARRANGEMENT - Panel dimensions and general instrument arrangement shall be as indicated on the drawings.

D. Interconnecting wiring and wiring to terminals for external connection shall be MTW or SIS 16 AWG, stranded copper wire, insulated for not less than 600 volts, with a moisture-resistant and flame-retardant covering rated for not less than 90 degrees Celsius except for electronic circuits and special instrument interconnect wiring which shall be in accordance with manufacturer requirements. Provide a switched fluorescent light at every four feet of panel length.

E. PANEL WIRING:

1. Power distribution wiring on line side of panel fuses minimum 12 AWG.
2. Secondary power distribution wiring and wiring for control circuits: Minimum number 14 AWG.
3. Annunciator and indicating light circuits: Minimum 14 AWG.
4. Electronic analog circuits within instrument and control panels: Minimum 16 AWG twisted and shielded pairs or triads rated not less than 16 volts.
5. Provide a 15 amp, 120 volt GFCI service outlet within each panel.
6. Wire Insulation Colors:
    a. Conductors supplying 120-volts AC power on the line side of a disconnecting switch shall have a black insulation for the ungrounded conductor.
    b. Grounded circuit conductors shall have white insulation.
    c. Insulation for ungrounded 120-volt AC control circuit conductors shall be red.
    d. All wires energized by a voltage source external to the control panels shall have yellow insulation.
    e. Insulation for all DC conductors shall be blue.
7. Wire Marking:
    a. Each signal, control, alarm, and indicating circuit conductor connected to a given electrical point shall be designated by a single unique number which shall be shown on all shop drawings.
    b. These numbers shall be marked on all conductors at every terminal.
8. For case grounding, panels shall be furnished with a ¼-inch by 1-inch copper ground bus complete with solderless connectors for all equipment ground conductors.
    a. Refer to Division 16 – Conduit Schedule for size and number of conductors.
9. Power Supply Wiring:
    a. Each and every loop and instrument requiring 120 VAC shall be protected by individual DIN rail mounted circuit breakers.
        1) The number of circuits depends on the circuit load as noted herein.
        2) The circuit load shall not exceed 10 amp.
        3) Different panel section or different process units must not use common branch circuits.
        4) Furnish and install DIN rail mounted circuit breakers for all individual instruments.

a) Circuit breakers shall be mounted on the back of the panel.

b) Identified by a service name tag.

b. Each potentiometer type instrument, electronic transducer, controller or analyzer shall have an individual DIN rail mounted circuit breaker located within the control panel.

1) Circuit breakers shall have plastic tags indicating instrument tag numbers.

2) Individual plug and cord set power supply connections require DIN rail mounted circuit breakers ahead of the receptacle.

10. Furnish circuit breakers for the panel lights, and for the panel receptacle.

11. Alarm Wiring:

a. Install and wire all alarms including light cabinets, audible signal units, test and acknowledge switches and remote logic units as specified.

b. Interconnecting wiring to panel mounted initiating devices shall also be wired.

c. Where plug and cord sets are provided for component interconnection, harness and support the cables in neat and orderly fashion. Where separate wire is required, install No. 16 AWG with MTW or TFFN insulation between all components.

12. Signal Wiring:

a. Signal Wire – Non Computer Use

1) Signal wire shall be twisted pair or triads in conduit or troughs. Cable shall be constructed of No. 16 AWG with MTW or TFFN insulation between all components.

2) Color code for instrument signal wiring shall be as follows:

a) Positive (+) – Black

b) Negative (-) – White.

3) Multiconductor cables where specified shall consist of No. 18 AWG copper signal wires twisted in pairs, pairs, with 90°C, 600 V insulation.

a) A copper drain wire shall be provided for the bundle with a wrap of aluminum polyester shield. The overall bundle jacket shall be PVC.

4) Use for connections between field terminal blocks and the PLC wiring arms for analog inputs and outputs.

b. Signal Wire – Computer Use

1) Signal wires shall be similar to those for non-computer use but each pair shall be triplexed with a copper drain wire and aluminum polyester tape shall be applied over the triplexed group.

2) All cable shields, including thermocouple extension leads shall be terminated at a single point within the control panel.

3) Continuity of the shield is to be maintained throughout the cable runs.

c. Multi-conductor cables, wireways and conduit shall be sized to allow for 20 percent signal wire.

13. Wiring Installation:

a. All wires shall be run in plastic wireways.

b. Exception:

1) Field wiring.

2) Wiring run between mating blocks in adjacent sections.

3) Wiring runs from components on a swing-out panel to components on a part of the fixed structure.

a) Wiring run from components on a swing-out or front panel to other components on a fixed panel shall be made up in tied bundles.

b) These bundles shall be tied with nylon wire ties, and shall be secured to panels at both sides of the “hinge loop” so that conductors are not strained at the terminals.

4) Wiring run to front panel-mounted components.

c. Signal and low voltage wiring shall be run separately from power and 120 VAC control wiring.

1) 120 VAC circuits shall be run through grey colored plastic wireways.

2) 24 VDC circuits shall be run through white colored plastic wireways.

d. Wiring to rear terminals on panel-mount instruments shall be run in plastic wireways secured to horizontal brackets run above or below the instruments in about the same plane as the rear of the instruments.

e. Provide an empty wireway for all field wiring connections.

1) 120 VAC circuits shall be run through grey colored plastic wireways.

2) 24 VDC circuits shall be run through white colored plastic wireways.

f. Conformance to the above wiring installation requirements shall be reflected by details shown on the shop drawings for the ENGINEER's review.

14. Grounding

a. Furnish equipment ground bus with lugs for connection of all equipment grounding wires.

F. ANALOG CIRCUITS AND AC POWER CIRCUITS: Separated.

G. INTERNAL PANEL WIRING COLORS:

a. AC Power Distribution: Red

b. DC Power and Control: Blue

c. Instrument: Black and white twisted shielded pair.

d. Other and in agreement with manufacturer's wiring diagrams as stated on manufactured drawing legend.

H. SURGE PROTECTION DEVICE FOR POWER ENTRANCES: Nominal 120 volts AC with a nominal clamping voltage of 200 volts; nonfaulting and noninterrupting design with a response time of not more than 5 nano-seconds. Utilize a branch panel TVSS unit.

I. TERMINAL BLOCKS FOR EXTERNAL CONNECTIONS: Suitable for specified AWG wire, rated 30 amperes at not less than 600 volts (for incoming power circuits, and for field 1/0 terminals they shall be Phoenix contact or equal as shown on the drawings); with marking strip, covers, pressure connectors, and labeled terminals, each conductor of external circuits plus one ground terminal for each shielded cable. Provide minimum 25 percent spare terminals.

J. Group cables, and firmly support wiring to the panel. Provide minimum 8 inches clearance between terminal strips and the base of vertical panels for conduit and wiring space. Individually fuse each control loop or system, and clearly label and locate fuses or circuit breakers for maintenance.

K. Furnish and install equipment grounding conductor in accordance with NEC 250. Provide power ground lugs. Provide signal insulated and isolated ground lugs.

L. Nameplates on Internal and External Instruments and Devices: Materials approximate dimensions with legends as indicated on the Drawings made of laminated phenolic material having engraved letters approximately 3/16 inch high extending through the black face into the white layer; firmly secured to panels.

M. POWER SUPPLIES/FUSING

1. Design and arrange regulated 24 volt DC power supplies for instrument loops so that loss of I loop does not affect more than one instrument loop or system. Provide power supplies suitable for an input voltage variation of plus or minus 10 percent. Fuse or short circuit protects the supply output.

2. Selectively fuse the power distribution from multi-loop supplies so that a fault in one instrument loop will be isolated from the other loops being fed from the same supply. Label and locate fuses for easy access.

3. Output Voltage Regulation: As required by the instrument or control equipment being supplied.

4. Backup power supply units shall be provided to automatically supply the load upon failure of the primary supply. Design backup supply systems so that either the primary or backup supply can be removed, repaired, and returned to service without disrupting the instrument system operation.

5. Oversize the multi-loop supply systems for an additional 25 percent future load. Indicate failure of a multi-loop supply on the respective instrument panel or enclosure.

6. Furnish and install signal repeaters for instrument loops that exceed the load impedance of the power supplies. Indicating fuses: Neon bulb type for 120 VAC circuit and glass indicating fuse type for 24 VDC circuits.

N. SOURCE QUALITY CONTROL:

1. Functionally factory test instrument and control panel items electrically and pneumatically before shipment.

O. PANEL ACCESSORIES:

1. Manufacturers: Weidmuller SAKS; Entrelec; Phoenix Contact; Wago; or equal.

   a. Terminal Blocks: Nickel plated copper only; DIN rail; universal foot with the following as required for the application.

      1) Universal type

      2) Feed through

      3) Ground

      4) Neutral disconnect

      5) Intrinsically safe

      6) Explosion-proof

      7) Fuse

      8) Knife disconnect

      9) Ground fault indicator

      10) Bolt connecting

   b. Terminal Block Labeling: Each terminal and each conductor as previously specified with machine labels only.

      1) Manufacturers: Phoenix Contact; Entrelec; or equal.

         a) Signal Interface Modules:

            1. Analog isolating converter

2. Ground loop isolations
3. Signal amplification
4. Signal level matching
5. 24 VDC power supply (120 VAC input)

2. Disconnect Switches:

a. Switches shall consist of a thermal magnetic circuit breaker with integral door operator – lockable

1) Minimum 22 KAIC

2) Not required for panels fed with 120 VAC or less. A nameplate must be furnished on the cover of the control panel identifying all sources of supply and foreign voltages within the control panel.

b. The main disconnect shall disconnect all power sources within the control panel.

c. Sized in accordance with the NEC and total connected horsepower and associated locked rotor currents.

d. A disconnect shall be provided for each motor controller/starter within the control panel. This disconnecting means shall disconnect power and control power to each motor controller. Each disconnect shall be equipped with a dead front operator through either the cabinet door or a dead front panel.

PART 3 - EXECUTION

END OF SECTION

SECTION 16119
CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install conductors and cables as required, and as shown on the Drawings. Materials employed shall be as indicated on the Drawings and specified herein.

1.2 SUBMITTALS

A. Submit product literature including manufacturer part number, model number, material, size, and specifications. Material shall not be installed until the Engineer has reviewed the submittal data.

B. Shop Drawings shall be submitted for review and acceptance showing routing, conduit size, and number and size of wires in each conduit before installation of conduit and any related work. Show proposed routing of conduits buried under floor slabs-on-grade, conduit and rebar embedded in floor slabs, columns, etc. Identify conduit by tag number of equipment served and by conduit schedule number.

1.3 QUALITY ASSURANCE

A. MANUFACTURERS: Firms regularly engaged in manufacture of conduits and raceway systems of type and sizes required, whose products have been in satisfactory use in similar service for not less than (3) years.

B. STANDARDS: Comply with applicable portions of the NEMA standards pertaining to raceways. Comply with applicable portions of UL safety standards pertaining to electrical raceway systems; and provide products and components which have been UL listed and labeled. Comply with NEC requirements as applicable to construction of raceway systems.

1.4 APPLICABLE SECTIONS

A. Section “Electrical General Requirements”.

B. Section “Electrical Acceptance Tests”.

PART 2 - PRODUCTS

2.1 COMPONENTS

A. 600 Voltage Conductors:

1. Copper with AWG sizes as shown or required:

a. Minimum size shall be No. 12 except where specified otherwise.

b. Conductors shall be stranded.

1) Insulation:

a) Conductor Size No. 2 And Smaller: 600V type THWN or XHHW (75° C). All conductors run in underground conduits shall be XHHW.

b)

c) Conductor Size No. 1 And Larger: 600V Type XHHW-2 (90° C).

2) Colors:

a) 120/240 V System

(1) Black: Line 1.

(2) Red: Line 2.

(3) Green: Ground.

(4) White: Neutral.

b) 208Y / 120 V System:

(1) Black: Phase A.

(2) Red: Phase B.

(3) Blue: Phase C.

(4) Green: Ground.

(5) White: Neutral.

c) 480Y / 277 Volt System:

(1) Brown: Phase A.

(2) Orange: Phase B.

(3) Yellow: Phase C.

(4) Neutral: Gray.

(5) Ground: Green.

d) Conductors size No. 10 and smaller shall be colored full length. Tagging or other methods for coding of conductors size No. 10 and smaller not allowed.

e) For feeder conductors larger than No. 10 at pull boxes, gutters, and panels, use taped band or color tag color-coded as specified above.

B. Instrumentation Cables:

1. Instrument cable shall be Type TC, and have the number of individually shielded twisted pairs indicated on the Drawings and shall be insulated for not less than 600 volts. Unless otherwise indicated, conductor size shall be No. 18 AWG minimum. Shielded, grounded instrumentation cable shall be used for all analog and low voltage digital signals.

2. The jacket shall be flame retardant with 90 degrees C temperature rating. The cable shield shall be a minimum of 2.3 mil aluminum or copper tape overlapped to provide 100 percent coverage and a tinned copper drain wire.

3. The conductors shall be bare soft annealed copper, Class B, 7 strand minimum concentric lay with 15 mils nominal thickness, nylon jacket, 4 mil nominal thickness, 90 degrees C temperature rating. One conductor within each pair shall be numerically identified.

4. Pairs shall be assembled with a nominal 2-inch lay and shall then be group shielded with a minimum of 1.3 mil aluminum or copper tape overlapped to provide 100 percent coverage. All group shields shall be completely isolated from each other.

C. Control Wires:

1. Copper with AWG sizes as shown or required:

a. Minimum size shall be No. 14 except where specified otherwise.

b. Conductors shall be stranded.

1) Insulation:

a) 600V type THWN or XHHW (75° C). All conductors run in underground conduits shall be XHHW.

2. Control wires may be run in same conduits as instrumentation cables.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Conductors and cables shall be continuous from source to equipment.

2. Do not use direct burial cable.

3. Instrumentation and control wires shall be run in conduits separate from power conduits.

B. 600 Voltage Conductors:

1. Install conductors in raceway except where specifically indicated otherwise. Run conductors of different voltage systems in separate conduits. All raceways shall include an equipment ground conductor.

2. Route circuits at own discretion, however, circuiting shall be as indicated or required. Group circuit homeruns to panels as shown on Drawings. No other groupings of circuits will be allowed.

3. Neutrals:

a. On three-phase, 4-wire systems: Do not use common neutral for more than one three phase circuit.

b. On single-phase, 3-wire systems: Do not use common neutral for more than one circuit per phase.

c. Run separate neutrals for each circuit where specifically noted on Drawings.

d. Where common neutral is run for two or three home run circuits, connect phase conductors to breakers in panel which are attached to separate phase legs so neutral conductors will carry only unbalanced current. Neutral shall be sized at 200% of full load.

4. Pulling Conductors:

a. Do not pull conductors into conduit until raceway system is complete and enclosures, cabinets, and boxes are free of foreign matter and moisture.

b. Install conductors in accordance with the manufacture's requirements.

c. Use only listed non-hardening wire pulling lubricants.

5. Provide positive supports for conductors in vertical raceways at following spacing minimum, unless shorter is recommended by manufacturer.

a.	No. 18 to 1/0	100 feet.
b.	No. 2/0 to 4/0	80 feet.
c.	250MCM to 350MCM	60 feet.
d.	d. 350MCM to 500MCM	50 feet.

C. Feeder and branch circuits shall be isolated from each other, and from instrumentation and control circuits. Instrumentation cables shall be installed in separate raceways from other cables and wiring. This includes portions running through manholes. Instrumentation cable shall be continuous between instruments or between field devices and instrument enclosures. There shall be no intermediate splices or terminal boards, unless otherwise shown on the Drawings.

D. Maintain electrical continuity of the shield when splicing twisted shielded pair conductors. Drain wires shall be terminated inside enclosures at grounded terminal blocks. Only one end of each instrument loop cable drain wire shall be grounded. Ground drain wire of shielded conductors at one end only.

E. Terminate instrumentation and control wiring, including spare wires, at control panels and motor control centers on terminal boards mounted inside the equipment.

1. CONTRACTOR shall supply terminal boards as required.

2. Do not field wire directly to devices.

F. Low Voltage Cables In Office Spaces (70 Volts or Less):

1. In inaccessible, concealed spaces, run cables in raceway. In accessible, unfinished areas, cables may be run exposed without raceway.

2. Run exposed cables parallel to or at right angles to building structure lines. Do not run exposed cables on floors or in such a way that they obstruct access to, operation of, or servicing of equipment. Keep cables 6 inches minimum from hot water pipes.

a. Support cables every 3 feet with permanent clips, straps, staples, or tie wraps approved for application and which will not cause cables to be pinched or deformed.

b. Securely attach clips and straps with nails or screws. Do not use wire or tape to support cables.

3. Bundle only cables of same systems together.

END OF SECTION

SECTION 16125

OPERATION AND MAINTENANCE MANUALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specifications sections, apply to work of this section.

B. Division-16 Electrical General Requirements sections apply to work of this section.

1.2 SUMMARY

A. Furnish four sets of bound operation and maintenance manuals. Manuals shall contain descriptive drawings and data which identify equipment installed at the project and detail the procedures and parts required to maintain and repair the equipment. Copies of approved submittals shall be included for all equipment.

1.3 OPERATION AND MAINTENANCE MANUAL FOR ELECTRICAL AND INSTRUMENTATION SYSTEMS

A. General:

1. The "Operating and Maintenance Manual" (Electrical and Instrumentation) is a bound compilation of drawings and data that the owner requires for each building or project. These manuals, complete with drawings and data, shall be furnished to the Owner.
2. The electrical CONTRACTOR has overall responsibility to obtain the necessary data and compile the data as set forth in this specification, including items or equipment purchased by the Owner and delivered to the CONTRACTOR for installation.
3. The number of binders (or "volumes") required will depend on the amount of information to be catalogued. Total "sets" see paragraph 1.02A.
4. Make all information legible and sufficiently marked to indicate the exact size, model, type, etc., of equipment furnished and installed.

B. Purpose: The Operating and Maintenance Manual is prepared to provide a ready reference to all important pieces of mechanical and electrical equipment installed on the project. It is also to provide the necessary operating and maintenance data for use by service personnel. It is also to provide information required for checking equipment performance or for planning of plant expansion or redesign.

PART 2 - PRODUCTS

2.1 PAGE SIZE:

A. All pages shall be standard 8-1/2 x 11 inches size or approximate multiples (preferably 11 x 17 inches) folded to 8-1/2 x 11 inch.

2.2 DRAWINGS:

A. All drawings larger than 8-1/2" x 11" shall be folded and inserted in individual 8-1/2" x 11" manila pockets, which shall have standard three-ring side punching for insertion in the binders. The equipment name, drawing description and number shall be written on the face of each manila pocket.

2.3 BINDERS:

A. Binders shall be Buckram (stiffened fabric), bar-lock type binders with block lettering for sheet size 8-1/2 x 11 inches with 2" to 3-1/2" expandable metal capacity as required for the project. The number of binders, however, shall be based on not filling them beyond 4".

B. Place the following information on the front cover and backbone:

1. "Operation and Maintenance Manual".
2. Project Name and Number (and volume number if more than one volume).
3. Equipment name and number.
4. ENGINEER's name.
5. General CONTRACTOR's name.
6. Electrical CONTRACTOR's name.

(Items 4 through 6 need not be printed on the backbone.)

2.4 CONTENTS AND INDEXING

A. Manuals shall contain descriptions of the electrical, control, and instrumentation systems in sufficient detail to adequately indicate the type of systems installed and the basic details of their operation.

B. All purchased equipment data shall be used to designate the sections. Within each section additional indexing of component parts may be required.

C. Operation and Maintenance Manuals shall contain to the fullest extent all possible information pertinent to the equipment. The arrangement and type of information to be filed shall be as follows:

1. Copy of purchase order change (if any).
2. Outline drawings, special construction details, “as-built” electrical wiring and control diagrams with wire and terminal number for panel and field wiring for all major and supplementary systems.
3. Manufacturer’s test or calculated performance data and certified test curves.
4. Installation, operating, and maintenance instructions, including a complete parts list and sectional drawing with parts identification numbers. Mark with model, size and plan number.
5. Manufacturer’s brochure marked to indicate exact equipment purchased. Brochures on component parts supplied by a manufacturer with his equipment, but not manufactured directly by him, shall also be included.

6. The serial numbers of each item of equipment installed are to be listed with the model numbers and plan symbols.
7. Include a Table of Contents. The contents shall be divided with tabbed index dividers into the following suggested parts:

    Part I Building and System Descriptions

    Part II Purchased Equipment Data

    Part III Test Reports and Charts

    Part IV Start-Up and Operation

    Part V Preventative Maintenance Recommendations

    Part VI Software/Programming Data/Program CD's
8. A copy of the approved submittals for each piece of equipment.
9. A copy of all testing reports.
10. Wiring diagrams, marked with model and size and plan symbol.
11. The index shall contain the name and address of the manufacturer and, if different, where replacement and repair parts may be obtained.
12. Copies of developed software, programmed setpoints, screens, etc. on C.D.

END OF SECTION

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SECTION 16131
CONDUIT

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install conduits and raceway systems as required, and as shown on the Drawings. Materials employed shall be as indicated on the Drawings and specified herein.

1.2 SUBMITTALS

A. Submit product literature including manufacturer part number, model number, material, size, and specifications. Material shall not be installed until the Engineer has reviewed the submittal data.

B. Shop Drawings shall be submitted for review and acceptance showing routing, conduit size, and number and size of wires in each conduit before installation of conduit and any related work. Show proposed routing of conduits buried under floor slabs-on-grade, conduit and rebar embedded in floor slabs, columns, etc. Identify conduit by tag number of equipment served and by conduit schedule number.

C. Proposed location and details of construction for openings in slabs and walls for conduit runs.

1.3 QUALITY ASSURANCE

A. MANUFACTURERS: Firms regularly engaged in manufacture of conduits and raceway systems of type and sizes required, whose products have been in satisfactory use in similar service for not less than (3) years.

B. STANDARDS: Comply with applicable portions of the NEMA standards pertaining to raceways. Comply with applicable portions of UL safety standards pertaining to electrical raceway systems; and provide products and components which have been UL listed and labeled. Comply with NEC requirements as applicable to construction of raceway systems.

1.4 PROJECT/SITE CONDITIONS

A. GENERAL:

1. Unless otherwise specified, equipment and materials shall be sized and derated for ambient site conditions, but in no case less than an ambient temperature of 40 degrees C at an elevation ranging from seal level to 1,601 feet without exceeding the manufacturer's stated tolerances.

B. AREA CLASSIFICATIONS

1. For the purpose of delineating the basic electrical construction materials and installation requirements for this project, areas of the project have been classified on the contract drawings as defined below. Electrical work within these areas shall conform to the requirements described below as well as the referenced code requirements.

   a. General Purpose (NEMA 1): Areas requiring general purpose (NEMA 1) construction are indoor areas typically architecturally finished and occupied by plant personnel.

b. Outdoor and Corrosive Process Areas (NEMA 4X): Areas requiring corrosion resistant (NEMA 4X) construction are all outdoor areas unless noted otherwise and all indoor corrosive process areas. Corrosive process areas typically contain pumping or piping systems and are subject to spills and washdown. Corrosive process areas shall also include those areas containing corrosive chemicals.

c. Hazardous Areas (NEMA 7): Unless otherwise indicated on the contract drawings, areas requiring hazardous location (NEMA 7) construction are classified as Class 1, Division 2 or Class1, Division 1 hazardous locations per Articles 500 and 501 of the National Electrical Code. See classification drawings.

d. Process Areas (NEMA 12): Areas requiring drip-proof (NEMA 12) construction are indoor process and support system areas and are not typically subject to spills, direct washdown, or corrosive chemicals under normal operating conditions.

C. CONSTRUCTION MATERIALS:

1. Construction materials required for each area classification are listed in table A below. Refer to the individual specification section for each component for material composition and installation practices.

	Area Classification				
Component	NEMA 1	NEMA 4X[1] Outdoor	NEMA 4X[1] Indoor Corrosive	NEMA 12[1]	NEMA 7 Classified Explosion Proof/Process Area
Conduit (exposed)	GRS	RA[7] PGRS	PVC8 PGRS	GRS PGRS	PGRS
Conduit (concealed)[4]	EMT[3]	GRS	PVC4	GRS	GRS
Flexible conduit[5]	LFS	LFS	LFN	LFN	Classified
Support systems	Galvanized Steel	Aluminum	Stainless steel	Aluminum	Stainless steel
Fastening hardware and hanger	Cadmium plated steel	Stainless steel	Stainless steel	Cadmium plated steel	Stainless steel
Control Stations[2,]	Painted	Non-Metallic	Non-Metallic	Painted Steel	Classified
Enclosures[2,6]	Painted	Non-Metallic	Non-Metallic	Painted Steel	Classified
Receptacles[2] Surface Recessed	General General	WP 8	WP[8] N/A	WP 8	Classified N/A

Switches[2] Surface Recessed	General General	WP 8	WP[8] N/A	WP 8	Classified N/A

Notes:

1. Enclosures, device boxes, control stations and raceway systems shall be mounted with ¼-inch (minimum) space between the electrical system and supporting structure.
2. Conduit terminations to control stations, enclosures, and device boxes in NEMA 4X, 7 and 12 areas shall be made through threaded hubs.
3. Rigid conduit concealed in framed walls, block walls and ceiling spaces shall be electrical metallic tubing, type EMT.
4. Conduit ductbank or beneath slab on grade shall be rigid HDPE conduit, continuous from device to device without pullboxes or conduit splices beneath grade due to high water table..
5. Flexible conduit shall be utilized for final connections to equipment.
6. Control station and enclosure sealing ratings shall meet or exceed the rating designated by the area classification.
7. Exposed conduit systems in areas containing equipment handling Ferric Chloride shall be PGRS.
8. Use gasketed lever type switches and up-in use red dot steel receptacle covers.

Legend:

EMT	Electrical Metallic Tubing
GRS	Galvanized Rigid Steel
LFS	Liquid Tight Flexible Steel
LFN	Liquid Tight Flexible Non-Metallic
PGRS	PVC Coated Galvanized Rigid Steel
PVC4	PVC Schedule 40
PVC8	PVC Schedule 80
RA	Rigid Aluminum
WP	Weatherproof – Use cast device boxes with threaded hubs
XP	Explosion proof – Approved conduit systems per classification listing
N/A	Non applicable

PART 2 - PRODUCTS

2.1 CONDUIT AND TUBING

A. GENERAL: Provide conduit and fittings of types, grades, sizes and weights (wall thicknesses) as indicated; with minimum trade size of 3/4".

B. ELECTRICAL METALLIC TUBING (EMT):

1. Per UL "Standard for Electrical Metallic Tubing" No. 797. Galvanized mild steel with interior coat of enamel.
2. Fitting shall be steel, compression type. Cast type or indenter type fittings are not acceptable.
3. Approved for interior locations of the Administration Building, and for concealed installation above ceilings and in walls for receptacle and lighting circuits.
4. Not approved for use in classified areas or process areas of the plant.

C. GALVANIZED RIGID METAL CONDUIT (GRC): FS WW-C-0581 and ANSI C80.1.

1. Per USAS C80.1, zinc-coated by hot-dip galvanizing or sherardizing with additional enamel or lacquer coating.
2. Couplings shall be threaded type of same material and finish as conduit. Connectors shall be Myers hubs or equal of same material and finish as conduit.
3. Approved Locations: Interior where exposed, where not exposed to moisture or corrosive atmosphere. Shall not be used in process areas of the plant.

   SCHEDULE 80 approved for above grade installation and for embedding in concrete slabs. Schedule 80 may be used within the process area of the plant, supported in frequent intervals, as per NEC, except elbows below concrete and risers through concrete shall be PVC Coated Ridged Conduit.

D. POLYETHYLENE PLASTIC PIPE (PVC), SCHEDULE 80, Based on Outside Diameter: ASTM D 2447

1. Un-plasticized polyvinyl - chloride heavy wall (PVC-80).
2. Fittings shall be threaded or solvent welded type of same material as conduit.
3. SCHEDULE 80 approved for above grade installation and for embedding in concrete slabs. Schedule 80 may be used within the process area of the plant, supported in frequent intervals, as per NEC, except elbows below concrete and risers through concrete shall be PVC Coated Ridged Conduit.
4. Threaded male plastic adapters shall be used where connected to metal conduits.

E. POLYETHYLENE PLASTIC PIPE (PVC), SCHEDULE 40, Based on Outside Diameter:

1. Un-plasticized polyvinyl - chloride standard (PVC-40).
2. Fittings shall be threaded or solvent welded type of same material as conduit.
3. Approved for underground direct burial, May be used where buried in earth under floor slabs. Minimum depth of bury under slab shall be 18 inches or of sufficient depth to allow for bending radius to rise out of the slab vertically. Shall have an exposed grounding electrode conductor in each trench.
4. Not approved for above grade installation nor for embedding in concrete slabs. Not approved for elbows or risers above 22.5 degree bend.

F. HIGH DENSITY POLYETHELYNE PLASTIC PIPE (HDPE), SCHEDULE 40, Based on Outside Diameter:

1. High density polyethylene heavy wall (HDPE-40) suitable for direct burial. 1” minimum size.

2. Fittings shall be threaded or heat welded type of same material as conduit. No splices are allowed underground due to high water table.
3. Approved for underground direct burial, May be used where buried in earth under floor slabs. Minimum depth of bury under slab shall be 18 inches or of sufficient depth to allow for bending radius to rise out of the slab vertically. Shall have an exposed grounding electrode conductor in each trench.
4. Not approved for above grade installation nor for embedding in concrete slabs. Not approved for elbows or risers above 22.5 degree bend.

G. PVC COATED GALVANIZED RIGID METAL CONDUIT (PGRC): NEMA RN 1.

1. Rigid galvanized conduit, prior to plastic coating, shall conform to ANSI Standard C80.1, UL 6, and CSA Standard C22.2 #45.
2. Nominal thickness of exterior PVC coating shall be 40 mils. A two-part red urethane coating of 2 mil thickness shall be applied to the interior of all conduits and fittings.
3. All hollow conduit fittings which serve as part of the raceway system shall be coated with exterior PVC coating and red interior urethane coating as described above.
4. Coated conduit shall conform to NEMA Standard No. RN1-1989. Shall be "Plastic-Bond Red" as manufactured by Robroy Industries, Inc.
    a. Approved Locations: Shall be used in all locations where conduits are buried, in contact with earth, and in wet and corrosive areas of the plant, and as noted on the drawings. All buried conduit between VFDs and motors. All risers through concrete floors.

H. LIQUIDTIGHT FLEXIBLE METAL CONDUIT: UL 360.

1. Galvanized steel with an extruded liquidtight PVC cover that is moisture and oil-proof, and UV resistant.
2. Fittings shall be liquidtight compression type, listed for grounding. Provide fittings with external bonding jumper where required for bonding.
3. Approved for flexible connections to equipment subject to vibration such as motors, fan, pumps, dry transformers, etc., 36-inch maximum, 18" minimum length for each connection.

I. FLEXIBLE METAL CONDUIT: UL 1.

1. Galvanized steel.
2. Approved for flexible connections to equipment in unclassified areas of the Administration Building.

J. RIDGED ALUMINUM CONDUIT:

Couplings shall be threaded type of same material and finish as conduit. Connectors shall be Myers hubs or equal of same material and finish as conduit.
Approved Locations: Interior where exposed, on the exterior exposed to moisture or corrosive atmosphere. Approved for above grade installation. May be used within the process area of the
plant.

K. CONDUIT BODIES:

1. Form 7 malleable iron with hot dip galvanized finish, PVC coated in wet or process areas of plant.
2. Gasketed cast iron, zinc plated cover with stainless steel screws.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL RACEWAYS

A. General Requirements: Unless otherwise indicated, wiring shall consist of insulated conductors installed in conduits or raceways.

3.2 CONDUIT AND TUBING SYSTEMS

A. Conduit and tubing systems shall be installed as indicated. Conduit sizes are based on the use of insulated, copper conductors. Minimum size of raceways shall be as noted. Only metal conduits will be permitted when conduits are required for shielding or other special purposes indicated, or when required by conformance to NFPA 70. PVC coated rigid metal conduit will be used in damp, wet or corrosive locations and the conduit or tubing system will be provided with the appropriate boxes, covers, clamps, screws or other appropriate type of fittings. Any exposed threads or metal shall be touched up with 3 coats of touch up material provided with conduit. Raceways shall be kept 6" away from parallel runs of any mechanical piping. Raceways shall be concealed where possible. Raceways crossing structural expansion joints shall be provided with suitable expansion fittings and will provide continuity for grounding.

3.3 BELOW SLAB-ON-GRADE OR IN THE GROUND

A. All electrical wiring below slab-on-grade shall be protected by a conduit system. Conduit passing through slabs-on-grade shall be PVC coated rigid metal conduit. PVC conduits shall be installed below slab-on-grade or in the earth. All underground bends over 22º and risers through concrete slab shall be PVC coated GRC.

3.4 INSTALLED IN SLABS INCLUDING SLABS ON GRADE

A. Conduit shall not be embedded in concrete slabs except as specifically detailed.

3.5 EXPOSED RACEWAYS

A. Exposed raceways shall be installed parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings. Raceways under raised floors and above ceilings shall be considered as exposed installations.

3.6 CHANGES IN DIRECTION OF RUNS

A. Changes in direction of runs shall be made with symmetrical bends or cast-metal fittings. Field made bends and offsets shall be made with an approved hickey or conduit bending machine. Crushed or deformed raceways shall not be installed. Trapped raceways in damp or wet locations shall be avoided where possible. Care shall be taken to prevent the lodgment of plaster, dirt, or trash in raceways, boxes, fittings and equipment during the course of construction. Clogged raceways shall be entirely freed from obstructions or shall be replaced.

3.7 SUPPORTS

A. Metallic conduits and tubing shall be securely and rigidly fastened in place at intervals of not more than 10' and within 3' of boxes, cabinets, enclosures, and fittings, with U-channel support systems, one hole conduit straps with clamp backs, and conduit hangers. All supports mounted in exterior, process, or exposed areas subject to corrosive atmosphere shall be stainless steel. Supports in other areas shall be hot dipped galvanized. C-clamps or beam clamps shall have strap or rod type retainers. Rigid plastic conduits (if permitted as wiring method) shall be supported as indicated above, except that they shall be supported at 3'-0" maximum on centers and as indicated in the NEC (NFPA 70). Loads and supports shall be coordinated with supporting structure to prevent damage or deformation to the structures, but no load shall be applied to joist bridging.

B. Fastenings shall be by wood screws or screw-type nails to wood; by toggle bolts on hollow masonry units; by expansion bolts on concrete or brick; by machine screws, welded threaded, heat-treated or spring-steel-tension clamps on steel work. Nail-type nylon anchors or threaded studs driven in by a power charge and provided with lock washers and nuts may be used in lieu of expansion bolts or machine screws. Raceways or supports shall not be welded to steel structures. Holes cut to a depth of more than 1-1/2 inches in reinforced concrete beams or to a depth of more than 3/4" in concrete joints shall avoid cutting the main reinforcement bars. Holes not used shall be filled. In partitions of light steel construction, sheet metal screws shall be used. Conduits shall not be supported using wire or nylon ties.

C. Raceways shall be installed as a complete system and shall be independently supported from the structure. Upper raceways shall not be supported of lower raceways. Supporting means shall not be shared between electrical raceways and mechanical piping or ducts and shall not be fastened to hung ceiling supports.

D. Support Installations:

1. U-channel supports generally are not detailed but must be adequate to support combined weights of conduit and conductors.

2. Clamps: Galvanized malleable iron one-hole straps with clamp backs, beam clamps or other approved device with necessary bolts, expansion shields. Perforated metal straps shall not be used.

3. Adjustable U-channel Supports: Used to support horizontal runs only, use trapeze hangers for parallel runs of conducts.

4. Surface mounted raceway bases shall be anchored to ceiling members or block walls on 5'-0" centers maximum spacing and at all junction and device boxes and at angle fittings. Anchors shall be: Expansion shields on concrete or solid masonry, toggle bolts on hollow masonry units or on suspended ceilings.

3.8 INSTALLATION OF RACEWAYS AND FITTINGS:

A. General:

1. All Conduit: In accordance with requirement of National Electrical Code and applicable local codes.

2. Steel Conduit: In accordance with recommendations of American Iron and Steel Institute "Design Manual on Steel Electrical Raceways," latest edition.

B. Electrical Continuity:

1. All metallic conduit systems shall be electrically continuous throughout.

C. Moisture:

1. All conduit systems shall be essentially moisture tight.

D. Alignment of Exposed Conduit:

1. Parallel with or at right angles to lines of structure.

E. Field Cuts and Threads:

1. Cuts shall be square, threads clean and sharp. Remove sharp or rough edges by reaming burrs. Before couplings or fittings are attached, apply one coat of red lead or zinc chromate to male threads of rigid steel conduit. Apply coat of red lead, zinc chromate or special compound recommended by manufacturer of conduit where conduit protective coating is damaged.

F. Bends:

1. Uniform, whether job-fabricated or made with standard fittings or boxes. Do not dent or flatten conduit.
2. Exposed Conduit: Symmetrical insofar as practicable.

G. Location:

1. Routing: Generally shown in schematic fashion, unless dimensioned or noted to contrary. Contractor shall determine actual routing as approved.
2. Conduit Not Shown: Contractor shall route as required to connect equipment as specified.
3. Vertical Risers, Equipment and Device Locations: Approximately as shown. Contractor shall coordinate installation of conduit, in locations indicated, with structure and equipment.
4. Conduit in Relation to Steam or Hot Water Lines or Other Hot Surfaces: Locate minimum of 6" away. If such separation is impracticable, protect from heat as approved.

H. Buried Conduit:

1. Depth of Burial: Minimum of 24" below finished grade with warning tape 12" above conduit.

I. Wall Penetrations: Required for passage of conduits installed by CONTRACTOR through walls, or partitions.

1. Penetrations Through Exterior Building Walls: Cast in sleeve/Core drill wall and provided conduit entrance seals as detailed. All penetrations shall be with rigid steel conduit PVC coated within the plant process areas.

2. Openings Required Through Existing Partitions: Shall be provided at CONTRACTOR's expense. Holes through masonry construction shall be cast/ drilled with suitable coring machine. Perform work neatly. Patches shall match original material in composition and appearance.
3. Provide fire seals where a fire rated partition or wall is penetrated.

J. Expansion Fittings:

1. Install in all conduit runs crossing structural expansion joint or in straight runs 75 feet or more in length.

K. Conduit Ends:

1. Cap spare conduits.
2. Open Conduit Ends Terminating in Switchboards, Cabinets or Similar Locations Where Exposed to Entrance of Foreign Material: Install insulating grounding bushing. Plug space around cables with sealing compound.
3. Cap or plug conduit ends to prevent entrance of foreign material during construction.

L. Conduit Connections:

1. Cabinets, Enclosures, and Boxes: Double lock nuts and insulating bushings for rigid conduits in unclassified areas, NEMA 1. Hubs for rigid conduits in damp, wet, exterior, or corrosive areas, NEMA 12, 3R, 4, 4X. Bushings, insulating type, bell ends, or insulated throat fittings shall be installed on the ends of all conduits. Grounding type fittings and bushings shall be utilized as required for bonding.
2. Metallic Conduit Terminating in Non-Metallic Manholes or Pull Boxes: Insulated grounding bushing with lay-in ground lugs.
3. Flexible conduit for connection to movable equipment shall be liquidtight, utilizing listed liquidtight fittings.

M. Cleaning:

1. Clean and swab inside of conduits by mechanical means to remove foreign materials and moisture before conductors are installed.

N. Spare Conduits:

1. Install nylon pull line for future installation of cables. Cap all conduits and mark where end is located on Record Drawings with dimensions.

END OF SECTION

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SECTION 16132
CONDUIT DUCTBANKS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install conduit ductbanks as required, and as shown on the Drawings. Materials employed shall be as indicated on the Drawings and specified herein. All exterior conduit shall be buried underground and embedded in sand as detailed.

1.2 SUBMITTALS

A. Submit product literature including manufacturer part number, model number, material, size, and specifications. Material shall not be installed until the Engineer has reviewed the submittal data.

B. Shop Drawings shall be submitted for review and acceptance showing routing, conduit size, and number and size of wires in each conduit before installation of conduit and any related work. Show proposed routing of conduits buried under floor slabs-on-grade, conduit and rebar embedded in floor slabs, columns, etc. Identify conduit by tag number of equipment served and by conduit schedule number.

1.3 QUALITY ASSURANCE

A. MATERIAL MANUFACTURERS: Firms regularly engaged in manufacture of duct system components of type and sizes required, whose products have been in satisfactory use in similar service for not less than (3) years.

B. STANDARDS: Comply with applicable portions of the NEMA standards pertaining to underground ducts. Comply with applicable portions of UL safety standards pertaining to electrical raceway systems; and provide products and components which have been UL listed and labeled. Comply with NEC requirements as applicable to construction of raceway systems.

1.4 APPLICABLE SECTIONS

A. Section “Earthworks”.

B. Section “Electrical General Requirements”.

C. Section “Conductors and Cables”.

PART 2 - PRODUCTS

2.1 DUCTS

A. Ducts shall be round-bore, size as indicated, Nonmetallic Conduit, HDPE-40 or PVC-40.

B. Duct elbows, bends, and off-sets above 22.5 degrees shall be fiberglass or pvc-coated GRC and shall at minimum be per the manufacturer’s requirements.

PART 3 - EXECUTION

3.1 CONDUIT BANKS

A. Each ductbank shall be completely encased in ~~red~~ uncolored bedding sand. Thickness of sand over, under and around ductbank shall be not less than 3 inches as detailed. All ductbanks shall include a grounding electrode conductor as detailed. Use red concrete if the site standard requires it.

B. Unless noted otherwise, the top of the concrete envelope shall be not less than 2'-6" below finished grade or paving. Absolute minimum burial of 18" below finished grade or paving.

C. Ducts shall be installed to provide a water-tight, continuous length duct. If required, joints in duct shall be as per the manufacturer's requirements, and staggered at least 6 inches.

D. Saddles shall be used for support as indicated on the drawings. Hold down anchors shall be provided as indicated and required to prevent duct from floating on wet concrete where applicable.

E. During construction, ends of ducts shall be plugged to prevent debris from entering into ducts. Particular care shall be taken to keep ducts clean of concrete or any other substance during the course of construction.

F. After each duct line has been completed, a mandrel not less than 12 inches long, having a cross section approximately 1/2" less than the inside cross section of the duct, shall be pulled through to clean out the duct of earth, sand or gravel.

G. Trenching, backfilling and surface repair shall be done in accordance with Division 2 of these specifications.

H. Ductbanks shall be straight without bends or off-sets where possible.

I. Over each ductbank at approximately 12 inches below grade, provide a detectable continuous red plastic warning tape to alert future excavators of the presence of the ductbank.

J. Provide nylon pull line in all ducts.

K. Coordinate trench requirements with existing and additional piping and utilities. Preserve and protect.

END OF SECTION

SECTION 16138

ELECTRICAL BOXES AND FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install electrical boxes and electrical fittings as required, and as shown on the Drawings. Materials employed shall be as indicated on the specified herein.

B. Types of electrical boxes and fittings in this section include the following:
   1. Outlet boxes
   2. Junction boxes
   3. Pull boxes
   4. Conduit bodies
   5. Bushings
   6. Locknuts and hubs
   7. Knockout closures
   8. Miscellaneous boxes and fittings.

1.2 SUBMITTALS

A. Submit product literature including manufacturer, model or part number, materials of construction, size, ratings, and listings as a minimum.

1.3 QUALITY ASSURANCE

A. Comply with NEC as applicable to construction and installation of electrical boxes and fittings.

B. Comply with ANSI C 134.1 (NEMA Standards Pub No. OS 1) as applicable to sheet-steel outlet boxes, device boxed, covers and box supports. Provide electrical boxes and fittings, which have been UL listed and labeled.

PART 2 - PRODUCTS

2.1 FABRICATED MATERIALS

A. Flush Interior Outlet or Device Boxes: Provide one piece, galvanized flat rolled sheet steel interior wiring boxes of types, shapes and sizes, including box depths, to suit each respective location and installation; construct with stamped knockouts in back and sides, and with threaded screw holes with corrosion-resistant screws for securing box covers and wiring devices; minimum depth 1-1/2". Provide minimum 2-1/8" depth for boxes with three or more conduit entries.

B. Interior Outlet or Device Box Accessories: Provide box accessories as required for each installation, including mounting brackets, hangers, extension or plaster rings, fixture studs, cable clamps and metal straps for supporting boxes, which are compatible with boxes being used and fulfilling requirements of individual wiring applications.

C. Exposed Outlet or Device Boxes: Provide corrosion- resistant cast-metal type FD weatherproof wiring boxes of types, shapes and sizes (including depth) required, with integral threaded conduit hubs, face plates with spring-hinged waterproof caps suitable configured for each application, with face plate gaskets and corrosion-resistant fasteners.

D. Junction and Pull Boxes: Provide junction and pull boxes with covers of types, shapes and sizes to suit each respective location and installation; with welded seams and equipped with stainless hardware. Provide underground concrete junction boxes as required or indicated on the Drawings. Provide cast steel boxes with threaded hubs and gasketed cover as required or indicated on the Drawings.

E. Conduit Bodies: Provide galvanized cast-metal Form 7 conduit bodies of types, shapes and sizes to suit respective locations and installation, construct with threaded-conduit-entrance ends, removable covers, and corrosion-resistant screws.

F. Bushings, Knockout Closures, Locknuts, and Hubs: Provide corrosion-resistant punched-steel box knockout closures, conduit locknuts and hubs, and conduit bushings and offset connectors of types, and sizes to suit respective uses and installation.

G. All boxes, fittings, and conduit bodies shall be PVC coated wherever PVC coated conduits are required elsewhere in this specification.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS:

A. General: Install electrical boxes and fittings where indicated, complying with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

B. Coordinate installation of electrical boxes and fittings with wire/cable and raceway installation work.

C. Provide cover plates for all boxes. See Section “Wiring Devices”.

D. Provide weatherproof outlets for interior and exterior locations exposed to weather or moisture.

E. Provide knockout closures to cap unused knockout holes where blanks have been removed.

F. Install boxes and conduit bodies to ensure ready accessibility of electrical wiring. Install recessed boxes with face of box or ring flush with adjacent surface.

G. Fasten boxes rigidly to substrates or structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry. Use bar hangers for stud construction. Use of nails for securing boxes is prohibited. Set boxes on opposite sides of common wall with minimum 10" of conduit between them.

H. Provide electrical connections for installed boxes.

END OF SECTION

SECTION 16140
WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install wiring devices as required, and as shown on the Drawings. Materials employed shall be as indicated on the Drawings and specified herein.

1.2 SUBMITTALS

A. Submit product literature including manufacturer, model or part number, materials of construction, size, ratings, and listings as a minimum.

1.3 QUALITY ASSURANCE

A. NECA - Standard of Installation.

B. NEMA WD 1 - General Requirements for Wiring Devices.

C. NEMA WD 6 - Wiring Device -Dimensional Requirements.

D. NFPA 70 - National Electrical Code.

E. UL - Underwriters Laboratories, Inc.

PART 2 - PRODUCTS

2.1 WALL SWITCHES

A. Manufacturers:
   1. Hubbell, Model HBL-1221, 1223, 1224 series.
   2. Arrow Hart, Model 1991.

B. Description: NEMA WD 1, Heavy-Duty Specification Grade AC only general-use snap switch.

C. Body and Handle: Gray plastic with toggle handle.

D. Indicator Light: Lighted handle type switch red color handle.

E. Locator Light: Lighted handle type switch; red color handle.

F. Ratings:
   1. Voltage: 120-277 volts, AC.
   2. Current: 20 amperes.

2.2 RECEPTACLES

A. Manufacturers:
   1. Hubbell, Model HBL 5362-SP.
   2. Arrow Hart, Model 5362-CR.

B. Description: NEMA WD 1, Heavy-duty specification grade general use receptacle.

C. Device Body: Gray plastic.

D. Configuration: NEMA WD 6, type as specified and indicated.

E. Convenience Receptacle: Type 5-20.

F. GFCI Receptacle: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.

2.3 WALL PLATES

A. Decorative Cover Plate: Brushed stainless steel in electrical/control/blower rooms.

B. Process Room/Exterior Cover Plate: Gasketed cast metal with hinged gasketed device cover. Lever type switch cover. Classified hazardous as required for process areas per drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that outlet or device boxes are installed at proper height.

B. Verify that wall openings are neatly cut and will be completely covered by wall plates.

C. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean debris from outlet boxes.

3.3 INSTALLATION

A. Install in accordance with NECA "Standard of Installation."

B. Install devices plumb and level.

C. Install switches with OFF position down.

D. Install receptacles with grounding pole on bottom.

E. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.

F. Install decorative plates on switch, receptacle, and blank outlets in finished areas.

G. Connect wiring devices by wrapping conductor around screw terminal.

H. Use jumbo size plates for outlets installed in masonry walls.

I. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Install wall switch 48 inches above finished floor.

B. Install convenience receptacle 18 inches above finished floor unless otherwise indicated.

C. Install convenience receptacle 6 inches above back-splash of counter.

D. Install dimmer 48 inches above finished floor.

E. Install telephone/data jack 18 inches above finished floor.

F. Install telephone/data jack for side-reach wall telephone to position top of telephone at 54 inches above finished floor.

G. Install telephone/data jack for forward-reach wall telephone to position top of telephone at 48 inches above finished floor.

3.5 FIELD QUALITY CONTROL

A. Inspect each wiring device for defects.

B. Operate each wall switch with circuit energized and verify proper operation.

C. Verify that each receptacle device is energized.

D. Test each receptacle device for proper polarity.

E. Test each GFCI receptacle device for proper operation.

F. Verify that each telephone jack is properly connected and circuit is operational.

3.6 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

3.7 CLEANING

A. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION

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SECTION 16155

EQUIPMENT WIRING

PART 1 - GENERAL

1.1 SCOPE

Furnish all labor, materials, equipment, appliances, and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work:

A. This section includes wiring connections to equipment specified in other sections.

B. Electrical connections to equipment: Provide the materials and make the electrical connections to all equipment having electrical requirements as indicated in the architectural and/or mechanical section of the specifications and drawings.

C. Provide conduit, wiring, connect motors and other mechanical equipment and electrical devices in other sections; also install, provide, support for, and connect starters, other control devices, control panels, furnished for such motors and equipment; complete all circuit leave in satisfactory operating conditions.

D. Provide control devices for equipment in addition to those furnished by the trades providing such equipment; refer to schedules on electrical and mechanical drawings for control devices to be furnished under scope of the electrical work.

E. Control devices and panels furnished by trades providing equipment will be delivered to electrician at site of project; acknowledge acceptance in writing; assume responsibility for particular installation before proceeding with installing and wiring them. Follow each manufacturer's printed installation directions and wiring diagrams for installing and making connections to his equipment and controls.

F. Consult contract drawings and specifications of trades providing equipment and controls, for control wiring diagrams, also refer to their shop drawings in order to become familiar with equipment type and operation of controls, their locations and extent of work required for installing, wiring and connecting them.

G. Starters for all motors requiring same shall be furnished by electrical contractor.

1.2 APPLICABLE SECTIONS

The General Conditions, Supplementary Conditions, Special Conditions, alternates, and addenda, applicable drawings, and the specifications including but not limited to the following:

A. Section “Electrical General Requirements”.

1.3 REFERENCES

A. Section “Quality Control”:

B. NEMA WD 1 - General Purpose Wiring Devices.

C. NEMA WD 6 - Wiring Devices - Dimensional Requirements.

D. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS FOR REVIEW

A. Section Submittals: “General”.

B. Section Submittals: “Procedures for submittals”.

C. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.

1.5 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.6 COORDINATION

A. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.

B. Determine connection locations and requirements.

C. Sequence rough-in of electrical connections to coordinate with installation of equipment.

D. Sequence electrical connections to coordinate with start-up of equipment.

PART 2 - PRODUCTS

2.1 CORDS AND CAPS

A. Manufacturers:
   1. Hubbell.
   2. Or equal.

B. Attachment Plug Construction: Conform to NEMA WD 1.

C. Configuration: NEMA WD 6; match receptacle configuration at outlet provided for equipment.

D. Cord Construction: NFPA 70, Type SJO multi-conductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.

E. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit over-current protection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energizing

3.2 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturer's instructions.

B. Make conduit connections to equipment using flexible conduit. Use liquid-tight flexible conduit with watertight connectors in damp or wet locations.

C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

D. Provide receptacle outlet to accommodate connection with attachment plug.

E. Provide cord and cap where field-supplied attachment plug is required.

F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

H. Install terminal block jumpers to complete equipment wiring requirements.

I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION

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SECTION 16164

ELECTRIC ACTUATORS

PART 1 – General

1.0 THE REQUIREMENT

A. The Contractor shall furnish, test, install, and place into satisfactory operation the electric actuators, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.1 The actuators shall be suitable for use on a nominal 460 volt, 3 phase, 60Hz power supply and are to incorporate motor, integral reversing starter, local control facilities and terminals for remote control and indication connections housed within a self-contained, sealed enclosure.

1.2 As a minimum the actuators should meet the requirements set out in EN15714-2 and ISA SP96.02

1.3 In order to maintain the integrity of the enclosure, setting of the torque levels, position limits and configuration of the indication contacts etc. must be carried out without the removal of any actuator covers and without mains power over an Infrared or *Bluetooth*® wireless interface. Sufficient commissioning tools must be provided with the actuators and must meet the enclosure protection and certification levels of the actuators. Commissioning tools must not form an integral part of the actuator and must be removable for secure storage / authorized release. In addition, provision shall be made for the protection of configured actuator settings by a means independent of access to the commissioning tool. Provision shall be made to disable *Bluetooth®* communications or only allow a *Bluetooth®* connection initiated by an Infra-Red command for maximum security.

1.4 The actuator shall include a device to ensure that the motor runs with the correct rotation for the required direction of valve travel irrespective of the connection sequence of the power supply.

1.5 As manufactured by:

a. Rotork.

b. Bray.

c. Or approved equal.

PART 2 - Actuator Sizing

2.1 The actuator must be sized to guarantee valve closure at the specified differential pressure and temperature. The safety margin of motor power available for seating and unseating the valve must be sufficient to ensure torque switch trip at maximum valve torque with the supply voltage 10% below nominal. For linear operating valves, the operating speed shall be such as to give valve closing and opening at approximately 10-12 inches per minute unless otherwise stated in the data sheet. For 90° valve types the operating time will be specified.

PART 3 - Environmental

3.1 Actuators must be suitable for indoor and outdoor use with a standard corrosivity category, C4 medium durability as per ISO 12944. The actuator must be capable of functioning in an ambient temperature ranging from -30°C (-22°F) to +70°C (+158°F), up to 100% relative humidity. Actuators for hazardous area applications must meet the area classification, gas group and surface temperature requirements specified in the data sheet.

PART 4 - Enclosure

4.1 Actuators shall be O-ring sealed, watertight to IP66/IP68 20m for 10 days, NEMA 4, 6. The motor and all other internal electrical elements of the actuator must be protected from ingress of moisture and

dust when the terminal cover is removed for site cabling. The terminal compartment must maintain the same ingress protection rating with the terminal cover removed. The actuator enclosure must allow for temporary site storage without the need for electrical supply connection. All external fasteners shall be suitable for the actuator corrosivity category and installation environment indicated on the datasheet.

PART 5 - Motor

5.1 The motor must be an integral part of the actuator, designed specifically for valve actuator applications. The motor shall be a low inertia, high torque design and class F insulated. Resulting in class B temperature rise with a time rating of 15 minutes at 40°C (104°F) at an average load of at least 33% of maximum valve torque. Temperature shall be limited by thermostat device embedded in the motor end windings and integrated into the actuator control. Electrical and mechanical disconnection of the motor shall be possible without draining the lubricant from the actuator gearcase. The actuator shall include a device to ensure that the motor runs with the correct rotation for the required direction of valve travel irrespective of the connection sequence of the power supply.

PART 6 - Motor Protection

6.1 Protection must be provided for the motor as follows:

- Stall - the motor must be de-energised within 8 seconds in the event of a stall when attempting to unseat a jammed valve.
- Over temperature - thermostat will cause tripping of the motor. Auto-reset on cooling
- Single phasing - lost phase protection.
- Direction – phase rotation correction.

PART 7 - Gearing

7.1 The actuator gearing must be totally enclosed in an oil-filled gearcase suitable for operation at any angle. Grease lubrication is not permissible. All drive gearing and components must be of metal construction and incorporate a lost-motion hammer blow feature. For rising spindle valves the output shaft shall be hollow to accept a rising stem, and incorporate thrust bearings of the ball or roller type at the base of the actuator. The design should be such as to permit the opening of the gearcase for inspection or disassembled without releasing the stem thrust or taking the valve out of service. For 90° operating type valves, drive gearing shall be self-locking to prevent the valve back-driving the actuator.

PART 8 - Hand Operation

8.1 A handwheel must be provided for emergency operation, engaged when the motor is declutched by a lever or similar means, the drive being restored to electrical operation automatically by starting the motor. The handwheel or selection lever must not move on restoration of motor drive. Provision shall be made for the hand/auto selection lever to be locked in both hand and auto positions. It should be possible to select hand operation while the actuator is running or start the actuator motor while the hand/auto selection lever is locked in hand without damage to the drive train.

8.2 Clockwise operation of the handwheel must give closing movement of the valve unless otherwise stated in the data sheet. For linear valve types the actuator handwheel drive must be mechanically independent of the motor drive and should be such as to permit valve operation in a reasonable time with a manual force not exceeding 400N through stroke and 800N for seating/unseating of the valve.

PART 9 - Drive Interface

9.1 The actuator shall be furnished with a drive bushing easily detachable for machining to suit the valve stem or gearbox input shaft. The drive bush shall be positioned in the base of the actuator. Thrust bearings shall be sealed for life and the base shall be capable of withstanding five times the rated thrust of the actuator.

PART 10 - Local Controls

10.1 The actuator must incorporate local controls for Open, Close and Stop operation and a Local/Stop/Remote mode selector switch. Mode selection must be lockable in any one of the following three positions: local control plus local stop only, stop (no electrical operation), remote control plus local stop only. It must be possible to select maintained or non-maintained local control.

10.2 The local controls shall be arranged so that the direction of valve travel can be reversed without the necessity of stopping the actuator.

10.3 The local controls and display shall be rotatable through increments of 90 degrees to suit valve and actuator orientation.

PART 11 - Torque and Limits

11.1 Torque and turns limitation to be adjustable as follows:

- Position setting range – multi-turn: 2.5 to 8,000 turns, with resolution to 7.5° of actuator output.
- Position setting range – direct drive part turn actuators: 90° +/-10°, with resolution to 0.1° of actuator output.
- Torque setting: 40% to 100% rated torque.

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11.2 Position measurement – Absolute position measurement should be incorporated within the actuator. The technology must be capable of reliably measuring position even in the case of a single fault. The design must be simple with the minimum amount of moving parts (no more than 5). Technologies such as LEDs or potentiometers for position measurement are considered unreliable and therefore not preferred.

11.3 Measurement of torque for multi-turn actuators must be from direct measurement of force at the output of the actuator. Methods of determining torque-using data derived from the motor such as motor speed, current, flux etc. are only acceptable for part-turn actuators.

11.4 A means for automatic “torque switch bypass” to inhibit torque off during valve unseating and “latching” to prevent torque switch hammer under maintained or repeated control signals shall be provided.

11.5 The electrical circuit diagram of the actuator should not vary with valve type remaining identical regardless of whether the valve is to open or close on torque or position limit.

PART 12 - Remote Valve Position and Status Indication

12.1 Four contacts must be provided which can be selected to indicate any position of the valve; Provision must be made for the selection of a normally closed or open contact form. Contacts shall maintain and update position indication during handwheel operation when all external power to the actuator is isolated.

12.2 The contacts must be rated for 5mA to 5A, 120V AC, 30V DC.

12.3 As an alternative to providing valve position indication, any of the four contacts shall be selectable to signal one of the following:

- Valve opening, closing or moving
- Thermostat tripped, lost phase
- Motor tripped on torque in mid travel, motor stalled
- Remote selected, Local selected, Stop selected
- Actuator being operated by handwheel
- Actuator fault

12.4 Provision shall be made in the design to support an additional eight contacts with the same configurable functionality.

12.5 A configurable monitor relay must be provided as standard, which can be used to indicate either Availability or Fault. The relay should be a spring return type with a Normally Open / Normally Closed contact pre-wired to the terminal block.

12.6 The Monitor (availability or fault) relay, being energized from the control transformer will de-energise under any one or more the following conditions:

12.7

Available Mode	Fault Mode
• Loss of main or customer 24V DC power supply	• Loss of main or customer 24V DC power supply
• Actuator control selected to local or stop	• Motor thermostat tripped
• Motor thermostat tripped	• Actuator internal fault
• Actuator internal fault	

12.8 Provision shall be made in the design for the addition of a contactless transmitter to give a 4-20mA analogue signal corresponding to valve travel and / or torque for remote indication when required. The transmitter will auto range to the set limits

PART 13 - Local Position Indication

13.1 The actuator display must include a dedicated numeric/symbol digital position indicator displaying valve position from fully open to fully close in 0.1% increments. Valve closed and open positions shall be indicated by symbols showing valve position in relation to the pipework to ensure that valve status is clearly interpreted. With mains power connected, the display must be backlit to enhance contrast at all ambient light levels and must be legible from a distance of at least 5m (16ft). A power save mode shall be available to switch off the display backlight during long periods of inactivity.

13.2 Red, green, and yellow LEDs corresponding to open, closed and intermediate valve positions must be included on the actuator display when power is switched on. The yellow LED should also be fully programmable for on/off, blinker and fault indication. The digital display must be maintained and updated during handwheel operation when mains power to the actuator is isolated.

13.3 The actuator display shall include a fully configurable dot-matrix display element with a minimum pixel resolution of 168 x 132 to display operational, alarm, configuration and graphical datalogger information. The text display shall be selectable between English and other languages such as: Spanish, German, French, and Italian. Provision shall be made to upload a different language without removal of any covers or using specialized tools not provided as standard with the actuator.

13.4 Datalogger graphical displays and trend graphs must be available on the local LCD for the following functions:

- Torque versus Position
- Number of Starts versus Position
- Number of starts per hour
- Dwell Time
- Average temperature

13.5 The main display must include configurable a minimum of four different home-screens that include the following information:

- Position and status
- Position and torque (analogue)
- Position and torque (digital)
- Position and demand (positioning)

13.6 An optional environmental cover to protect the display from high levels of UV radiation or abrasive materials must be available and shall be fitted without the need for any special tooling.

13.7 The local controls and display must be rotatable through increments of 90 degrees to suit valve and actuator installation orientation.

PART 14 - Integral Starter and Transformer

14.1 The reversing starter, control transformer and local controls must be integral to the valve actuator and suitably housed to prevent breathing and condensation. The starter shall be suitable for 60 starts per hour during normal service or 1,200 starts per hour under reduced load conditions and of rating appropriate to motor size. The controls supply transformer shall be fed from two of the incoming three phases and incorporate overload protection. It must have the necessary voltage tapping and be adequately rated to provide power for the following functions:

- Energizing of the contactor coils
- 24V DC or 110V AC output for remote controls (maximum 5W/VA)
- Supply for all the internal electrical circuits

14.2 An alternative solid state motor starter is permissible for applications requiring up to 1,200 starts per hour. 24VDC remote controls should be used in combination with a solid state starter to maximise response time. The solid state starter must facilitate configurable electrical braking functionality.

14.3 Speed adjustable actuators must have an integral motor controller to manage starting, speed and operation.

PART 15 - Remote Control Facilities

15.1 The necessary control, wiring and terminals must be contained within the actuator enclosure. Open and close external interlocks must be made available to inhibit local and remote valve opening / closing control. It must be possible to configure the interlocks to be active in remote control only. Remote control signals fed from an internal 24VDC (or 110VAC) supply and/or from an external supply between 20V and 60VDC or 40V and 120VAC, must be suitable for any one or more of the following methods of control:

- Open, Close and Stop control
- Open and Close maintained or “push to run” (inching) control
- Overriding Emergency Shut-Down; to close (or open) valve from a normally closed or open contact
- Two-wire control; energise to close (or open), de-energise to open (or close)

15.2 Additionally, provision shall be made for a separate ‘drive enable’ permissive input to prevent any unwanted electrical operation.

15.3 It must be possible to reverse valve travel without the necessity of stopping the actuator or moving through an intermediate stop control position. The motor starter must be protected from excessive current surges during rapid travel reversal. The internal circuits associated with the remote control and monitoring functions are to be designed to withstand simulated lightning impulses up to 2kV.

15.4 Operation by distributed control system must be possible utilising one or more of the following network systems:

- Profibus
- Modbus
- Foundation Fieldbus
- DeviceNet
- Pakscan
- HART

PART 16 - Monitoring Facilities

16.1 Facilities to indicate actuator availability and monitor operation must be included as standard.

16.2 Actuator text display indication of the following status/alarms:

- Closed Limit, open limit, moving open, moving closed, stopped
- Torque trip closing, torque trip opening, motor stalled

- ESD active, interlock active
- Thermostat trip, phase lost, 24V supply lost, local control failure
- Configuration error, position sensor failure, torque sensor failure
- Battery low, battery discharged, power loss inhibit

16.3 Integral datalogger to record and store the following operational data:

- Opening last / average torque against position
- Closing last / average torque against position
- Opening motor starts against position
- Closing motor starts against position
- Total open / closed operations
- Maximum recorded opening and closing torque values
- Event recorder logging operational conditions (valve, control and actuator)

16.4 The event log must include time and date information for each stored event.

A. Logged data must be accessible via non-intrusive *Bluetooth®* communication and also visible on the actuator display. An intrinsically safe portable tool must be provided to extract datalogger and actuator configuration files from the actuator. The portable tool must permit *Bluetooth®* connection with a PC to perform file transfer. The actuator manufacturer must supply PC software to enable extracted actuator files to be viewed and analysed.

PART 17 - Wiring and Termination

17.1 Internal wiring shall be tropical grade PVC insulated stranded cable of appropriate size for the control and power. Each wire shall be clearly identified at both ends. The terminals shall be embedded in a terminal block of high tracking resistance compound.

17.2 The terminal compartment must be separated from the inner electrical components of the actuator by means of a watertight seal. A minimum of four threaded cable entries with provision for an additional four extra conduit entries must be available to accommodate wiring connections.

17.3 All wiring supplied as part of the actuator must be contained within the main enclosure for physical and environmental protection. External conduit connections between components are not acceptable. A durable terminal identification card showing a plan of terminals must be attached to the inside of the terminal box cover indicating:

- Serial number
- External voltage values
- Wiring diagram number
- Terminal layout

17.4 The code card must be suitable for the contractor to inscribe cable core identification alongside terminal numbers.

PART 18 - Commissioning Kit

18.1 Each actuator must be supplied with a start-up kit comprising installation instruction manual, electrical wiring diagram and cover seals to make good any site losses during the commissioning period. In addition, sufficient actuator commissioning tools shall be supplied to enable actuator set up and adjustment during valve/actuator testing and site installation commissioning.

PART 19 - Performance and Test Certificate

19.1 Each actuator must be performance tested by the manufacturer and individual test certificates are to be supplied free of charge. Test certificates must be retained by the manufacturer for the serviceable life of the product. The test certificate must include details of the equipment specification such as:

- Serial number

- Test date
- Manufacturing site address
- Customer
- Customer order number (where applicable)
- Actuator size
- Mounting flange
- Enclosure type
- Lubricant
- Paint coating
- Power supply
- Operating speed/time
- Drive close direction
- Gear ratio for second stage gearbox (where applicable)
- Electrical optional extras
- Catalogue performance

19.2 The test equipment should simulate a typical valve load. The following parameters must be recorded and clearly stated on the certificate:

- Torque at maximum torque setting in both directions
- Current at maximum torque setting in both directions
- Flash test statement
- Test power supply voltage

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SECTION 16174
ELECTRICAL MOTORS

PART 1 - GENERAL

1.1 SCOPE

A. This section specifies alternating current induction motors 300 horsepower and less to be provided with the driven equipment. This section refers to motors by the enclosure type as defined in NEMA MG 1. Compliance by the supplier to the requirement of the specification does not relieve them of responsibility of furnishing motors and motor accessories that are suitable for the specified service conditions.

1.2 QUALITY ASSURANCE

A. General
   1. Motors shall be built in accordance with UL 1004, NEMA Standard MG 1, and to the requirements specified herein.

B. References
   1. This section references the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
FORM A-1 1	Motor Data Sheet
IEEE 85	Test Procedure for Airborne Sound Measurements on Rotating Machinery
NEMA ICS 6	Enclosure for Industrial Controls and Systems
NEMA MG 1	Motors and Generators
UL 1004	Motors, Electric
NEC	National Electric Code, Latest Edition

1.3 SUBMITTAL DATA

A. Complete motor data shall be submitted with the driven machinery submittals. Motor data shall include.
   1. Machine tag and loop number, as identified in the P&IDs, and specifications number of driven machine.
   2. Motor manufacturer.
   3. Motor Type or model and dimension drawing.
   4. Nominal horsepower at installed altitude.
   5. Nominal efficiency.
   6. NEMA design.
   7. Frame size.
   8. Enclosure.
   9. Winding insulation class and treatment.

10. Rated ambient temperature.
11. Service factor.
12. Voltage, phase, and frequency rating.
13. Full load current at rated horsepower for application voltage.
14. Starting code letter, or locked rotor KVA, or current.
15. Special winding configuration such as part winding, star-delta.
16. Rated full load speed.
17. Power factor at full load.
18. Power and connection requirements of motor winding heaters.
19. Temperature protective devise ratings and connection information.
20. Recommended maximum size power factor correction capacitor.
21. Motor insulation dielectric withstand rating.
22. If driven from a variable frequency drive:
    a. Certification that the motor meets the requirements of NEMA MG-1 1993 part 31.
    b. Certification that the motor and mechanical drive are matched in design and suitable for use together for the specific installation and driven equipment conditions.

B. The OWNER/CONTRACTOR shall complete the motor data sheet at the end of this Section for each and every motor supplied, and submit the completed forms to the ENGINEER for review, as part of the submittal package for each piece of equipment.

C. Motor insulation resistance test report.

1.4 SERVICE CONDITIONS

A. Environmental Conditions
1. All motors are subject to hose directed spray and up to a temperature 40°C. Motors shall be totally enclosed unless otherwise specified and shall be rated for service at elevation 4,300 feet above mean sea level or the elevation of the installation, whichever is most correct. Motors shall meet the criteria as specified in NEMA MG 1 for usual environmental conditions.

B. Operating Conditions
1. Motors shall be selected for the operating conditions of the driven equipment in accordance with NEMA MG 1. Motors shall be subject to the vibration performance limits as follows:
    a. The rotor shall be dynamically balanced according to NEMA Standards. Balance limits shall be 1/2 the limits shown on NEMA MG 1-12.06. The depositing of metal on the rotor (solder, weld, etc.) to achieve balance is not acceptable. Pavement metal is to be removed to achieve a balance only without effecting the structural strength of the rotor. Chiseling or sawing parent metal is prohibited. The addition of weights is acceptable.

1.5 PERFORMANCE REQUIREMENTS

A. Motors shall be continuous duty of the type generally described as having normal starting torque with low current, NEMA design “B”.

B. Starting current for fully loaded motors shall be as defined by NEMA design “B”.

C. Motors shall be sized for operation at their respective horsepower rating, never at their service factor rating. All motors shall be rated with a service factor of at least 1.15.

D. The motor must develop sufficient locked rotor torque to provide breakaway of the load and to provide adequate torque during the acceleration period to overcome the load and inertial forces.

E. Acceleration time must be short enough to be within the thermal limits of the motor, but not so short that it over stresses the driven equipment.

F. Overhung load requirements such as the number and pitch radius of the motor-shaft-mounted pulley sprocket, etc., and the distance from the motor front bearing to the center of the pulley, sprocket, etc. must be determined and included in the purchase order.

G. Motors are to be manufactured with multiple dips of Class H varnish in order to accommodate the application of adjustable speed drive systems voltage and severe duty environments.

H. All equipment manufacturers shall provide a totally enclosed fan cooled motor, corrosion resistant and rated for severe, continuous duty operation.

I. Motors shall operate successfully at rated load under the various combinations of voltage and frequency variations specified in section 12.44 of NEMA MG1-1998.

J. Motors shall operate successfully under running conditions at rated load and frequency when the voltage unbalance at the motors terminals does not exceed 1%.

K. Motor balance and vibration shall meet NEMA standards as defined in MG1-1998 part 7. The motor shall be dynamically balanced to meet 0.08 in/s maximum velocity at the bearing housing when measured in the horizontal, vertical and axial plane (0.12 in/s on 2-pole motors frame 280 and above).

L. Unless otherwise specified in the equipment description, the motor rotation shall be possible in either direction – application permitting. See motor data sheet.

1.6 MOTOR CONSTRUCTION

A. Mechanical and Electrical Features:
   1. All motors ¼ Hp through 2 Hp may have either NEMA C-Face or floor mounted feet, or both. Motors above 2 Hp shall be foot mounted in preference to any other method. Mounting requirements are provided in the horsepower descriptive section of the documents.

2. All motors controlled by a variable speed drives shall be equipped with motor shaft ground rings.
3. Long shaft motors are preferred over short shaft for close-coupled applications. Shafts shall have Impro seal supplied on both bearings. Motor shaft diameter shall comply with NEMA standard size for the motor frame size specified. Reduced, custom, or special shaft diameter motors are not acceptable unless specifically required by the application and approved, in writing, by project engineer. Notification of such variance must be submitted with bid proposals.
4. Motor speeds are dictated in the equipment descriptive documents included with this specification.
5. The following NEMA frame size shall be provided unless specifically approved by the project engineer (3600, 1800, 1200 & 900 RPM):
    a. 1 Hp through 2 Hp on a 143 T(C) to 213 T (C).
    b. 3 Hp through 5 Hp on a 182 T(C) to 254 T (C).
    c. 7.5 Hp through 10 Hp on a 213 T(C) to 284 TS
    d. 15 Hp through 25 Hp on 254 T to 326TS
    e. 30 Hp through 50 Hp on 286T to 404T
    f. 60 Hp through 100 Hp on a 364 T to 445T
    g. 125 Hp through 300 Hp on a 445TS to 5010 US
    h. Above 200 Hp, frame selection shall be defined on equipment data and motor data sheets.
6. Stator frame, end brackets, fan cover and conduit box shall be manufactured of high 25 grade cast iron. All frames shall be designed and constructed such that on direct-coupled applications the motor can be mounted and aligned without distortion of the feet, and sufficient strength to withstand overhung loads for belt drive applications. The motor shall be designed with the capabilities for mounting the drive side vertically up or down as required by the application.
7. Ventilating fans shall be non-sparking bronze alloy or non-conductive nylon 66 materials. The ventilation shall be such that cool air is drawn in and hot air expelled to avoid mixing with the incoming air.
8. All motors 1 Hp to 250 Hp shall be rated and wired as 3 phase, 60 Hertz 460 volt operation. Exceptions to this requirement must be reviewed and authorized by the project engineer. If wired for 230/460 volt, a wiring diagram shall be illustrated on the inside of the conduit box or name plate.
9. Moisture inhibiting coating shall protect the rotor and stator. These coatings must match or exceed the anticipated full load thermal conditions, vibration, and shock electrical insulation ratings of the motor.
10. All cast iron motor parts shall be primed and painted with epoxy or polyester resin enamel or similar coatings for additional corrosion and moisture protection.
11. Motor stator and rotor steel shall be low-loss C-5 electrical grade silicon steel with interlamination insulation capable of withstanding a minimum of 1000 ^{o}F burnout. Stator random windings shall be copper and shall be insulated with class H insulation.
12. Bearings shall be either 300 series ball bearings or cylindrical roller bearings on the drive end and opposite drive end. Bearings shall be selected to provide a minimum L-10 life of 50,000 hours with an external load per NEMA MG 1-14 and a L-10 life of 100,000 hours in direct coupled applications. Bearing type shall be defined on the motor data sheet.

13. Bearings shall have a maximum of 45°C rise at rated horsepower (50 °C for 2-pole motors).
14. Bearings on frames 143T through 5010UZ shall be regreaseable with regreasing instructions labeled on the motors. The bearings found in frames 213T and larger shall have open bearings with cast iron inner bearing caps. If motor is to be operated by a variable frequency drive the manufacturer shall provide optional insulated bearings on both end of direct coupled motors. See motor data sheets for VFD motors.
15. The motor bearing housing shall have an extended automatic grease relief valve to effectively prevent bearings from being over-lubricated.
16. The motor nameplate shall have raised letters stamped on 304 stainless steel and be fastened to the motor frame with four stainless steel drive pins.
17. All motor hardware shall be English type and grade 5 zinc-dichromate plated.
18. The winding insulation system shall be Class H or better, non-hygroscopic, chemical, corrosion, fungus and humidity resistant. The complete insulation system will have a minimum resistance of 1.5 megohms after 168 hours of testing in a humidity chamber maintained at 100% relative humidity and 40º C ambient with both end bells removed. Motors used in adjustable speed drive applications shall have an insulation rating of 1860 vac peak with a 0.1 micro second rise time.
19. Motor leads shall be stranded copper, permanently identified on both ends and are brought out into the motor terminal box through a neoprene lead-positioning gasket with compression type terminal lugs. Each of the three leads shall be brought through a single hole into the conduit and termination box.
20. The conduit box shall be cast iron and threaded for rigid conduit connection. Conduit box shall be located at the F1 position of the motor unless otherwise noted on the motor data sheet. Conduit box volumes shall exceed the NEMA minimum standards by a minimum of 25% and boxes shall be able to rotate 90-degree increments. A bronze ground lug shall be provided in the conduit box.
21. A lifting eyebolt shall be provided for motor lifting (180 frame and larger). Eyebolt holes shall be threaded blind holes.
22. Motors shall be suitable for field configuration to any ceiling, wall, or floor mounting by rotating conduit box, end shield, and rotor – per application requirements (143T through 365T).
23. All motors shall meet the “NEMA Premium” efficiency requirements as outline by NEMA Table 12.12. Any deviation from this specification shall be received in writing from the project engineer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
   1. Smith & Loveless
   2. General Electric Company
   3. Louis Allis (Division of MagneTek, Inc.)
   4. U.S. Motors Corporation
   5. Toshiba.

6. Reliance.
7. Baldor Gold Series.

B. The OWNER/CONTRACTOR shall assign to the designated equipment supplier the responsibility to select and supply suitable electric motors for the equipment. The choice of motor manufacturer shall be subject to review and acceptance by the ENGINEER. Such review will consider future availability of replacement parts and compatibility with driven equipment.

2.2 MOTORS LESS THAN ½ HORSEPOWER:

A. General
1. Unless otherwise specified, motors less than 1/2 horsepower shall be squirrel cage, single phase, and capacitor start induction run. Small fan motors may be split-phase or shaded pole type. Wound rotor or commentator type single phase motors are acceptable where its characteristics are necessary for the application. Conductors shall be copper.

B. Rating
1. Motors shall be rated for operation at 115 volts, single phase, 60 Hz, and shall be continuous-time rated in conformance with NEMA Standard MG 1-10.35. Dual voltage rated motors are acceptable if all leads are brought out to the conduit box.
1. Locked rotor current shall not be greater than specified in NEMA Standard MG1-10.36, Design “N”.

C. Enclosures
1. Unless otherwise specified, motors shall be totally enclosed.

D. Bearings
1. Motors shall be provided with sleeve-type or sealed ball bearings lubricated for 5 years normal use.

E. Insulation
1. Comply with NEMA 1-1.65.
1. Motors shall be furnished with Class F insulation, rated to operate at a maximum ambient temperature of 40ºC and at the altitude where the motors will be installed and operated, without exceeding temperature rise limits stated in NEMA MG 1-12.42 for a Class B insulation at ambient temperature of 40°C, and without using the service factor.

2.3 MOTORS 1/2 HORSEPOWER THROUGH 300 HORSEPOWER:

A. General
1. The nominal motor horsepower shall be adequate for the driven machine without infringement upon the motor service factor at the installed altitude and specified ambient conditions.

2. The motor horsepower shall be not more than the estimated maximum specified for each driven machine.
    a. If the estimated maximum horsepower specified is not adequate to satisfy the foregoing restriction or any other requirements of these specifications, the motor with the next larger horsepower shall be supplied at no additional cost to the OWNER.
    b. In addition, any changes caused by increase in motor horsepower shall be made by the OWNER/CONTRACTOR at no additional cost to the OWNER; such changes may involve circuit breakers, motor controllers, VFDs, motor and branch circuit and feeder conductors and conduit sizes, etc.
3. Some requirements of the Section may be excluded for motors which are part of valve operators, submersible pumps, or motors which are an integral part of standard manufactured equipment (i.e., non-NEMA mounting, common shaft with driven element), to the extent that such variation reflects a necessary condition of motor service or a requirement of the specified driven equipment.
4. Motor Voltage Ratings: The OWNER/CONTRACTOR is required to review the Electrical Drawings and Specifications and to furnish all motors with voltage and phase as shown on the electrical drawings.
    a. The OWNER/CONTRACTOR shall notify the ENGINEER of any discrepancy between any motor sizes indicated by the Drawings and specified elsewhere, and any requirements of the driven equipment and the availability of motors from the manufacturers listed above.
5. Special Requirements: The OWNER/CONTRACTOR shall refer to individual equipment specifications and the Drawings for special requirements such as motor part winding start, multi-speed windings, protective devices, auxiliary devices, etc.
6. Horizontal Motors Installed Outdoors: All horizontal motors which will be installed outdoors shall be totally enclosed, fan cooled (TEFC) severe duty and/or chemical duty rated with a Service Factor of 1.15 unless otherwise noted or if the area classification required a more stringent motor enclosure.
7. Horizontal Motors Installed Indoors: Unless otherwise specified, all horizontal motors which will be installed indoors shall be TEFC (totally enclosed fan cooled) with a service factor of 1.15 minimum.
    a. All motors larger than 1 HP, located in damp environment such as in pump and pipe galleries, tunnels, chemical feed and sludge areas, shall be severe duty and/or chemical duty rated complying with IEEE 45.
8. High Efficiency Motors: Motors with a nameplate rating of 5 HP and above shall be “premium efficiency” units. Criteria stated herein, apply to horizontal motors without exception and apply to vertical motors insofar as they are available at time of construction.
    a. Efficiency shall be determined by the test as set forth in IEEE 112, Method B.
    b. If the inrush current due to the high efficiency design of the motor exceeds the available settings of the motor circuit protector, the motor circuit protector may be changed to a thermal magnetic circuit breaker, with the permission of the ENGINEER, at no additional cost to the OWNER.
    1) If is the OWNER/CONTRACTOR’S responsibility to perform the motor starting requirement coordination, and to notify the ENGINEER of any discrepancies.

B. Three Phase Motors

1. All motors 1/2 HP and larger shall be three phases unless otherwise indicated on Drawings, or specified elsewhere.
1. Voltage: All three phase motors shall be suitable for operation on 208, 230 and 460 VAC, unless otherwise indicated on the electrical plans.
2. NEMA Design:
    a. Electric Motors shall be NEMA Design B, (except as noted in equipment specifications for motors controlled as variable speed operation and other special motors), constant speed squirrel-cage induction motors having normal starting torque with low starting current.
    b. In no case shall starting torque or breakdown torque be less than the value specified in NEMA MG 1.
    c. Starting kilovolt ampere per horsepower shall not exceed values as specified in NEMA MG-1-10.37.
    d. Motors shall be suitable for operation on the following starting mechanisms as shown on the drawings:
    1) Across the line.
    2) Reduced voltage solid state starter.
    3) Variable frequency drive-inverter duty rated.
    4) 2 speed 2 winding.
3. Insulation:
    a. Comply with NEMA 1-1.65.
    b. Motors shall be furnished with Class H insulation or with Class F insulation, rated to operate at a maximum ambient temperature of 40ºC and at the altitudes where the motors will be installed and operated, without exceeding temperature rise limits stated in NEMA MG1-12.42 for Class B insulation at a 40º C ambient, and without using the service factor.
4. Motor Bearings:
    a. Antifriction, re-greaseable, and filled initially with grease suitable for ambient temperature to 40ºC.
    1) Suitable for intended application and have AFBMA B-10 rating L-10 life of 60,000 hours or more.
    2) Bearing mounting shall be designed with easily accessible grease supply, flush, drain, and relief fittings using extension tubes where necessary.

C. Vertical Motors
1. Comply with the requirements for three phase motors except where the following requirements are more stringent.
1. Enclosure:
    a. All vertical motors installed outdoors shall have Weather Protected Type II (WPII) enclosures.
    b. All vertical motors installed indoors shall have Weather Protected Type I (WP I) enclosures.
2. All vertical motors shall have a Service Factor of 1.15.
3. Motor Bearings:
    a. Antifriction, oil lubricated, and filled initially with oil suitable for ambient temperatures to 40º C.
    1) Suitable for intended application and have AFBMA B-10 rating life of 60,000 hours or more.

2) Bearing mounting shall be designed with easily accessible oil supply, flush, drain, oil level gauge, and relief fittings using extension tubes where necessary.

b. Furnished with re-lubricate ball, spherical, roller, or plate type thrust bearings. Lubrication shall be per manufacturer's recommendation for smooth operation and long life of the bearings.

2.4 COMPONENTS

A. Motor Enclosures:

1. Open Drip Proof:
   a. Stamped steel conduit boxes.
   b. 1.15 service factor at 40º C ambient.
2. Totally Enclosed Fan Cooled:
   a. Cast iron conduit box.
   b. 1.15 service factor at 40º C ambient
   c. Tapped drain holes with Type 316 stainless steel plugs for frames 286T and smaller.
   d. Automatic breather and drain devices for frames 324T and larger.
   e. Upgraded insulation by minimum of 3 dips and bakes and sealer coat of epoxy or silicone.
3. Severe Duty:
   a. Corrosion resistant type conforming to motors designated by manufacturer as:
   1) Chemical Duty.
   2) Mill and Chemical.
   3) Custom Sever Duty.
   4) Or similar applicable manufacturer's quality designation.
   b. 1.15 service factor at 40º C ambient.
   c. Tapped drain holes with Type 316 stainless steel plugs for frames 286T and smaller.
   d. Automatic breather and drain devices for frames 324T and larger.
   e. 2 cycles of vacuum epoxy impregnation of the motor windings.

2.5 ACCESSORIES

A. Conduit Boxes

1. Horizontal motors 3 HP and larger, and all vertical motors, shall have split-type cast metal conduit boxes.
2. Boxes on motors other than open drip-proof shall be gasketed.
1. Boxes shall be furnished with the size and number of openings as required for the conduits indicated on the Drawings.
2. Boxes shall be rotatable through 360 degrees in 90 degree increments.
3. Shall be furnished with an integral equipment ground lug installed and sized as required for the conductors indicated on the Drawings.

B. Lifting Devices: All motors weighing 265 lb (120 Kg) or more shall have suitable lifting devices for installation and removal.

C. Space Heaters:

1. All motors 1 HP and larger shall be furnished with winding heaters where installed outdoors.
2. Space heater ratings shall be 120 volts, single-phase, unless otherwise shown.
3. Bring power leads for heaters into conduit box.

D. Nameplate:
1. All motors shall be fitted with a permanent, stainless steel nameplate indelibly stamped or engraved with:
   a. NEMA Standard motor data.
   b. Bearing description and lubrication instructions.
   c. Insulation class.
   d. Ambient temperature.
   e. Altitude rating.
   f. Power factor at full load.

2.6 CURRENT BALANCE

A. Current unbalance on polyphase motors shall not exceed the values tabulated below when motor is operating at any load within its service factor rating and is fed by a balanced voltage system:
1. Under 5 horsepower: 25 percent
2. 5 horsepower and above: 10 percent

2.7 OVER-TEMPERATURE PROTECTION

A. General
1. Over-temperature protection devices shall provide a normally closed contact rated NEMA ICS Class B1 50. Relays or solid state contacts which are required shall be provided in an enclosure on or near the motor. Relay enclosure shall be in accordance with NEMA ICS-6 and shall be NEMA 4 for all motors.

B. Requirements
1. Over temperature protection is not required for motors rated less than 25 horsepower.
2. Over temperature protection for motors rated 25 horsepower or greater but less than 200 horsepower shall be thermal switches, NEMA MG 1-12.57, Type 2.
3. Over temperature protection for motors rated 200 horsepower or greater shall consist of a minimum of six 100 OHM Platinum RTD's embedded in the motor windings, and one 100 OHM for each bearing. Wiring to an external junction box shall be provided. Motor supplier shall coordinate with motor controller supplier to ensure RTD's match Multilin 369 requirements.

2.8 SHAFT CURRENT PROTECTION

A. All motors coupled with a variable frequency drive (VFD) shall include a shaft grounding system. Acceptable systems include Mercotac Rotary Electrical Connectors, AEGIS SGR, or equal.

PART 3 - EXECUTION

3.1 TESTING

A. Each motor shall be given a routine commercial test as required by NEMA MG 1 to demonstrate that it is free from electrical or mechanical defects. Copies of routine test reports shall be submitted in the format specified by NEMA.

END OF SECTION

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SECTION 16200
DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 SCOPE

A. This Section consists of dry type transformers and related items necessary to complete the work indicated within the Contract Documents.

1.2 REFERENCES

A. NEMA ST 1 – Specialty Transformers (Except General – Purpose Type).

B. NEMA ST 20 – Dry Type Transformers for General Applications.

C. NETA ATS – Acceptance Testing Specifications for Electrical Power Distribution Equipment (International Electrical Testing Association).

D. NFPA 70 – National Electrical Code.

E. UL – Underwriters Laboratories, Inc.

1.3 SUBMITTALS

A. Product Data: provide outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, tap configurations, insulation system type and rated temperature rise.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water construction debris, and traffic.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

PART 2 - PRODUCTS

2.1 DRY TYPE TRANSFORMERS

A. Transformers shall be premium high efficiency quiet type with copper windings, and shall be installed where indicated on the Drawings. The primary winding of the transformers shall have two 2-1/2 percent taps above, and below normal.

B. The transformers shall have a BIL of 10 KV with a temperature class of 185 degrees C for transformers up to 25 KVA, and a temperature class of 220 degrees C for larger transformers.

C. The sound level shall not exceed 44 dBa measured at 5 feet from the transformer after installation. Core and coil assemblies 30 KVA and larger, shall be mounted on rubber vibration isolators, designed to reduce harmonics generated noise.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set transformer plumb and level.

B. Use flexible conduit, 2 feet minimum length for connections to transformer case. Make conduit connections to side panel of enclosure.

C. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by the manufacturer.

D. Mount floor-mounted transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.

E. Mount trapeze-mounted transformers as indicated.

F. Provide grounding and bonding in accordance with Division 16.

3.2 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.2.

3.3 ADJUSTING

A. Adjusting installed work.

B. Measure primary and secondary voltages and make appropriate tap adjustments.

END OF SECTION

SECTION 16233
STATIC UN-INTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

1.1 SCOPE

Furnish all labor, materials, equipment, appliances, and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work:

A. Stand alone cord and plug connected UPS systems.

B. Provide one shelf mounted UPS in each PLC cabinet (PLC-A, PLC-B, PLC-SH, PLC-FE).

C. Provide one UPS for each computer system (SCADA, Historian Server, HMI Directory Server).

1.2 APPLICABLE SECTIONS

The General Conditions, Supplementary General Conditions, alternates and Addenda, applicable drawings and the technical specification including but not limited to the following;

A. Section “Electrical General Requirements”.

B. Section “Conductors and Cables”.

1.3 REFERENCES

A. IEEE 519 - Guide for Harmonic Control and Reactive Compensation of Static Power Converters.

B. NEMA PE 1 - Un-interruptible Power Systems.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

D. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS

A. Submit under provisions of Section 16 05 00.

B. Shop Drawings: Indicate electrical characteristics and connection requirements. Provide battery rack dimensions; battery type, size, dimensions, and weight; detailed equipment outlines, weight, and dimensions; location of conduit entry and exit; single-line diagram indicating metering, control, and external wiring requirements; heat rejection and air flow requirements.

C. Product Data: Provide catalog sheets and technical data sheets to indicate physical data and electrical performance, electrical characteristics, and connection requirements.

D. Manufacturer's Installation and Operating Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product. Include equipment installation outline, connection diagram for external cabling, internal wiring diagram, and written instruction for installation.

E. Manufacturer's Certificate: Certify that Products meet or exceed specified requirements.

1.5 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 16 05 00.

B. Operation Data: Description of operating procedures.

C. Maintenance Data: Description of servicing procedures; list of major components; recommended remedial and preventive maintenance procedures; spare parts list.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years experience.

1.7 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 16 05 00.

B. Accept Products on site in factory packing. Inspect for damage.

C. Protect equipment from extreme temperature and humidity by storing in a conditioned space.

D. Protect equipment from dust and debris by wrapping unit in dust tight cover and storing away from construction activity.

1.9 MAINTENANCE SERVICE

A. Furnish service and maintenance of un-interruptible power supply for one year from Date of Substantial Completion.

B. Include coverage of travel, labor, parts, and service.

1.10 WARRANTY

A. Provide two year warranty under the provisions of Section 16 05 00.

B. Warranty: Include coverage for batteries.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Liebert

B. Powerware/Eaton

C. APC

D. Substitutions: Under provisions of Section 16 05 00.

2.2 UN-INTERRUPTIBLE POWER SUPPLY

A. System Configuration: Non-redundant on-line, dual conversion type.

B. Components:

1. Battery.
2. Rectifier/charger to maintain battery charge and to provide input to inverter when utility power is available.
3. Inverter to provide power to load during normal operation.
4. Monitors, sensors, and control circuits.

C. Design Standards: IEEE 519 and NEMA PE 1.

2.3 SYSTEM RATINGS AND OPERATING CHARACTERISTICS

A. System Continuous Rating: 700 VA/490 W over entire battery voltage range at specified power factor. Maintain output voltage within specified limits at any load from full load to no-load.

B. Battery Capacity: Capable of operating at full load for 30 minutes.

C. Voltage Rating: 120 volts.

D. Input Voltage Operating Range: Plus or minus 10 percent.

E. Input Frequency Operating Range: 60 Hz.

F. Input Current Limit: Adjustable to maximum of 125 percent of that required to operate at full load with battery bank on float charge.

G. Harmonic Distortion of Input Current Wave Form: 5 percent maximum at full load.

H. Output Voltage Regulation.

I. The UPS shall include a plug-in load bypass switch which allows the replacement of the UPS without interrupting power to the load served.

2.4 BATTERY

A. Storage Battery: Heavy duty VRLA type industrial battery, designed for auxiliary power service. Provide battery with impact resistant plastic case. Provide cells with explosion proof vents, and ample space for plate growth without stressing container and cover.

B. Electrolyte Specific Gravity: No greater than 1.250 when full charged and measured at 77 degrees F (25 degrees C).

C. Ampere-Hour Rating: Sufficient to supply direct current to inverter for outage period specified, with inverter operating at full rated output, to a discharge limit of not less than 1.65 volts per cell.

2.5 CONTROLS AND INDICATORS

A. Indicators:

1. "On-Line"
2. "Fail"

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.2 FIELD QUALITY CONTROL

END OF SECTION

SECTION 16353

SURGE PROTECTION DEVICES

PART 1 – GENERAL

1.01 SCOPE

The Contractor shall furnish and install the Surge Protective Device (SPD) equipment having the electrical characteristics, ratings, and modifications as specified herein and as shown on the contract drawings. To maximize performance and reliability and to obtain the lowest possible let-through voltages, the ac surge protection shall be integrated into electrical distribution equipment such as switchgear, switchboards, panelboards, busway (integrated within bus plug), or motor control centers. Refer to related sections for surge requirements in:

1.02 RELATED SECTIONS

1. Section 16426A – Metal Enclosed Draw out Switchgear (Magnum DS) – Low Voltage
2. Section 16426B – Metal Enclosed Draw out Switchgear (DSII) – Low Voltage
3. Section 16428 – Switchboards – Low Voltage (Compartmentalized Feeders – Pow-R-Line *i*)
4. Section 16429 – Switchboards – Low Voltage (Group Mounted Feeders – Pow-R-Line C)
5. Section 16431 – Switchboards – Low Voltage (Commercial Metering)
6. Section 16466 – Busway – Low Voltage
7. Section 16470 – Panelboards
8. Section 16482A & B – Motor Control Centers – Low Voltage (Freedom and Advantage)

1.03 REFERENCES

9. SPD units and all components shall be designed, manufactured, and tested in accordance with the latest applicable standards
    A. ANSI/UL 1449 4th Edition or later
    B. ANSI/UL 1283 5th Edition or later (type 2 applications)
    C. IEEE C62.41.1
    D. IEEE C62.41.2
    E. IEEE C62.43-2005
    F. IEEE C62.45-2002
    G. IEEE C62.48-2005
    H. IEEE C62.62-2010
    I. UL 96A

J. NFPA 780

1.04 SUBMITTALS – FOR REVIEW/APPROVAL

10. The following information shall be submitted to the Engineer:

    A. Provide verification that the SPD complies with the required ANSI/UL 1449 4th Edition or later listing by Underwriters Laboratories (UL). Compliance may be in the form of a file number that can be verified on UL's website www.ul.org, the website should contain the following information at a minimum: model number, SPD Type, system voltage, phases, modes of protection, Voltage Protection Rating (VPR), and Nominal Discharge Current (In).

11. Where applicable the following additional information shall be submitted to the engineer:

    A. Descriptive bulletins

    B. Product sheets

1.05 SUBMITTALS – FOR CONSTRUCTION

12. The following information shall be submitted for record purposes:

    A. Final as-built drawings and information for items listed in Section 1.04 and shall incorporate all changes made during the manufacturing process

2.08 QUALIFICATIONS

13. The manufacturer of the electrical distribution equipment shall be the manufacturer of the SPD within the electrical distribution equipment.

14. For the equipment specified herein, the manufacturer shall be ISO 14001 and ISO 9001 or 9002 certified.

15. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of twenty-five (25) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

16. The SPD shall be compliant with the Restriction of Hazardous Substances (RoHS) Directive 2011/65/EU and have a visible label showing compliance.

17. The SPD shall be UL 1449 current edition listed, 20 kA nominal discharge current, Type 1 or Type 2 for use in UL 96A systems.

1.07 DELIVERY, STORAGE AND HANDLING

Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of manufacturer's instructions shall be included with the equipment at time of shipment.

1.08 OPERATION AND MAINTENANCE MANUALS

Operation and maintenance manuals shall be provided with each SPD shipped.

PART 2 – GENERAL

2.01 MANUFACTURERS

1. Match panel brand
2. Or prior approved equal.

The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features, and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.02 VOLTAGE SURGE SUPPRESSION – GENERAL

1. Electrical Requirements

A. Unit Operating Voltage – Refer to drawings for operating voltage and unit configuration.

B. Maximum Continuous Operating Voltage (MCOV) – The MCOV shall not be less than 115% of the nominal system operating voltage.

C. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards. End of life mode to be open circuit. Unit with end of life short-circuit mode are not acceptable.

D. Unit shall operate without the need for an external overcurrent protection device, and be listed by UL as such. Unit must not require external overcurrent protective device or replaceable internal overcurrent protective devices for the UL Listing.

E. Protection Modes – The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

	Protection Modes			
Configuration	L-N	L-G	L-L	N-G
Wye	●	●	●	●
Delta	N/A	●	●	N/A
Single Split Phase	●	●	●	●

High Leg Delta	●	●	●	●

F. Nominal Discharge Current (I_n) – All SPDs applied to the distribution system shall have a 20kA I_n rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an I_n less than 20kA shall be rejected.

G. ANSI/UL 1449 4th Edition Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449 4th Edition VPR for the device shall not exceed the following:

Modes	208Y/120	480Y/277	600Y/347
L-N; L-G; N-G	700	1200	1500
L-L	1200	2000	3000

2. SPD Design

A. Maintenance Free Design – The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable single-mode modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

B. Balanced Suppression Platform – The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules shall not be accepted.

C. Electrical Noise Filter – Each Type 2 unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method. Products unable able to meet this specification shall not be accepted.

a. Type 2 units with filtering shall conform to UL 1283 5th Edition

b. Type 1 units shall not contain filtering or have a UL 1283 5th Edition Listing.

D. Internal Connections – No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.

E. Monitoring Diagnostics – Each SPD shall provide the following integral monitoring options:

a. Protection Status Indicators - Each unit shall have a green / red solid-state indicator light that reports the status of the protection on each phase.

i. For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes. Wye configured units shall also contain an additional green / red solid-state indicator light that reports the status of the protection elements and

circuitry in the N-G mode. SPDs that indicate only the status of the L-N and L-G modes shall not be accepted.

ii. For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes

iii. The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.

b. Remote Status Monitor (optional) – The SPD must include Form C dry contacts (one NO and one NC) for remote annunciation of its status. Both the NO and NC contacts shall change state under any fault condition.

c. Audible Alarm and Silence Button (optional) – The SPD shall contain an audible alarm that will be activated under any fault condition. There shall also be an audible alarm silence button used to silence the audible alarm after it has been activated.

d. Surge Counter (optional) – The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of 50 ± 20A occurs. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. In order to prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of 2 seconds in order to clear the surge count total.

i. The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored. The surge counter's memory shall not require a backup battery in order to achieve this functionality.

F. Thermal MOV Protection

The unit shall contain thermally protected MOVs. These self-protected MOVs shall have a thermal protection element integrated with the MOV and a mechanical disconnect with arc quenching capabilities in order to achieve overcurrent protection of the MOV. The thermal protection assembly shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.

Fully Integrated Component Design – All of the SPD's components and diagnostics shall be contained within one discrete assembly. The use of plug in single-mode modules that must be ganged together in order to achieve higher surge current ratings or other functionality shall not be accepted.

G. Safety Requirements

The SPD shall minimize potential arc flash hazards by containing no single-mode plug in user serviceable / replaceable parts and shall not require periodic maintenance. SPDs containing items such as replaceable single-mode plug in modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

a. SPDs designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit. Such units shall have any required conductors be factory installed.

2.03 SYSTEM APPLICATION

1. The SPD applications covered under this section include distribution and branch panel locations, busway, motor control centers (MCC), switchgear, and switchboard assemblies. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.

2. Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
Category	Application	Per Phase	Per Mode
C	Service Entrance Locations (Switchboards, Switchgear, MCC, Main Entrance)	250 kA	125 kA
B	High Exposure Roof Top Locations (Distribution Panelboards)	160 kA	80 kA
A	Branch Locations (Panelboards, MCCs, Busway)	120 kA	60 kA

2.04 LIGHTING AND DISTRIBUTION PANELBOARD REQUIREMENTS

1. The SPD application covered under this section includes lighting and distribution panelboards. The SPD units shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category B environments.

   A. The SPD shall not limit the use of through-feed lugs, sub-feed lugs, and sub-feed breaker options.

   B. SPDs shall be installed immediately following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs.

   C. The panelboard shall be capable of re-energizing upon removal of the SPD.

D. The SPD shall be integral to the panelboard and connected directly to the bus. Alternately, an integral SPD can be connected to a circuit breaker for disconnecting purposes if a disconnect is required.

E. The SPD shall be included and mounted within the panelboard by the manufacturer of the panelboard.

F. The SPD shall be of the same manufacturer as the panelboard.

G. The complete panelboard including the SPD shall be UL67 listed.

2.05 SWITCHGEAR, SWITCHBOARD, MCC AND BUSWAY REQUIREMENTS

A. The SPD application covered under this section is for switchgear, switchboard, MCC, and busway locations. Service entrance located SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C environments.

B. The SPD shall be of the same manufacturer as the switchgear, switchboard, MCC, or busway

C. The SPD shall be factory installed integral to the switchgear, switchboard, MCC, and/or bus plug at the assembly plant by the original equipment manufacturer

D. Locate the SPD on the load side of the main disconnect device, as close as possible to the phase conductors and the ground/neutral bar.

E. The SPD shall be connected through a disconnect (30A circuit breaker). The disconnect shall be located in immediate proximity to the SPD. Connection shall be made via bus, conductors, or other connections originating in the SPD and shall be kept as short as possible.

F. The SPD shall be integral to switchgear, switchboard, MCC, and/or bus plug as a factory standardized design.

G. All monitoring and diagnostic features shall be visible from the front of the equipment.

2.06 SERVICE ENTRANCE REQUIREMENTS

A. Service entrance located SPDs shall be tested and designed for applications within ANSI/IEEE C62.41 Category C environments. EXECUTION.

2.07 EXAMINATION

2.08 FACTORY TESTING

1. Standard factory tests shall be performed on the equipment under this section. All tests shall be in accordance with the latest version of NEMA, IEEE, and UL standards.

2.09 INSTALLATION

1. The installation of the SPD shall be factory installed integral to the distribution equipment. The Contractor shall install all distribution equipment per the manufacturer's recommendations, applicable electrical codes and the contract drawings.

2.10 WARRANTY

1. The manufacturer shall provide a ten (10) year warranty (15 year warranty with registration) that covers replacement of the complete unit from the date of shipment against any SPD part failure when installed in compliance with manufacturer's written instructions and any applicable national or local electrical code.

END OF SECTION

SECTION 16400
SERVICE AND DISTRIBUTION SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

A. Provide all operations, methods, labor and equipment and provide and install all materials and incidentals necessary for the completion of the work as specified herein or included on the Drawings.

1.2 WORK INCLUDED

A. Electrical work required is indicated on the Drawings and specified herein and elsewhere includes, but is not necessarily limited to:
   1. Complete electrical distribution systems for power, control, and instrumentation as shown.
   2. Complete system of raceways, conductors, and equipment for all other auxiliary systems required. If noted, the equipment and wiring of these auxiliary systems will be furnished and installed under their respective sections; however, the conduit or raceway systems will be furnished and installed in accordance with Division 16.

B. The CONTRACTOR shall furnish and install all component parts of all the systems required for their safe and proper operation, whether or not specifically mentioned or noted on the Drawings, except those items or articles which are specifically noted as being supplied otherwise.

C. Perform all trenching and backfilling required in connection with the work which shall be in strict accordance with the provisions of Division 16 of these specifications.

D. Provide all required electrical conduits, conductors, and connections to items described in all other sections of these specifications.

1.3 APPLICABLE SECTIONS

A. The General Conditions, Supplementary Conditions, Special Conditions, Alternates and addenda, applicable drawings and the technical specifications herein shall apply.

B. Section “Distribution Panelboards”.

1.4 ELECTRICAL SERVICE

A. New underground electrical service(s) from the local utility shall be at 480/277 volt, three phase, four wire, 60 hertz AC with current ratings as indicated on the Drawings.

B. The installation shall be in accordance with the utility company’s published requirements. The CONTRACTOR shall coordinate the installation with the utility.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation of the service entrance sections shall be in accordance with the manufacture's requirements.

3.2 INSTALLATION OF GROUNDING ELECTRODE SYSTEM

A. The service entrance section shall be bonded to the grounding electrode system (GES). The GES consists of, but not limited to, the metal underground water pipes, metal frame of the building or structure, concrete encased electrode (UFER), ground rings, rods, pipe, or plate electrodes, and other metal underground systems or structures as in compliance with the NEC. Provide bonding jumper same size as system ground to provide ground continuity from customer's side of metallic lines service entrance and street side of metallic mains. The neutral (grounded conductor) and grounding electrode system shall be connected together at the service disconnect only.

B. The UFER ground system consists of a bare copper conductor, size as indicated in the Drawings, concrete encased 2" above the bottom of the foundation footing of the building or structure which is in direct contact with earth. The UFER ground will make a complete loop in the foundation and is bonded to the rebar steel at least in two locations. UFER ground connections shall be exothermic welds.

C. The equipment grounding system shall be such that all metallic structures, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, portable equipment and other conductive items in close proximity with the electrical circuits operate continuously at ground potential and provide a low impedance path for the possible ground fault currents. The system shall comply with the National Electrical Code, modified as indicated on the Drawings or specifications.

D. The distributions system shall be provided with a separate equipment grounding conductor for each single or three-phase feeder, each branch circuit, each motor circuit, control or instrument raceways as indicated. The grounding conductor shall be installed in the common raceway with the related phase and/or neutral conductors. Flexible conduit equipment connections utilized in conjunction with branch circuits or feeders shall be provided with suitable bonding jumpers connected to listed grounding type fittings when required.

3.3 TESTING

A. General: Upon completion of this portion of the work, test all parts of the electrical system in the presence of the ENGINEER.

B. Test Requirements: All systems shall test free from short circuits and grounds, shall be free from mechanical and electrical defects, and shall show an insulation resistance between phase conductors and ground of not less than that required by the manufacturers.

3.4 FINAL INSPECTION

A. The CONTRACTOR shall be present at the final acceptance of the work by the OWNER.

B. The CONTRACTOR shall have pad and pencil to list all deficient items noted. Corrections and adjustments of deficient items shall be done after the inspection, not during.

C. See Section for other requirements for final acceptance.

END OF SECTION

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SECTION 16401

PROCESS CONTROL & INSTRUMENTATION SYSTEM-GENERAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. General requirements applicable to all process control work.
2. The requirements of this Section apply to all components of the Software Systems unless indicated otherwise.
3. General requirements for programming submittals.

B. Related sections:

1. The Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the CONTRACTOR and its Subcontractors to review all sections to ensure a complete and coordinated project:
    a. Items involving electrical, control, and instrumentation construction may be shown on Drawings or referred to in Specifications that do not apply specifically to electrical, control and instrumentation systems.

C. The Programming Contractor shall program all PLC's and the SCADA system. The Programming Contractor shall provide all software as specified herein for programming the system. The Programming Contractor and the electrical contractor shall be responsible to test each device and loop to verify proper function of all equipment on the project, whether provided by the contractor or by the owner. They shall then work with the owner to test and commission the entire system as described herein. The programming contractor shall be present to test the I/O for each equipment subsystem. The I/O to the PLC systems shall be tested at this time. The programming contractor shall provide and install a simple testing routine in each PLC in order to verify all I/O is functioning properly. All I/O shall be tested from its respective field device to the software level in the PLC. If final PLC programming is complete at the time of testing, the final software programming shall be used to test each device

D. The Programming Contractor shall design the operator interface graphics, human machine interface (HMI) graphics, PLC logic, and control systems hardware as specified herein.

E. Contract Documents:

1. General:

a. Contract documents consist of drawings, specifications, and other documents issued by the ENGINEER. The Drawings and Specifications are complementary and are to be used together in order to fully describe the Work, and requirements shown, written or reasonably inferred there from on one is considered as written, shown or implied in all. In the event work is called for in more than one place and there are conflicting requirements, the right shall be reserved to require the installation of the larger or the more expensive.

b. Schematic Diagrams:

1) All controls are shown de-energized.

a) Schematic diagrams show control function only. Incorporate other necessary functions for proper operation and protection of the system.

b) Control schematics are to be used as a guide in conjunction with the descriptive operating sequences found in the Drawings or Specifications. Combine all information and furnish a coordinated and fully functional control system program.

1.2 REFERENCES

A. Code Compliance:

1. The publications are referred to in the text by basic designation only. The latest edition accepted by the Authority Having Jurisdiction of referenced publications in effect at the time of Bid governs

2. The following codes and standards are hereby incorporated into these Specifications:

a. National Fire Protection Association (NFPA):

1) NFPA 70 - National Electric Code (NEC).

2) NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

3) NFPA 496 - Purged and Pressurized Enclosures for Electrical Equipment, where applicable.

4) NFPA 820 - Standard for Fire Protection in Wastewater Treatment and Collection Facilities.

b. Underwriters Laboratories, Inc. (UL):

1) UL 508 - Industrial Control Equipment.

c. American National Standards Institute (ANSI):

1) ANSI B16.5 - Pipe Flanges and Flanged Fittings.

d. American Petroleum Institute (API):

1) API RP551 - Process Measurement Instrumentation.

2) API RP552 - Transmission Systems.

3) API RP553 - Refinery Control Valves.

4) API RP554 - Process Instrumentation and Control.

5) API RP555 - Process Analyzers.

6) API RP556 - Fired Heaters & Steam Generators.

7) API RP557 - Guide to Advanced Control Systems.

e. American Society of Testing and Materials (ASTM):

1) ASTM A269 - Seamless and Welded Austenitic Stainless Steel Tubing for General Service.

f. Instrumentation, Systems, and Automation Society (ISA):

1) ISA-5.1 - Instrumentation Symbols and Identification.

2) ISA-5.2 - Binary Logic Diagrams for Process Operations.

3) ISA-5.3 - Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer Systems.

4) ISA-5.4 - Instrument Loop Diagrams.

5) ISA-5.5 - Graphic Symbols for Process Displays.

6) ANSI/ISA-7.00.01 - Quality Standard for Instrument Air.

7) ISA-RP - 12.4 - Pressurized Enclosures.

8) ANSI/ISA-18.1 - Annunciator Sequences and Specifications.

9) ISA-20 - Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves.

10) ISA-TR20.00.01 - Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations Updated with 27 New Specification Forms in 2004-2005.

11) ANSI/ISA-50.00.01 - Compatibility of Analog Signals for Electric Industrial Process Instruments.

12) ISA-51.1 - Process Instrumentation Terminology.

13) ISA-RP60.3 - Human Engineering for Control Centers.

14) ISA-71.01 - Environmental Conditions for Process Measurement and Control Systems: Temperature and Humidity.

15) ISA-71.02 - Environmental Conditions for Process Measurement and Control Systems: Power.

16) ISA-71.03 - Environmental Conditions for Process Measurement and Control Systems: Mechanical Influences.

17) ISA-71.04 - Environmental Conditions for Process Measurement and Control Systems: Airborne Contaminants.

1.3 DEFINITIONS

A. Definitions of terms and other electrical and instrumentation considerations as set forth in the:

1. National Electrical Code.
2. Institute of Electrical and Electronic Engineers.
3. Instrumentation, Systems, and Automation Society.
4. National Fire Protection Association.
5. National Electrical Testing Association.

B. Specific Definitions:

1. Control Circuit: Any circuit operating at 120 volts AC or DC or less, whose principal purpose is the conveyance of information (including performing logic) and not the conveyance of energy for the operation of an electrically powered device.
2. Panel: An instrument support system that may be either a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process control systems. Unless otherwise specified or clearly indicated by the context, the term “panel” in these Contract Documents is interpreted as a general term, which includes flat surfaces, enclosures, cabinets and consoles.
3. Power Circuit: Any circuit operating at 90 volts (AC or DC) or more, whose principal purpose is the conveyance of energy for the operation of an electrically powered device.
4. Signal Circuit: Any circuit operating at less than 50 volts AC or DC, which conveys analog information or digital communications information.
5. Digital Bus: A communication network, such as Profibus, Foundation Fieldbus, or DeviceNet, allowing instruments and devices to transmit data, control functions and diagnostic information.
6. 2-Wire Transmitter (Loop Powered): A transmitter that derives its operating power supply from the signal transmission circuit and requires no separate power supply connections. As used in this Specification, two-wire transmitter refers to a transmitter that provides 4 to 20 mA current regulation of a signal in a series circuit with an external 24 VDC driving potential.
7. Field Bus Communications signal or both.
8. Powered Transmitters: A transmitter that requires a separate power source (120 VAC, 240 VAC, etc.) in order for the transmitter to develop its signal. As used in this Specification, the produced signal may either be a 4 to 20 mA current signal, a Digital Bus communications signal or both.
9. Modifications: Changing, extending, interfacing to, removing or altering an existing circuit.

C. Acronym Definitions:

1. ES: Enterprise System: Computer based communications or data sharing system utilized for non-process control functions such as E-mail, sharing files, creating documents, etc.
2. FAT: Factory Acceptance Test.

3. HOA: Hand-Off-Auto control function that is totally PLC based. In the Hand mode of control equipment is started or stopped, valves are opened or closed through operator direction under the control of the PLC software. In the Auto mode of control equipment is started or stopped, valves are opened or closed through a control algorithm within the PLC software. In the Off mode the equipment is prohibited from responding from the PLC control.
4. HMI: Human Machine Interface: PLC based operator interface device consisting of an alphanumeric display and operator input devices. The HMI is typically a flat panel type of display with either a touch screen or tactile button interface.
5. HVAC Heating, Ventilation, & Air Conditioning.
6. ICSC: Instrumentation and Control System Contractor: Subcontractor who specializes in the design, construction, fabrication, software development, installation, testing, and commissioning of industrial instrumentation and control systems.
7. IJB: Instrument Junction boxes. A panel designed with cord sets to easily remove, replace or relocate instrument signals.
8. I/O: Input / Output.
9. LCP: Local Control Panel: Operator interface panel that may contain an HMI, pilot type control devices, operator interface devices, control relays, etc. and does not contain a PLC or RIO.
10. LAN: Local Area Network: A control or communications network that is limited to the physical boundaries of the facility.
11. LOR: Local-Off-Remote control function. In the Remote mode equipment is started or stopped, valves are opened or closed through the PLC based upon the selection of the HOA. In Local control, equipment is started or stopped, valves are opened or closed based upon hardwired control circuits completely independent of the PLC with minimum interlocks and permissive conditions. In the Off mode, the equipment is prohibited from responding to any control commands.
12. OIT: Operator Interface Terminal. PC based interface device used for operator interface with the SCADA system.
13. P&ID: Process and Instrumentation Diagram.
14. PC: Personal Computer.
15. PCIS: Process Control and Instrumentation System, includes the entire instrumentation system, the entire control system, and all of the work specified in Division 17 and depicted on the Instrumentation Drawings.
16. PCM: Process Control Module: An enclosure containing any of the following devices: PLC, RIO.
17. PJB: Power Junction Box: An enclosure with terminal blocks that distribute power to multiple instruments.
18. PLC: Programmable Logic Controller.
19. RIO: Remote I/O device for the PLC consisting of remote I/O racks, or remote I/O blocks.

20. RTU: Remote Telemetry Unit: A controller typically consisting of a PLC, and a means for remote communications. The remote communications devices typically are radios, modems, etc.
21. SCADA: Supervisory Control and Data Acquisition system consists of the computer-based software system that includes the operator interface, data storage, data retrieval, archiving, alarming, historian, reports, trending, and other higher level control system software.
22. UPS Uninterruptible Power Supply.
23. VCP: Vendor Control Panel: Control panels that are furnished with particular equipment by a vendor other than the ICSC. These panels may contain PLCs, RIO, OIT, HMI, etc.
24. WAN: Wide Area Network: A control or communications network that extends beyond the physical boundaries of the facility.

1.4 SYSTEM DESCRIPTION

A. General Requirements:

1. The Work includes everything necessary for and incidental to executing and completing the general requirements for programming the control system described in the Contract Drawings and Specifications and reasonably inferable there from including but not limited to:
    a. Procure all software.
    b. With the electrical contractor, perform post programming tests on panels.
    c. With the electrical contractor, oversee, document, and certify system pre-commissioning.
    d. With the electrical contractor, conduct the Performance Tests.
    e. Prepare Operation and Maintenance Manuals.
    f. Conduct training classes.
    g. Develop all requisite loop descriptions, functional narrative and instructions and record drawings associated with the programs provided under other Divisions of these Specifications.
2. It is the intent of these Specifications that the programmed system be complete and operable.
3. Furnish detailed, complete, and thorough operations and maintenance documentation, including, but not limited to: Operations Manuals, Maintenance Manuals, Training Manuals, As-Built Software Documentation, final as installed software configurations, and software disks including installed program disk.

1.5 SUBMITTALS

A. General:

1. Furnish Submittals that are fully developed for a given section of the work and fully indexed with a tabbed divider for every element and component.

2. Sequentially number the pages within the tabbed sections. Submittals and Operation and Maintenance manuals that are not fully indexed and tabbed with sequentially numbered pages, or are otherwise unacceptable, will be returned without review.
3. Edit all Submittals and Operation and Maintenance Manuals so that the submittal specifically applies to only the equipment furnished. Neatly cross out all extraneous text, options, models, etc. that do not apply to the equipment being furnished, so that the information remaining is only applicable to the equipment being furnished.
4. Submittal Requirements:
    a. Submit copies of shop drawings, and product data, in accordance with the requirements of this Section:
        1) Show information on software to be supplied, SCADA screens, reports, menus, operation, etc.
5. Exceptions to Specifications and Drawings:
    a. Include a list of proposed exceptions to the Specifications and Drawings along with a detailed explanation of each.
    b. Any exceptions to the Specification and Drawings must be noted and the reason for the exception explained.
    c. If there is insufficient explanation for the deviation, the submittal will be returned requiring Revision and Re-submittal.
    d. Acceptance of any exception is at the sole discretion of the ENGINEER. Furnish all items (materials, features, functions, performance, etc.) that are not listed as exceptions strictly in accordance with the Specifications and Drawings.
    e. Replace all items that do not strictly meet the requirements of the Specifications, which were not previously accepted as exceptions, even if the Submittals contained information indicating the failure to meet the requirements.
6. Submittal Organization:
    a. First page:
        1) Specification Section reference.
        2) Name and telephone number of individual who reviewed submittal before delivery to ENGINEER.
        3) Name and telephone number of individual who is primarily responsible for the development of the submittal.
        4) Place for CONTRACTOR's review stamp and comments.
    b. Next pages:

1) Provide confirmation of Specification compliance in a tabular form that individually lists each Specification section, paragraph, and sub-paragraphs and unequivocally states compliance with said requirement or takes exception to the requirement and lists the reason for said exception and offers alternative means for compliance.

2) Include a response in writing to each of the ENGINEER's comments or questions for submittal packages which are re-submitted:

c. In the order that the comments or questions were presented throughout the submittal.

d. Referenced by index section and page number on which the comment appeared.

e. Acceptable responses to ENGINEER's comments are either:

f. ENGINEER's comment or change is accepted and appropriate changes are made.

g. Explain why comment is not accepted or requested change is not made.

h. Explain how requirement will be satisfied in lieu of comment or change requested by ENGINEER.

i. Any re-submittal, which does not contain responses to the ENGINEER's previous comments, shall be returned for revision and re-submittal.

j. No further review by the ENGINEER will be performed until a response for previous comments has been received.

k. Remaining pages:

1) Actual Submittal data:

a) Organize Submittals in exactly the same order as the items are referenced, listed, and/or organized in the Specification section.

b) For Submittals that cover multiple devices used in different areas under the same Specification section, the Submittal for the individual devices must list the area where the device is intended to be used.

l. Specific Submittal requirements:

1) Furnish the submittals required by each Section or Division 17:

a) Product Data.

b) Shop Drawings.

m. Furnish submittals in the following general order, each in a separate bound set:

1) Product Data.

2) After approval of the Product Data, submit the Project Shop Drawing submittals

3) Testing, Calibration and Start-up procedures.

4) Operation and Maintenance Data.

5) Training Submittals.

6) Record Documents.

B. Product Data:

1. General:

a. Submitted for non-custom manufactured material listed in this and other sections and shown on shop drawings.

b. Furnish sufficient information to evaluate the suitability of the proposed material or equipment for the intended use, and for compliance with these Specifications.

c. Include:

1) Catalog cuts.

2) Bulletins.

3) Brochures.

4) Quality photocopies of applicable pages from these documents.

5) Identify on the data sheets the project name, applicable specification section, and paragraph.

6) Identify model number and options for the actual equipment being furnished.

d. Neatly cross out options that do not apply or equipment not intended to be supplied.

2. Software Data Sheets and Cut Sheets:

a. Provide fully completed data sheets , in hardcopy, for each software package. Including the following information on the data sheet:

1) License limitations, points, screens available.

2) Description of software compatibilities with hardware (PLC's, ethernet communications, P.C.'s, modems, HMI's, etc.)

3) Description of software capabilities, function and use.

3. Software Program Submittal:

a. Prepare a program submittal to demonstrate how the programs address the following:

1) Alarm indication and notification.

2) Alarm acknowledgement.

3) Operational sequences.

4) Communications.

5) Recording and trending – show for each recorded or tended tag.

6) Report generation with samples.

7) Maintenance information and notes storage.

8) Samples of each screen shot and report.

C. Operation and Maintenance Manuals:

1. Furnish the ENGINEER with a complete preliminary set of written Operation and Maintenance Manuals 2 weeks before start-up and/or testing.
2. Furnish in accordance with the following additional requirements.
3. Submit preliminary sets of these manuals to the ENGINEER for review of format and content:
   a. ENGINEER will return 1 set with comments.
   b. Revise and/or amended as required and submit the requisite number of copies to the ENGINEER 15 days before Pre-commissioning of the systems.
4. Incorporate changes that occur during startup and submit as part of the final manuals.
5. Provide comprehensive information on all systems and components to enable operation, service, maintenance, and repair.
6. Organize the Operation and Maintenance Manuals for each process in the following manner:
   a. Section A-Description of operation.
   b. Section B- Screen shots.
   c. Section C- Report samples.
   d. Section D- Trending/recording operations.
   e. Section E- Software information with disks.
   f. Section F- Operational Manual.
   g. Section G- Spare Parts List.
7. Training Submittals:
   a. Develop and submit for review a General Training Plan. Include complete descriptions of all planned training classes, a preliminary training schedule, a list of all proposed instructors along with resumes, examples of proposed training manuals, and a description of any special training tools to be used (simulators, self-paced modules, personal computer-based training, etc.).
   b. The ENGINEER will review the General Training Plan. Special emphasis will be placed on review of the qualifications of the proposed instructors and the timing of the individual courses to maximize their effectiveness. If, in the opinion of the ENGINEER, the proposed instructors are not sufficiently qualified to conduct the specified training courses, or lack experience, where required, on the specific configuration of the system provide more qualified instructors.
   c. Training Course Plan submittals:
      1) For each training course or other training activity, submit a detailed, complete outline and agenda for each lesson.

2) Describe any student pre-requisites for the course or training activity.

3) Provide an updated schedule for all sessions of the course, including dates, times, durations, and locations.

4) Submit training materials.

d. Incorporate all submittal review comments into the course.

e. Do not conduct training courses before review and acceptance of the Course Plan submittal for the course.

D. Responsibilities

1. The Programming Contractor, shall be responsible to the OWNER for the implementation of the software and programmed systems.

2. Instrumentation & Control System Contractor (ICSC) Responsibilities:

a. The Programming Contractor shall assume full responsibility to perform all engineering to select, furnish, install, test, calibrate, and place into operation all software for PLC's and SCADA P.C.'s.

b. The Programming Contractor shall be responsible for coordination with OWNER to provide a complete, integrated and functional software system.

c. As a minimum, the Programming Contractor shall perform the following work:

1) Prepare software submittals.

2) Design, develop, and implement controls, screens, reporting, recording, etc.

3) Prepare the test plan, the training plan, and the spare parts submittals.

4) Procure all software.

5) Perform tests on PLC and SCADA software.

6) Participate in system pre-commissioning.

7) Participate in the performance tests.

8) Prepare Technical Manuals.

9) Conduct training classes.

3. Owner's Responsibilities:

a. Assist the Programming Contractor in coordinating and integrating the system controls.

b. The Programming Contractor shall not be responsible for providing or testing any hardware.

4. The Programming Contractor and the Instrumentation & Control System Contractor will be one and the same for this contract.

E. Programmer Qualifications:

1. The Qualification requirements specified in these paragraphs apply to the portions of the Process Control and Instrumentation System Work to be provided by the Programming Contractor.

2. The Programming Contractor shall meet the following minimum qualifications:
    a. The Programming Contractor shall have completed at least five (5) successfully completed projects for a pumping system of similar scope and complexity in which the Programming Contractor used components the same as those intended for use on this project, performed system programming, documentation, including software configuration and documentation, field testing, calibration and start-up, operator instruction and maintenance training.
    b. The Programming Contractor company shall be actively involved in the instrumentation, PLC based control systems, and SCADA systems business for a minimum of ten years and has adequate facilities, organization structure, manpower and technical and managerial expertise to properly perform the WORK under and in conformance with these Specifications.

1.6 SEQUENCING

A. General:
    1. Testing requirements are specified in Division 27.
    2. Work restrictions and other scheduling requirements are specified in the General specifications.

B. Pre-submittal Conferences:
    1. Before producing any submittals, schedule a pre-submittal Conference for the purposes of reviewing the entire project, equipment, control philosophy, schedules, and submittal requirements.

C. Training:
    1. Complete all training before the pre-commissioning phase of the project may start.
    2. Schedule the training sessions a minimum of 15 days prior to the start date of the courses.
    3. Submit training manuals to the ENGINEER a minimum of 10 days before starting the training session.
    4. Within 10 days after the completion of each session, submit the following:
        a. A list of all OWNER personnel that attended the session.
        b. A copy of the training materials utilized during the lesson with all notes, diagrams, and comments.

D. Performance Testing:
    1. Complete Pre-commissioning test a minimum of 5 days before the Performance Test.
    2. Conduct a 90-day Performance Test.

1.7 WARRANTY

A. Warrant the Software and Programming in accordance with the General Conditions:

1. Provide additional warranty as specified in the individual Division 17 Specifications.

1.8 SYSTEM STARTUP

A. Replace or modify software, and materials that do not achieve design requirements after installation in order to attain compliance with the design requirements:

1. Following replacement or modification, retest the system and perform additional testing to place the complete system in satisfactory operation and obtain compliance acceptance from the ENGINEER.

1.9 MAINTENANCE

A. Before Substantial Completion, perform all maintenance activities required by any sections of the Specifications including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems in service.

PART 2 - PRODUCTS

PART 3 - EXECUTION

3.1 DEMONSTRATION AND TRAINING

A. Training:

1. General:

a. Provide system maintenance and operator training courses for all the instrumentation and control systems furnished.

b. Conduct all training at the Project Site unless another location is approved by the ENGINEER and OWNER.

1) Include instruction on the use of all maintenance equipment and special tools provided under the contract.

c. Tailor training classes to the specific needs of the class participants:

1) The specific categories and number of personnel in each category are identified below.

2) Furnish training courses that are a combination of classroom and hands-on training:

3) Present the minimum number of sessions, specified in Table 1, for each course in order to satisfy class size restrictions and limitations scheduling OWNER staff.

4) Furnish additional sessions if required to accommodate the total number of personnel identified for each course.

5) Schedule individual training classes with the OWNER at least 3 weeks before the start of the class.

6) Schedule all training classes Monday - Friday between 7:30 AM and 3:30 PM.

7) Each individual daily training session, travel time excluded:

   a) Minimum duration of 4 hours.

   b) Maximum duration of 7 hours.

   c) Breaks scheduled at least every 90 minutes and 1 hour for lunch.

8) Complete training for maintenance personnel 90-days before Performance Testing.

9) Complete operator training classes before startup of the SCADA system, or any part of it:

10) Refer to Paragraph 1.09 of this Section.

11) Schedule follow-up training classes after SCADA startup on a schedule determined by the OWNER.

   a) Furnish highly qualified training instructors for technical training with demonstrated expertise in not only control system functionality but also professional training techniques:

   b) Provide completion reports in accordance with Paragraph 1.09 of this Section.

2. Training Manuals and Materials:

   a. Furnish training manuals and other materials for training courses.

   b. Manuals are to be professionally written to present the course material in a format that is easy to comprehend.

   c. The manuals are to serve as teaching aids during presentation of the training classes.

   d. Manuals are to serve as reference material after the training has been completed.

Table 1

Course Title	Minimum Course Length (days per session)	Personnel (Estimated Number of Students)	Minimum Number of Sessions
SCADA, HMI, PLC Software	1	5	1

3. Training Course Requirements:

   a. Software Training:

1) Furnish training on software and on related systems, including operation alarms, control, recording, reporting, etc.

2) Furnish training on features, operation, troubleshooting, and maintenance.

b. HMI Training:

1) Provide the following:

a) Overview of firmware, including starting, stopping, and PLC interface.

b) Troubleshooting.

c. Follow-up Training:

1) Provide on-site follow-up training class beginning after startup of the SCADA system. The intent for these classes is to provide the OWNER's personnel the opportunity for a review and "refresher" of the training topics and material after they have had some experience using the system.

2) Mutually schedule and develop the content of these classes with the OWNER no later than 1 month before the beginning of the first session:

a) Schedule at the OWNER's discretion on non-consecutive days spaced out over the start-up and warranty period.

END OF SECTION

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SECTION 16412

DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To

1. Furnish and install disconnects as described in Contract Documents, except those provided integral with equipment.

B. Related Sections

1. Section “Electrical General Requirements”.
2. Section “Electrical Identification”.
3. Section “Fuses”.

1.2 SUBMITTALS

A. Submit product literature including manufacturer part number, model number, material, size, ratings, and specifications.

B. Refer to Section 16 05 00 for submittal requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Manufacturer

1. 1. Same MANUFACTURER as Panels.

B. Disconnect Switches:

1. Heavy duty quick-make, quick-break type, fused, unless indicated otherwise. Provide a control switch for VFD fed motors which will disengage the VFD prior to opening the switch.
2. Provide interlock to prevent opening of door when switch is in ON position.
3. Provide means to lock switch in OFF position with padlock.
4. Disconnects for motor circuits shall be horsepower rated.
5. Where indicated on Drawings for small motors, disconnects shall be manual starter with thermal overload relay.
    a. Device shall have one pole per ungrounded conductor of motor.
    b. Provide overload relay to match motor full load amps.

c. Equip with lockout device.

6. Enclosures:

   a. Interior Dry locations - NEMA Type 12, or as indicated or required.

   b. Exterior, Damp, or Wet Locations - NEMA Type 4X Stainless steel, or as indicated or required.

7. Fuses:

   a. Fuse fused disconnects with dual-element time delay fuses and equip with rejection type fuse holders.

   b. Fuses on shall be from single manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Label disconnects to indicate equipment served, such as Condensing Unit CU-1. Use 1/16 inch (1.6 mm) thick laminated plastic composition material with contrasting color core. Engraved letter shall be 1/4 (6 mm) inch high. Attach labels with screws.

END OF SECTION

SECTION 16413
COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Scope of work

1. This section includes minimum requirements for product design, quality, and performance, including preparation and installation of telecommunications balanced unshielded twisted pair (UTP) cabling.

2. Balanced category 6 UTP horizontal cable is deployed from the telecommunications room (TR) to each workstation outlet. Category 6 cable is also used for backbone cabling. Riser cable is permitted for use in non-plenum areas. Plenum rated cable is required everywhere else. Terminated horizontal cables define the permanent link. Transmission testing is required for each cabled link. It is the responsibility of the cable installer to follow recognized installation practices. Compliance with codes and standards is required to achieve specified performance and network reliability.

3. This section includes specific requirements for the following:

a) Cable - category 6 balanced UTP, 550 mhz.

1.2 QUALITY ASSURANCE

A. Category 6 cables shall be installed according to recognized category 6 installation practices, and applicable codes and standards.

B. Installed category 6 cable shall be manufactured by an ISO 9001 certified facility.

C. Installed category 6 cable shall be free from defects in material or workmanship from the manufacturer, and shall be of the quality indicated.

D. Specified cable is based on acceptable manufacturers listed in the construction documents.

E. All methods of construction that are not specified in the contract documents shall be subject to control and approval by the owner or owner's representative.

F. Installed cable shall be lot-traceable by lot number and date of manufacture printed on the outer cable jacket.

G. All critical internal manufacturing operations for category 6 cable shall have documented in-process inspection and testing according to ISO 9001.

H. Where "approved equal" is stated, any substitute product shall be equivalent to all requirements specified, and is subject to approval.

I. Materials and work specified in this document shall comply with, and are not limited to the applicable requirements of standards, codes, and publications listed below:

1. ANSI/TIA/EIA-568-b.1, commercial building telecommunications cabling standard (and all published addenda), part 1: general requirements, 2001.

2. ANSI/TIA/EIA-568-b.2, commercial building telecommunications cabling standard (and all published addenda), part 2: balanced twisted pair cabling components, 2001.

3. ANSI/TIA/EIA-568-b.2-1, commercial building telecommunications cabling standard, part 2: balanced twisted pair cabling components, addendum 1: transmission performance specifications for 4-pair 100 ohm category 6 cabling, 2002.
4. TIA/TSB-155 (current draft), telecommunications system bulletin: characterizing existing category 6 cabling for 10 gb/s Ethernet operation over 55 meters channel length.
5. ANSI/ICEA-S-90-661, category 6 individually unshielded twisted-pair indoor cables, with of without an overall shield, for use in communications wiring systems technical requirements, 2004.
6. IEEE 802.3af, data terminal equipment (DTE) power over media dependent interface (MDI), 2003 (superseded by IEEE 802.3-2005).
7. IEEE 802.3, information technology – telecommunications and information exchange between systems – local and metropolitan area networks – specific requirements part 3: carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications, 2005.
8. IEEE 802.3an (current draft), specification for 10 gb/s (10 gigabit Ethernet) operation over category 6 or higher 4-pair balanced twisted pair cabling.
9. ANSI/TIA/EIA-569-b, commercial building standard for telecommunications pathways and spaces, 2003.
10. ANSI/TIA/EIA-606-a, administration standard for commercial telecommunications infrastructure, 2002.
11. ANSI j-std-607-a, commercial building grounding and bonding requirements for telecommunications, 2002.
12. ISO/IEC 11801, information technology – generic cabling for customer premises, 2002.
13. ISO/IEC 18010, information technology – pathways and spaces for customer premises cabling, 2005.
14. ISO/IEC 14763-1, information technology – implementation and operation of customer premises cabling – part 1: administration, 2004.
15. BS EN 50173-1, information technology – generic cabling systems – part 1: general requirements, 2002.
16. BS EN 50174-1, information technology – cabling installation – part 1: specification and quality assurance, 2001
17. National fire protection association, inc., NFPA 70: national electric code (NEC), 2005.
    a. NEC article 250: grounding and bonding
    b. NEC article 800: communications circuits
18. CSA c22.1-06, Canadian electric code (CEC), 2006
19. Underwriters laboratory, inc., UL1863: standard for safety – communications circuit accessories, 4th ed, 2004.

20. Telecommunications distribution methods manual, 10th ed., building industry consulting services international (BICSI), 2003.
21. Information transport systems installation manual, 4th ed., building industry consulting services international (BICSI), 2004.

1.3 SUBMITTALS

A. Product data sheet
B. Manufacturer's instructions
C. Product catalog literature
D. Product drawing
E. Third party verification certificates (upon request)

1.4 REFERENCES

A. Master format, 2004 ed., the construction specifications institute, 2004.
B. The project resource manual, CSI manual of practice, 5th ed., the construction specifications institute, 2005.

1.5 WARRANTY

A. Product is warranted free of defects in material or workmanship.
B. Product is warranted to perform the intended function within design limits.
C. Installed category 6 cable may be granted a full link or channel warranty by Hubbell premise wiring under the conditions stated below.
    1. Construction is performed by an installer that is certified by the Hubbell mission critical® warranty program or equal of amp or Leviton.
    2. Contractors performing the certified installation are properly registered in the Hubbell mission critical® warranty program.
    3. The link or channel components are supplied entirely by Hubbell or equal of amp or Leviton (including patch cords for channel).
    4. Cable used in the installation is qualified and recognized by the manufacturer.
    5. Links or channels in the installation are properly documented and tested with a "pass" result. (see "field quality control – testing" in part 3 of this document for testing details).
    6. Required test results and project documentation is submitted to the manufacturer by the registered contractor.

PART 2 - PRODUCTS

2.1 CABLE - CATEGORY 6 BALANCED UTP CABLE, 550 MHZ RISER

A. Design requirements
    1. Cable construction shall be four twisted pairs of 23 AWG insulated solid conductors, with a ripcord, surrounded by a tight outer jacket.

2. Cable shall be manufactured with an “x”-shaped pair-divider along the center to maintain separation of individual pairs.

3. Conductor diameters shall be 0.0224” ± .0003” solid copper.

4. Conductor insulation diameter shall be 0.040” ± .0005” flame retardant polyolefin.

5. Twist lay of each pair shall vary in a manner to optimize noise immunity and minimize crosstalk.

6. Outer jacket diameter shall be 0.230” ± .008” PVC, with a nominal wall thickness of 0.015”.

7. Ripcord shall be directly underneath the outer jacket.

8. Cable shall be marked: “Hubbell premise wiring nextspeed category 6 550 mhz – riser -- 4 pr 23 AWG C(UL)US CMR – (UL) verified to TIA/EIA-568-b.2-1 -- z/yy(xxxx) – nnnn”.

    a) Frequency of marking shall be every 2.0 ft.

    b) ‘z’ represents the month of manufacture.

    c) ’yy’ indicates the year of manufacture.

    d) ’xxxx’ indicates the job number.

    e) ’nnnn’ indicates the sequential footage markers.

9. UL, ETL, or CSA agency certification or verification markings shall be marked on the cable jacket according to the certifying agency’s requirements.

10. Color coding of the pairs shall be as follows:

    a) Pair 1: white/blue; blue

    b) Pair 2: white/orange; orange

    c) Pair 3: white/green; green

    d) Pair 4: white/brown; brown

11. Cable shall be supplied in 1000 ft spools or 1000 ft reelex boxes.

B. Performance requirements

1. All transmission performance parameters shall be independently verified by a UL or ETL third party testing organization.

2. Cable shall exceed category 6 transmission requirements specified in ANSI/TIA/EIA-568-b.2-1, and shall be tested through 550 mhz.

3. Cable shall exceed the requirements of TIA/TSB-155: 10 gb/s Ethernet operation over 55 meters channel length.

4. Worst-case cable performance shall be +8.0 db headroom over current TIA/EIA and ISO standards limits for next and PSNEXT loss, and ELFEXT and PSELFEXT loss.

5. Insertion loss shall be 3.0% lower than standard Hubbell category 6 plenum and riser cables described in section 16761.

6. Worst case electrical performance characteristics shall be as follows:

   a) Characteristic impedance:100 +15(1.0-100 MHz) 100 +20(101-250 MHz)

   b) Maximum conductor resistance:9.38 Ohm /100 meters @ 20°c

   c) Maximum resistance unbalance: 3%

   d) Maximum mutual capacitance: 5.6 nF/100 meters @ 1 kHz

   e) Maximum capacitance unbalance: 330 pF/100 meters

   f) Maximum delay skew: 25 ns/100 meters

7. The manufacturer shall provide category 6 component compliance certificates from third party testing organization upon request.

8. Cable shall be UL and C(UL) listed.

9. Cable shall exceed IEEE 802.3 DTE power specification to 4 times the rated current limits with no degradation of performance or materials.

10. Cable shall be third party verified, error free gigabit Ethernet performance to IEEE 802.3 standard.

11. Cable shall meet or exceed the 4-connector channel performance requirements of category 6, per the ANSI/TIA/EIA-568-b.2-1 standard.

12. The 4-connector channel test configuration shall utilize category 6 jacks and patch panels, with category 6 patch cords, from the same manufacturer, with qualified category 6 cable.

13. The 4-connector channel performance margins in the table below shall be guaranteed, provided the configuration satisfies requirement no. 12 above.

Electrical parameter (1 - 250mhz)	Guaranteed margins to category 6 / class e channel specifications
Insertion loss	3 %
NEXT	4 dB
PSNEXT	5 dB
ELFEXT	4 dB
PSELFEXT	5 dB
Return loss	2 dB

PART 3 - EXECUTION

3.1 PREPARATION

A. Horizontal pathways (conduit, cable tray, raceway, etc.) Shall be fully deployed from the TR or TE to each wall plate location according to applicable codes and standards.

B. Metallic horizontal cable pathways shall be bonded to an approved ground according to ANSI-J-STD-607-a.

3.2 INSTALLATION

A. Using approved methods, pull cable into conduits, or place into raceway or cable tray as specified. Do not exceed 25 lb pull force per cable. Use appropriate lubricants as required to reduce pulling friction.

B. All exposed wiring shall be installed in surface raceway.

C. All wiring above ceilings or below access floors shall be installed in cable tray or open-top cable hangers.

D. Cable slack and service loops shall be stored properly above the ceiling or under the access floor. A “figure-eight” service loop is recommended for category 6 cabling to reduce EMI coupling.

E. Pathway fill ratio in conduit, tray, raceway, etc. Shall not exceed 40% of pathway cross-sectional area.

F. Installed cable bend radius shall be greater than 4x cable diameter. Avoid kinking or twisting the cable during installation.

G. Do not over-tighten cable ties, and do not use staples or clamps to anchor cables. Velcro straps are recommended.

H. Recommended spacing of cable supports above the ceiling shall be 48”.

I. Maintain the following clearances from EMI sources:

1. Power cable in parallel: 12 in.
2. Power cable intersections: 6 in.
3. Florescent lights: 12 in.
4. Transformers and electrical service enclosures: 36 in.

J. Communications cabling that must cross power cables or conduit shall cross at a 90-degree angle, and shall not make physical contact.

K. Length of each horizontal cable run from the TR to the wall outlet shall not exceed 90 meters.

L. Leave sufficient slack for 90 degree sweeps at all vertical drops.

M. Do not install cable in wet areas, or in proximity to hot water pipes or boilers.

N. Cable ends for termination shall be clean and free from crush marks, cuts, or kinks left from pulling operations.

O. Installed cable jackets shall have no abrasions with exposed conductor insulation or bare copper 'shiners". The installer is responsible to replace damaged cables.

P. Horizontal cables extending from mounted jacks or panels shall maintain a minimum bend radius of at least 4 times the cable diameter.

Q. Firestop all cable penetrations through fire-rated barriers per local codes.

R. For termination of panels in the tr, refer to section 16760: "communications termination blocks and patch panels".

S. For termination of jacks in the wall outlet, refer to section 16761: "communications faceplates and connectors".

3.3 FIELD QUALITY CONTROL – TESTING

A. Cables are tested in the fully terminated condition, as part of the installed horizontal cabling system. Jacks in the wall outlet, and panels in the tr are to be terminated complete, with faceplates assembled complete and properly mounted.

B. For termination of panels in the TR, refer to section "communications termination blocks and patch panels".

C. For termination of jacks in the wall outlet, refer to section "communications faceplates and connectors".

D. Each link or channel in the horizontal cabling system shall be identified and tested individually, using an industry standard level iii tester with correct settings.

A. Test cables in the horizontal channel or link for the parameters listed below.

1. Wire map / Continuity
2. Length
3. Insertion Loss
4. NEXT
5. PSNEXT
6. ELFEXT
7. PSELFEXT
8. Delay and Delay Skew
9. Return Loss

E. A "pass" indication shall be obtained for each channel or link, using a level iii tester. The installer is responsible to correct any test failures.

F. Completed test reports shall be submitted per contract requirements of "field test reporting".

G. See "warranty" in part 1 for provisions of the Hubbell link or channel full coverage warranty.

END OF SECTION

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SECTION 16416
BRANCH CIRCUIT PANELBOARD

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Lighting and Appliance Panelboard - Furnish and install lighting and appliance panelboard(s) as specified herein and where shown on the associated schedules drawings.

1.2 REFERENCES

The panelboard(s) and circuit breaker(s) referenced herein are designed and manufactured according to the latest revision of the following specifications.

A. NEMA PB 1 – Panelboards

B. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

C. NEMA AB 1 - Molded Case Circuit Breakers

D. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

E. UL 50 - Enclosures for Electrical Equipment

F. UL 67 – Panelboards

G. UL 98 - Enclosed and Dead-front Switches

H. UL 489 - Molded-Case Circuit Breakers and Circuit Breaker Enclosures

I. CSA Standard C22.2 No. 29-M1989 - Panelboards and Enclosed Panelboards

J. CSA Standard C22.2 No. 5-M91 - Molded Case Circuit Breakers

K. Federal Specification W-P-115C - Type I Class 1

L. Federal Specification W-C-375B/Gen - Circuit Breakers, Molded Case, Branch Circuit And Service.

M. NFPA 70 - National Electrical Code (NEC)

N. ASTM - American Society of Testing Materials

1.3 SUBMITTAL AND RECORD DOCUMENTATION

A. Approval documents shall include drawings. Drawings shall contain overall panelboard dimensions, interior mounting dimensions, and wiring gutter dimensions. The location of the main, branches, and solid neutral shall be clearly shown. In addition, the drawing shall illustrate one line diagrams with applicable voltage systems.

1.4 QUALIFICATIONS

A. Company specializing in manufacturing of panelboard products with a minimum of fifty (50) years documented experience.

B. Panelboards shall be manufactured in accordance with standards listed.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inspect and report concealed damage to carrier within their required time period.

B. Handle carefully to avoid damage to panelboard internal components, enclosure, and finish.

C. Store in a clean, dry environment. Maintain factory packaging and, if required, provide an additional heavy canvas or heavy plastic cover to protect enclosure(s) from dirt, water, construction debris, and traffic.

1.6 OPERATIONS AND MAINTENANCE MATERIALS

A. Manufacturer shall provide installation instructions and NEMA Standards Publication PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

1.7 WARRANTY

A. Manufacturer shall warrant specified equipment free from defects in materials and workmanship for the lesser of one (1) year from the date of installation or eighteen (18) months from the date of purchase.

1.8 RELATED WORK

A. Section “Transient Voltage Surge Suppression” or “Surge Protection Devices”.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D Company Type NF - Class 1670.

B. Cutler Hammer / Eaton.

C. General Electric.

2.2 LIGHTING AND APPLIANCE PANELBOARD TYPE

A. Fabrication:

1. Interior

a. Continuous current ratings, as indicated on Drawings, not to exceed 600 amperes maximum for main breaker panelboards and not to exceed 800 amperes for main lug panelboards.

b. Minimum Short Circuit Rating: as indicated on the Drawings.

c. Provide one (1) continuous bus bar per phase. Each bus bar shall have sequentially phased branch circuit connectors limited to bolt-on branch circuit breakers. The bussing shall be fully rated. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67. Bussing rated 100-400 amperes shall be plated copper. Bussing rated for 600 and 800 amperes shall be plated copper as standard construction. Bus bar plating shall run the entire length of

the bus bar. Panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230-F and -G.

d. All current-carrying parts shall be insulated from ground and phase-to-phase by high dielectric strength thermoplastic.

e. A solidly bonded copper equipment ground bar shall be provided.

f. Split solid neutral shall be plated and located in the mains compartment up to 250 amperes so all incoming neutral cable may be of the same length.

g. Interior trim shall be of dead-front construction to shield user from energized parts. Dead-front trim shall have pre-formed twistouts covering unused mounting space.

h. Nameplates shall contain system information and catalog number or factory order number. Interior wiring diagram, neutral wiring diagram, UL Listed label and short circuit current rating shall be displayed on the interior or in a booklet format.

i. Interiors shall be field convertible for top or bottom incoming feed. Main circuit breakers in 125A interiors shall be vertically mounted. Main circuit breakers over 125A shall be vertically mounted. Sub-feed circuit breakers shall be vertically mounted. Main lug interiors up to 400 amperes shall be field convertible to main breaker. Interior leveling provisions shall be provided for flush mounted applications.

j. Interior phase bus shall be pre-drilled to accommodate field installable options. (i.e., Sub-Feed Lugs, Sub-Feed Breakers, Thru-Feed Lugs)

k. Interiors shall accept 125 ampere breakers in group mounted branch construction.

2. Main Circuit Breaker

a. Shall be bolt-on type circuit breakers.

b. Main circuit breakers shall have an over center, trip-free, toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have a permanent trip unit with thermal and magnetic trip elements in each pole. Each thermal element shall be true RMS sensing and be factory calibrated to operate in a 40° C ambient environment. Thermal elements shall be ambient compensating above 40° C.

c. Two and three pole circuit breakers shall have common tripping of all poles. Circuit breakers frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the breaker that allows the user to simultaneously select the desired trip level of all poles. Circuit breakers shall have a push-to-trip button for maintenance and testing purposes.

d. Circuit breaker handle and faceplate shall indicate rated ampacity.

Standard construction circuit breakers shall be UL Listed for reverse connection without restrictive line or load markings.

e. Circuit breaker escutcheon shall have international I/O markings, in addition to standard ON/OFF markings. Circuit breaker handle accessories shall provide provisions for locking handle in the ON or OFF position.

f. Lugs shall be UL Listed to accept solid or stranded copper conductors only. Lugs shall be suitable for 90° C rated wire, sized according to the 75° C temperature rating per NEC Table 310-16. Lug body shall be bolted in place; snap-in designs are not acceptable.

g. The circuit breakers shall be UL Listed for use with the following accessories: Shunt Trip, Under Voltage Trip, Ground Fault Shunt Trip, Auxiliary Switch, Alarm Switch, Mechanical Lug Kits, and Compression Lug Kits.

3. Branch Circuit Breakers

a. Circuit Breakers shall match the brand of the panel. Circuit breakers shall be UL Listed with amperage ratings, interrupting ratings, and number of poles as indicated on the panelboard schedules drawings.

b. Molded case branch circuit breakers shall have bolt-on type bus connectors.

c. Circuit breakers shall have an over center toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have thermal and magnetic trip elements in each pole. Two- and three-pole circuit breakers shall have common tripping of all poles.

d. There shall be two forms of visible trip indication. The circuit breaker handle shall reside in a position between ON and OFF. In addition, there shall be a red VISI-TRIP® indicator appearing in the clear window of the circuit breaker housing.

e. The exposed faceplates of all branch circuit breakers shall be flush with one another.

f. Lugs shall be UL Listed to accept solid or stranded copper conductors only. Lugs shall be suitable for 90° C rated wire, sized according to the 75° C temperature rating per NEC Table 310-16.

g. Breakers shall be UL Listed for use with the following factory installed accessories: Shunt Trip, Auxiliary Switch, and Alarm Switch.

h. Breaker shall be UL Listed with the following ratings: (15-125A) Heating, Air Conditioning, and Refrigeration (HACR), (15-30A) High Intensity Discharge (HID), and (15-20A) Switch Duty (SWD)

4. Enclosures

a. Type 1 Boxes

1) Boxes shall be galvanized steel constructed in accordance with

UL 50 requirements. Galvannealed steel will not be acceptable.

2) Boxes shall have removable end walls with knockouts located on one end. Boxes shall have welded interior mounting studs. Interior mounting brackets are not required.

3) Box width shall not exceed 26" wide.

b. Type 1 Fronts

1) Front shall meet strength and rigidity requirements per UL 50 standards. Shall have ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.

2) Fronts shall be hinged 1-piece with door. Mounting shall be surface as indicated on associated drawings. All covers shall be hinged cover type.

3) Panelboards rated 250 amperes and below shall have MONO-FLAT fronts with concealed door hinges and trim screws. Front shall not be removable with the door locked. Panelboards rated above 250 amperes shall have vented fronts with concealed door hinges. Doors on front shall have rounded corners; edges shall be free of burrs.

4) Front shall have flat latch type lock with catch and spring loaded stainless steel door pull. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock. A clear plastic directory card holder shall be mounted on the inside of door.

c. Type 4, and 12

1) Enclosures shall be constructed in accordance with UL 50 requirements. Enclosures shall be painted with ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.

2) All doors shall be hinged cover type. All doors shall be gasketed and equipped with a tumbler type vault lock and two (2) additional quarter turn fasteners on enclosures 59 inches or more in height. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock. A clear plastic directory card holder shall be mounted on the inside of door.

3) Maximum enclosure dimensions shall not exceed 21" wide and 9.5" deep.

5. Surge Protective Device

a. Integral Surge Suppressor shall be provided for each branch circuit panelboard.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards in accordance with manufacturer's written instructions, NEMA PB

1.1 and NEC standards.

3.2 FIELD QUALITY CONTROL

A. Inspect complete installation for physical damage, proper alignment, anchorage, and grounding.

B. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads within 20% of each other. Maintain proper phasing for multi-wire branch circuits.

C. Check tightness of bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written specifications.

3.3 INSTALLATION OF PANELS

A. Installation: Unless otherwise indicated on the drawings, install wall panels with the top of the trim 6'-0" above the finished floor. Panels located in equipment rooms and wire closets shall be surface mounted. Floor mounted panels shall be provided with a 4" concrete housekeeping pad. Floor mounted panels shall be anchored to floor at all four corners and to wall or structural member at top for seismic restraint.

B. Directories: Mount a typewritten directory behind glass or plastic on the inside of each panel door. On the directory, show the circuit number and complete description of all outlets with specific locations on each circuit. In addition, provide a typewritten label inside door showing source of power to panel both as to feeder switch, panel designation and location within buildings.

END OF SECTION

SECTION 16419
PATCH CORDS, STATION CORDS & CROSS CONNECT WIRE

PART 1 - GENERAL

1.1 SUMMARY

A. Scope of work

1. This section includes minimum requirements for product design, quality, and performance, including preparation and installation of telecommunications balanced unshielded twisted pair (UTP) cabling.
2. Balanced category 6 UTP horizontal cable is deployed from the telecommunications room (TR) to each workstation outlet. Category 6 cable is also used for backbone cabling. Riser cable is permitted for use in non-plenum areas. Plenum rated cable is required everywhere else. Terminated horizontal cables define the permanent link. Transmission testing is required for each cabled link. It is the responsibility of the cable installer to follow recognized installation practices. Compliance with codes and standards is required to achieve specified performance and network reliability.
3. This section includes specific requirements for the following:
    a) Cable - category 6 balanced UTP, 550 mhz.

1.2 QUALITY ASSURANCE

A. Category 6 cables shall be installed according to recognized category 6 installation practices, and applicable codes and standards.

B. Installed category 6 cable shall be manufactured by an ISO 9001 certified facility.

C. Installed category 6 cable shall be free from defects in material or workmanship from the manufacturer, and shall be of the quality indicated.

D. Specified cable is based on acceptable manufacturers listed in the construction documents.

E. All methods of construction that are not specified in the contract documents shall be subject to control and approval by the owner or owner's representative.

F. Installed cable shall be lot-traceable by lot number and date of manufacture printed on the outer cable jacket.

G. All critical internal manufacturing operations for category 6 cable shall have documented in-process inspection and testing according to ISO 9001.

H. Where "approved equal" is stated, any substitute product shall be equivalent to all requirements specified, and is subject to approval.

I. Materials and work specified in this document shall comply with, and are not limited to the applicable requirements of standards, codes, and publications listed below:

1. ANSI/TIA/EIA-568-b.1, commercial building telecommunications cabling standard (and all published addenda), part 1: general requirements, 2001.
2. ANSI/TIA/EIA-568-b.2, commercial building telecommunications cabling standard (and all published addenda), part 2: balanced twisted pair cabling components, 2001.

3. ANSI/TIA/EIA-568-b.2-1, commercial building telecommunications cabling standard, part 2: balanced twisted pair cabling components, addendum 1: transmission performance specifications for 4-pair 100 ohm category 6 cabling, 2002.
4. TIA/TSB-155 (current draft), telecommunications system bulletin: characterizing existing category 6 cabling for 10 gb/s Ethernet operation over 55 meters channel length.
5. ANSI/ICEA-S-90-661, category 6 individually unshielded twisted-pair indoor cables, with of without an overall shield, for use in communications wiring systems technical requirements, 2004.
6. IEEE 802.3af, data terminal equipment (DTE) power over media dependent interface (MDI), 2003 (superseded by IEEE 802.3-2005).
7. IEEE 802.3, information technology – telecommunications and information exchange between systems – local and metropolitan area networks – specific requirements part 3: carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications, 2005.
8. IEEE 802.3an (current draft), specification for 10 gb/s (10 gigabit Ethernet) operation over category 6 or higher 4-pair balanced twisted pair cabling.
9. ANSI/TIA/EIA-569-b, commercial building standard for telecommunications pathways and spaces, 2003.
10. ANSI/TIA/EIA-606-a, administration standard for commercial telecommunications infrastructure, 2002.
11. ANSI j-std-607-a, commercial building grounding and bonding requirements for telecommunications, 2002.
12. ISO/IEC 11801, information technology – generic cabling for customer premises, 2002.
13. ISO/IEC 18010, information technology – pathways and spaces for customer premises cabling, 2005.
14. ISO/IEC 14763-1, information technology – implementation and operation of customer premises cabling – part 1: administration, 2004.
15. BS EN 50173-1, information technology – generic cabling systems – part 1: general requirements, 2002.
16. BS EN 50174-1, information technology – cabling installation – part 1: specification and quality assurance, 2001
17. National fire protection association, inc., NFPA 70: national electric code (NEC), 2005.
    a. NEC article 250: grounding and bonding
    b. NEC article 800: communications circuits
18. CSA c22.1-06, Canadian electric code (CEC), 2006
19. Underwriters laboratory, inc., UL1863: standard for safety – communications circuit accessories, 4th ed, 2004.
20. Telecommunications distribution methods manual, 10th ed., building industry consulting services international (BICSI), 2003.

21. Information transport systems installation manual, 4th ed., building industry consulting services international (BICSI), 2004.

1.3 SUBMITTALS

A. Product data sheet

B. Manufacturer's instructions

C. Product catalog literature

D. Product drawing

E. Third party verification certificates (upon request)

1.4 REFERENCES

A. Master format, 2004 ed., the construction specifications institute, 2004.

B. The project resource manual, CSI manual of practice, 5th ed., the construction specifications institute, 2005.

1.5 WARRANTY

A. Product is warranted free of defects in material or workmanship.

B. Product is warranted to perform the intended function within design limits.

C. Installed category 6 cable may be granted a full link or channel warranty by Hubbell premise wiring under the conditions stated below.

1. Construction is performed by an installer that is certified by the Hubbell mission critical® warranty program or equal of AMP (TE Connectivity by CommScope Holding Company) or Leviton.

2. Contractors performing the certified installation are properly registered in the Hubbell mission critical® warranty program.

3. The link or channel components are supplied entirely by Hubbell or equal of AMP (TE Connectivity by CommScope Holding Company) or Leviton (including patch cords for channel).

4. Cable used in the installation is qualified and recognized by the manufacturer.

5. Links or channels in the installation are properly documented and tested with a "pass" result. (see "field quality control – testing" in part 3 of this document for testing details).

6. Required test results and project documentation is submitted to the manufacturer by the registered contractor.

PART 2 – PRODUCTS

2.1 CATEGORY 6 PATCH CORDS

A. Design requirements

1. Category 6 patch cords shall be constructed with a smoke-colored polycarbonate plug having vertically staggered, trifurcated contacts, each having 50 micro-inches of gold plating.

2. Plug dimensions and function shall comply with FCC 47, part 68.5.

3. Patch cords shall have a snag-less feature, integral to the strain relief boot on each end. Strain relief boot shall be molded PVC, and color matched to the cable jacket.

4. Patch cords shall be constructed with category 6 patch cable, with 24 AWG 7/32 tinned copper stranded conductors, each insulated with polyethylene, and overall jacket with UL flame-retardant PVC.

5. Patch cords shall be manufactured using a T568b wiring format, and shall function suitably for either T568a or T568b wiring schemes.

6. Patch cords shall be available in the following colors: black, blue, gray, yellow, orange, red, green, white, and purple. Custom lengths and colors shall be available with a delivery lead-time quotation.

7. Standard patch cord lengths shall range from 3 ft. to 20 ft.

8. Category 6 patch cords shall be backward compatible with existing category 3, 5, and 5e cabling systems for fit, form, and function.

B. Performance requirements

1. All transmission performance parameters shall be independently verified by a UL or ETL third party testing organization.

2. Category 6 patch cords shall be channel performance balanced with Hubbell category 6 jacks, patch panels, and punch-down blocks.

3. Category 6 patch cords shall meet or exceed category 6 component transmission requirements for connecting hardware, as specified in ANSI/TIA/EIA-568-b.2-1 standard.

4. The manufacturer shall provide category 6 component compliance certificates from third party testing organization upon request.

5. Patch cords shall be CUL and UL listed 1863.

6. Patch cords shall exceed IEEE 802.3 DTE power specification to 4 times the rated current limits with no degradation of performance or materials.

7. Patch cords shall be third party verified, error-free gigabit Ethernet performance to IEEE 802.3 standard.

8. Jacks shall exceed 4 gb/s data transmission capacity within the bandwidth of 1 – 250 mhz when configured in a 4-connector channel.

9. Category 6 patch cords shall meet or exceed the 4-connector channel transmission performance requirements of category 6, per ANSI/TIA/EIA-568-b.2-1 standard.

10. The 4-connector channel test configuration shall utilize category 6 patch panels, blocks, and jacks, with category 6 patch cords, all from the same manufacturer, with qualified category 6 cable.

11. The 4-connector channel performance margins in the table below shall be guaranteed, provided the configuration satisfies requirement no. 9 above.

12. Category 6 patch cords shall meet the current draft 10 gb/s transmission performance requirements of TSB-155, provided the configuration satisfies requirement no. 9 above.

Electrical parameter (1 - 250mhz)	Guaranteed margins to category 6 / class e channel specifications
Insertion loss	3 %
NEXT	4 db
PSNEXT	5 db
ELFEXT	4 db
PSELFEXT	5 db
Return loss	2 db

PART 3 - EXECUTION

3.1 PREPARATION

A. Horizontal and backbone cabling of the proper category shall be fully deployed throughout the building according to applicable codes and standards.

B. Telecommunications outlet locations, patch panels in each TR, and patch panels in the ER shall be installed and terminated complete per manufacturer's instructions, and applicable codes and standards.

C. Where applicable, any consolidation point or MUTOA locations shall be permanently mounted and terminated complete.

D. Faceplates at each outlet shall be assembled complete and properly mounted.

E. Metallic horizontal cable pathways shall be bonded to an approved ground according to ANSI-J-STD-607-a.

3.2 INSTALLATION

A. Remove patch cords from bags and apply channel or port identification labels per specification. Patch cord lengths should match the distance between connection points, with enough slack for cable management and bend radius control.

B. For cross-connect panels in the ER or TR, place the patch cords properly into the installed front cable organizer. Plug each end into the respective panel and equipment ports. Push the plug into the receptacle until the latch clicks into position. Installed patch cords should be neat, with no kinks, tangles, or tight bends.

C. To connect workstation equipment to the outlet, route the patch cord behind furniture and plug into the network port. Patch cords should not interfere with the operator space or electrical cords. Note: workstation cords are normally installed after placement of office furniture.

3.3 FIELD QUALITY CONTROL – TESTING

A. Note: if permanent link tests are complete, and channel testing is not required in the contract documents, then channel testing after patch cord installation is not required. Proceed with step 'b' below only if channel testing is required in the contract documents.

B. For channel testing, each channel in the horizontal and backbone cabling system shall be identified and tested individually, using an industry standard level iii tester with correct settings.

C. Each channel, including patch cord on each end, shall be tested for the parameters listed below.

1. Wire map / Continuity
2. Length
3. Insertion Loss
4. NEXT
5. PSNEXT
6. ELFEXT
7. PSELFEXT
8. Delay and Delay Skew
9. Return Loss

D. A "pass" indication shall be obtained for each channel using a level iii tester.

E. Completed test reports shall be submitted per contract requirements of "field test reporting".

F. See "warranty" in part 1 for provisions of the Hubbell channel full coverage warranty.

END OF SECTION

SECTION 16423
FIBER CABLE AND EQUIPMENT

PART 1 GENERAL

1.1 SCOPE

A. Section Includes:

1. Requirements for fiber optic cable and related hardware including:
    a. Fiber Optic Cable.
    b. Fiber Splices and Terminations
    c. Fiber Patch Panels.
    d. Related accessories.
2. Requirements for Video and control using Fiber and Coax cable.

B. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the CONTRACTOR and its Sub-Contractors to review all sections to ensure a complete and coordinated project.

C. Furnish all a complete fiber optic network as indicated in the plans, as shown on the cable or system block diagrams; and as specified herein.

1.2 REFERENCES

A. Fiber optic cable and termination equipment supplied under this contract shall be designed, manufactured, and tested in accordance with the latest version of the following standards:

1. Electronic Industry Association (EIA) 455B "Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components".

FOTP – 1	Cable Flexing for Fiber Optic Interconnecting Devices
FOTP – 2	Impact Test Measurements for Fiber Optic Devices
FOTP – 3	Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components
FOTP – 4	Fiber Optic Connector/Component Temperature Life
FOTP – 5	Humidity Test Procedure for Fiber Optic Connecting Devices
FOTP – 11	Vibration Test Procedure for Fiber Optic Connecting Devices and Cables.
FOTP – 17	Maintenance Aging of Fiber Optic Connectors and Terminated Cable Assemblies
FOTP – 18	Acceleration Testing of Fiber Optic Components and Assemblies
FOTP – 21	Mating Durability for Fiber Optic Interconnecting Devices

FOTP – 25	Repeated Impact testing of Fiber Optic Cables and Cable Assemblies
FOTP – 26	Crush Resistance of Fiber Optic Interconnecting Devices
FOTP – 28	Method of Measuring Dynamic Tensile Strength of Optical Fibers
FOTP – 31	Fiber Tensile Proof Test Method
FOTP – 32	Fiber Optic Circuit Discontinuities
FOTP – 33	Fiber Optic Cable Tensile Loading and Bending Test
FOTP – 34	Interconnecting Device Insertion Loss Test
FOTP – 35	Fiber Optic Component Dust (Fine Sand) Test
FOTP – 36	Twist Test for Fiber Optic Connecting Devices
FOTP – 37	Low or High Temperature Bend Test for Fiber Optic Cable
FOTP – 41	Compressive Loading Resistance of Fiber Optic Cables
FOTP – 59	Measurements of Fiber Point Defects Using an OTDR
FOTP – 61	Measurement of Fiber or Cable Attenuation Using an OTDR
FOTP – 78	Spectral Attenuation Cutback Measurement for Single mode Optical Fibers
FOTP – 80	Cutoff Wavelength of Un-cabled Single mode Fiber by Transmitted Power
FOTP – 81	Compound Flow (Drip) Test for Filled Fiber Optic Cable
FOTP – 82	Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable
FOTP – 85	Fiber Optic Cable Twist Test
FOTP – 86	Fiber Optic Cable Jacket Shrinkage
FOTP – 88	Fiber Optic Cable Bend Test
FOTP – 89	Fiber Optic Cable Jacket Elongation and Tensile Strength
FOTP – 91	Fiber Optic Cable Twist-Bend Test
FOTP – 98	Fiber Optic Cable External Freezing Test
FOTP – 169	Chromatic Dispersion Measurement of Single mode Optical Fibers by the Phase-Shift Method
FOTP – 170	Cable Cutoff Wavelength of Single mode Fiber by Transmitted Power
FOTP – 178	Measurements of Strip Force Required for Mechanically Removing Coatings from Optical Fibers

2. TIA/EIA Standards:
   a. TIA/EIA-568-B (Series), Commercial Building Telecommunications Standards.
   b. TIA/EIA-569 (Series), “Commercial Building Standard for Telecommunications Pathways and Spaces.”
3. Bellcore Standards:

a. Bellcore GR-20, “Generic Requirements for P\Optical Fiber and Optical Fiber Cables.

b. Bellcore GR-409, “Generic Requirements for Intrabuilding Fiber.”

4. ICEA Standards:

a. S-83-596 “Fiber Optic Premises Distribution Cables.”

b. S-87-640, “Fiber Optic Outside Plant Communications Cable.”

c. S-104-696, “Fiber Optic Premises Distribution Cables.

1.3 SUBMITTALS

A. Product Data:

1. Complete manufacturer’s brochures that identify instrument construction, accuracy, ranges, materials, and options. Mark up to clearly show options and components to be provided, and cross out any options or components that will not be provided.

2. Completed data sheets, including catalog number and source for determining catalog number.

3. Manufacturer’s installation instruction.

4. Produce data submitted under this section shall include:

a. Provide manufacturer’s data on testing equipment used on this project.

b. Provide manufacturer’s specifications and data sheets for all fiber types.

c. Provide manufacturer’s specifications and data sheets for all connectors, bulkheads, splicing kits, breakout devices and appurtenances used connecting and terminating the fiber spans.

B. Shop drawings showing interconnection cabling diagrams for the complete system showing every fiber in each cable.

C. Catalog data on all testing devices proposed for use plus certifications of accuracy, calibration, and traceability to standards of the national Institute for Standards and Testing.

D. Drawings indicating the locations of all pull boxes, include pull box identifiers and lengths.

E. Cable pulling calculations for all conduit runs. Indicate on the submittal any additional pull boxes that are required, including pull box identifiers and a written description of the location.

F. Test Reports:

1. The results of all tests specified under this section shall be submitted to the ENGINEER. Fiber tests shall include:

a. Factory test results on fiber optic cable.

b. Field test on delivered fiber optic cable before installation.

c. Field test on installed fiber optic cable before termination.

d. Field tests on installed fiber optic cable after all splices and terminations are completed.

G. Operating Manuals:

1. After completion of testing, the test reports, instruction manuals, and manufacturer's information shall be compiled into the "operating manuals".

H. Record Drawings:

1. Electrical drawings, network diagrams, and fiber cable block diagrams shall be updated at the end of construction and submitted as record drawings.

1.4 QUALITY ASSURANCE

A. Furnish materials suitable for the purpose for which they are used, considering strength, ductility, and durability.

B. All cable and appurtenances have been manufactured within one year of installation.

C. All optical fibers shall be proof tested by the fiber manufacturer at a minimum load of 50 kpsi.

D. All optical fibers shall be 100 percent attenuation tested. The attenuation of each fiber shall be provided with each cable reel.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Fiber optic cable and termination equipment shall be delivered complete, in manufacturer's original, unopened protective packaging. Packing materials shall be such as to prevent damage to the materials during transportation and handling.

B. Maintain protective coverings until ready for installation.

C. The completed cable shall be packaged for shipment on non-returnable wooden reels.

D. Top and bottom ends of the cable shall be available for testing on reels.

E. Each cable reel shall have a weatherproof label, which shows the actual length of cable on the reel.

F. Both ends of the cable shall be sealed to prevent the ingress of moisture.

G. The cable manufacturer shall provide installation procedures and technical support concerning the items contained in this specification.

1.6 PROJECT/SITE CONDITIONS

A. Fiber optic installation work may need to occur in parallel with heavy construction work. The CONTRACTOR shall take steps, as necessary, to protect the fiber system from physical damage and the encroachment of dust.

B. Refer to Section “project environmental conditions”.

1.7 WARRANTY

A. All cable and equipment shall carry a one year parts and labor warranty.

PART 2 - PRODUCTS

2.1 CABLE ASSEMBLIES

A. General Fiber Cable Requirements:

1. Cable construction shall be suitable for the environment where it is scheduled to be installed.
2. Each fiber shall be distinguishable from others by means of color coding according to EIA/TIA-598, “Color Coding of Fiber Optic Cables.”
3. Buffer tubes containing fibers shall also be color coded with distinct and recognizable colors according to EIA/TIA-598, “Color Coding of Fiber Optic Cables.”
4. In buffer tubes containing multiple fibers, the colors shall be stable during temperature cycling and not subject to fading or smearing onto each other or into the gel filling materials. Colors shall not cause fibers to stick together.
5. Buffer tubes shall be a single layer nylon construction of similar mechanical performance.
6. Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed.
7. The central anti-buckling member shall consist of a glass reinforced plastic rod. The purpose of the central member is to prevent buckling of the cable.
8. Binders shall be applied with sufficient tension to secure the buffer tubes to the central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking (or rendered so by the flooding compound), and dielectric with low shrinkage.
9. The cable shall contain at least one ripcord under the sheath for each sheath removal.
10. Tensile strength shall be provided by high tensile strength aramid yards.
11. The high tensile strength Aarmid yards, Keviar, and/or fiberglass shall be helically stranded evenly around the cable core. There shall be no metallic elements whatsoever in non-armored cable so that the cable is entirely an insulator.
12. The jacket or sheath shall be free of holes, splits, and blisters.

13. The jacket or sheath shall be marked with the manufacturer's name, the words "Optical Cable," year of manufacture, and sequential meter marks. The markings shall be repeated every one-meter. The actual length of the cable shall be within 1 percent of the length marking. The marking shall be in a contrasting color to the cable jacket. The height of the marking shall be approximately 2.5 mm.

14. The shipping, storage, and operating temperature range of the cable shall be -40 degrees C to +70 degrees C.

15. General Performance Characteristics:

    a. The rated tensile load of the cables shall be 2670 N (600 lbf). Fibers within the cable shall experience a fiber strain of no greater than 60 percent of the fiber proof test level.

    b. The non-armored fiber optic cables shall withstand a compressive load of 220 N/cm applied uniformly over the length of the cable. The armored fiber optic cables shall withstand a compressive load of 440N/cm applied uniformly over the length of the cable. The average increase in attenuation for the fibers shall be < 0.10 dB at 1550 nm for a cable subjected to this load. The cable shall not exhibit any measurable increase in attenuation after load removal. Testing shall be in accordance with FOTP-41, "Compressive Loading Resistance of Fiber Optic Cable", except that the load shall be applied at the rate of 3 mm to 20 mm per minute and maintained for 10 minutes.

    c. The cable shall be capable of withstanding 25 cycles of mechanical flexing at a rate of 30-+ 1 cycles/minute. The average increase in attenuation for the fibers shall be < 0.10 dB at 1550nm at the completion of the test. For armored cables, any visible cracks causing separation of the armor and propagating more than 5 mm shall constitute failure. Outer cable jacket cracking or splitting observed under 10 X magnification, shall constitute failure.

16. Packaging:

    a. Fiber cable assemblies shall be placed on reels such that both cable ends are available for testing. Fable ends shall be sealed against the entrance of moisture.

    b. Cable reel markings shall include the following:

        1) Manufacturer

        2) Date of Manufacture

        3) Shipping date

        4) Cable Identification

        5) Cable configuration/Fiber Count

        6) Cable Length

        7) Gross Weight

        8) Cable test data

        9) Handling instructions

        10) Direction to unreel

17. Acceptable fiber cable assembly manufacturers:
    a. ~~ADC/KRONE~~ TE Connectivity by CommScope Holding Company Group
    b. Berk-Tek
    c. Corning Cable Systems
    d. Pirelli
    e. Or Approved equal

B. Outside Plant Cable:
    1. General:
        a. Application: Install cable outside of structures. Install in conduit unless otherwise indicated.
    2. Cable Construction:
        a. Cable Type: Outdoor only. Fully preventing the entrance of water.
        b. Fiber count: 24
        c. Fiber Type: Single mode
        d. Buffer Tube: Loose Tube
        e. Armoring: None
        f. Strength Member: Central nonmetallic strength member with a coefficient of thermal expansion similar to the fibers.
        g. Design and Test Criteria: ICEA S-87-640.
    3. Where require each buffer tube shall be filled with a non-hygroscopic, non-nutritive to fungus, electrically non-conductive, homogenous gel. The gel shall be free from dirt and foreign matter. The gel shall be readily removable with conventional non-toxic solvents.
    4. The cable core interstices shall be filled with a water-blocking compound that is a non-hygroscopic, non-nutritive to fungus, electrically non-conductive, homogenous gel. The gel shall be free from dirt and foreign matter. The gel shall be readily removable with conventional non-toxic solvents.
    5. Armored cables shall have an inner sheath of low or medium density polyethylene. The minimum nominal jacket thickness of the inner sheath shall be 0.5 mm. The inner jacket shall be applied directly over the tensile strength members and flooding compound. The armor will be a corrugated stainless steel tape, plastic-coated on both sides for corrosion resistance, and applied with an overlapping seam with the corrugations in register. All armor splices shall be recoated with plastic to further enhance the armor's corrosion resistance. The outer jacket shall be applied over the corrugated steel tape armor. The outer jacket shall be a low or medium density polyethylene with a minimum nominal jacket thickness of 1.25 mm. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

6. The fiber optic cable shall withstand water penetration when tested with a one meter static head or equivalent continuous pressure applied at one end of a one meter length of filled cable for one hour. No water shall leak through the open cable end. Testing shall be done in accordance with FOTP-82, "Fluid Penetration Test for Filled Fiber Optic Cable."
7. The cable shall exhibit no flow (drip or leak) at 80 degrees C. The weight of any compound that drips from the sample shall be less than 0.05 grams (0.002 ounce). A representative sample of cable shall be tested in accordance with FOTP-81, "Compound Flow (Drip) Test for Filled Fiber Optic Cable." The test sample shall be prepared in accordance with method A.
8. Acceptable fiber cable assembly manufacturers:
    a. ~~ADC/KRONE~~ TE Connectivity by CommScope Holding Company Loose Tube Outside Plant Cable.
    b. Berk-Tek.
    c. Corning Cable Systems.
    d. Pirelli.
    e. Or approved equal.

C. Indoor Cable:
1. General:
    a. Application: Install in conduit in the interior of structures where exposure to moisture can be minimized.
2. Cable Construction:
    1) Cable Type: Indoor – Flame Retardant, Low Smoke, Zerio Halogen.
    2) Fiber Count: 24.
    3) Fiber Type: Singlemode.
    4) Buffer Tube: Loose Tube.
    5) Armoring: None.
    6) Strength Member: Central nonmetallic strength member with a coefficient of thermal expansion similar to the fibers.
    7) Approvals and Listings: NEC OFN approved to general purpose indoor applications.
    8) Design and Test Criteria: S-83-596.
    b. All fiber in the cable shall conform to a proof test of 100 kpsi. Each optical fiber shall conform to Bellcore GR-409 strip force testing. There shall be no gaps between the coating material and the buffer material visible under a 50-power microscope.

c. The outer jacket material shall be a linear low-density polyethylene. The color of the polyethylene jacket material shall be black in accordance with ASTM D 1248. The indoor cable jacket shall meet all requirements of the NEC for use in all indoor areas without being enclosed in conduit. The indoor jacket shall be flame retardant riser rated conforming to UL 1666. Jacket shall be printed with all necessary UL marks and manufacturer identification. Additionally, sequential printing of footage shall occur in 2-foot increments. A ripcord shall be incorporated under the cable jacket.

3. Acceptable fiber cable assembly manufacturers:
   a. Corning/Altos non-conductive plenum rated.
   b. ~~ADC/KRONE~~ TE Connectivity by CommScope Holding Company Group.
   c. Berk-Tek.
   d. Pirelli.
   e. Or approved equal.

D. Singlemode Fibers:
1. All fibers in the cable must be usable fibers and meet required specifications.
2. All optical fibers shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification.
3. Each optical fiber shall consist of a doped silica core surrounded by a concentric silica cladding.
4. Single Mode Fiber Specifications.
   a. All fiber optic cables between facilities shall be single-mode.
   b. Optical Specifications
      1) Fibers shall operate at wavelengths between 1310 nm and 1625 nm.
      2) Attenuation: ≤ 0.03 dB/km at 1310 nm and ≤0.02 dB/km at 1550 nm.
   c. Dimensional Specifications
      1) Fiber Curl ≥ 4.0 radius of curvature
      2) Cladding diameter 125.0 ± 0.7 µm
      3) Core-Clad Concentricity ≤ 0.5 µm
      4) Non-Circularity ≤ 0.7%
      5) Coating diameter 245 ± 5 µm
      6) Coating-Cladding Concentricity < 12 µm
   d. Environmental Specifications
      1) Operating Temperature Range: -60ºC to +85ºC
   e. Mechanical Specifications
      1) The entire fiber length is subjected to a tensile stress ≥ 100 kpsi

5. Acceptable fiber cable manufacturers:
    a. ~~ADC/KRONE~~ TE Connectivity by CommScope Holding Company Group
    b. Berk-Tek
    c. Corning Cable Systems

2.2 ACCESSORIES

A. Fiber Patch Panels – LIU – Light Interface Unit.
    1. All optical fibers shall be provided with strain relief and terminated at a fiber patch panel. All patch panel terminations shall be SC type. Final connections between the patch panel and the fiber optic network equipment shall be made via fiber optic patch cords.
    2. All fibers, active and dark, shall be terminated at the patch panels.
    3. Interconnect and patch panel housings shall provide space for excess fiber and provide strain relief for the fiber cable.
    4. Fiber cables shall be installed such that the outer sheath of the cable is carried into the interconnect enclosure or patch panels before breaking out buffer tubes.
    5. Wall Mounted Interconnect:
        a. Application: Use for the termination of a single cable outside of cabinets, in small enclosures or as indicated on the plans.
        b. Wall mounted fiber interconnects shall be provided as complete units including the housing, the connector panels and the fiber connectors.
        c. Wall mounted fiber interconnects shall provide physical protection for both the incoming cable and the outgoing patch cords.
        d. Accessories:
            1) Door lock
            2) Blanks for unused connector panels.
        e. Manufacturers:
            1) The part number shall match those existing in the treatment plant, or approved by OWNER.
    6. Rack Mounted Fiber Patch Panel – LIU – Light Interface Unit.
        a. Application: Use for the termination of one or more fiber cables terminating on open EIA racks and in enclosures with EIA racks.
        b. Fiber patch panels shall be provided as complete units including the housing, the connector panels, mounting hardware and the fiber connectors.
        c. patch panels shall be provided with hardware for standard 19-inch or 23-inch rack mounting, as required.
        d. Capacity: As shown in the Contract Documents.

e. Manufacturers:

1) The part number shall match those existing in the treatment plant, or approved by OWNER.

B. Patch Cords:

1. General:

a. Connector types shall be selected by the CONTRACTOR to match supplied equipment and the patch panel terminations.

b. Two spare patch cords (or one duplex patch cord) of each type used shall be provided at each patch panel.

c. Cables shall be factory assembled and optically tested.

2. Manufacturer:

a. Multimode:

1) MM patch cords shall be CommScope 62.5 SC/SC duplex patch cords

2) MM patch cords shall be CommScope 62.5 SC/ST duplex patch cords.

3) MM patch cords shall be CommScope 62.5 ST/ST duplex patch cords.

b. Single Mode:

1) SM patch cords shall be CommScope Single Mode SC/SC duplex patch cords.

2) SM patch cords shall be CommScope Single Mode SC/ST duplex patch cords.

3) SM patch cords shall be CommScope Single Mode ST/ST duplex patch cords.

c. Or approved equal.

C. Fiber Connectors:

1. Fiber optic cable connectors shall be the heat-cured epoxy and polish kit type. Kit shall contain all necessary items to perform the connections and polishing including: connectors, hardware, tools, epoxy, oven, and other supplies. Terminations shall be SC, with composite hardware, over-cured epoxy, and composite or ceramic ferrules. Crimp on or UV-curable connectors are not acceptable.

2. Manufacturer:

a. Multimode: Connectors shall be CommScope epoxy/polish MM connectors.

b. Single Mode: Connectors shall be CommScope epoxy/polish SM connectors.

D. Splices:

1. All splice locations shall be approved by the ENGINEER prior to install of the fiber cables.

2. Field splices shall be placed in a splice tray and these splice tray(s) shall then be placed in a splice enclosure. Splice enclosure shall be waterproof. Splice enclosure shall be Tyco/Raychem FOSC style splice enclosure, or equal.

3. The individual fibers shall be looped a minimum of one full turn within the splice tray to avoid macro/micro bending.
4. All splices shall be protected with a thermal shrink sleeve.
5. All FIBER OPTIC CABLE splicing shall be of the fusion type and meet the following requirements:
    a. Joins multimode or single mode fibers
    b. Establishes a permanent fusion splice.
    c. Waterproof.
    d. Reenterable, rearrangable and reusable.
    e. Splice loss < 0.10 dB.
    f. Protected by a Splice Enclosure
    g. Outdoor: The fiber splice enclosure shall seal, bond, anchor and protect fiber optic cable splices. The splice enclosure shall be a stand-alone unit that does not require an outer enclosure. An outdoor splice enclosure shall provide for a maximum of six (6) cable entries in a butt-end configuration. The splice enclosure shall be used in aerial, underground, and direct buried applications.
    h. Indoor: The fiber splice enclosure shall anchor and protect fiber optic cable splices. The splice enclosure shall be a stand-alone unit that does not require an outer enclosure. The enclosure shall provide for the minimum number of splices at the location plus additional capacity for reconfigurations.
    i. If any splice has a loss greater than 0.10 dB it shall be re-spliced at the CONTRACTOR's expense.
6. All fiber optic connectors shall be fabricated using oven heat cured epoxy method. Ambient cured or UV cured epoxy methods are not acceptable. Each connector shall be hand polished to a maximum insertion loss when mated of 0.75 dB.
7. Active and spare fiber optic cables shall be provided and installed with all required connectors and appurtenances for all data highway links.

E. Terminations:
1. All fiber cables shall terminate at a fiber patch panel.
2. Outdoor cables shall be terminated using a breakout kit that seals the cable and provides physical protection for the fiber strands.
3. Indoor cables shall be terminated using breakout kits with field installed terminators.
4. All splices performed in termination cabinets and enclosures shall be installed in splice trays.
5. All cable terminations shall be permanently labeled. Labels shall be comparable in print quality and durability to labels produced by a Bradymaker printer using pressure sensitive polyester labels. Patch panels shall be labeled according with the Division 16 requirements for the labeling of cables.

F. Provide inner duct in fiber optic conduits.

G. Innerduct

1. All fiber cabling shall be run in innerduct. The innerduct shall be sized by the CONTRACTOR.

H. Buffer Tube Fiber Fan-Out Kits
1. Buffer Tube Fan-Out Kits shall be supplied for the termination of each buffer tube at end of the installed fiber cables.
2. Fan-Out Kits shall be color coded to match the color scheme of the fiber cabling.
3. Fan-Out Kits shall have a minimum length of 25 inches.
4. Fan-Out Kits shall be Corning FAN-BT25-12 or approved equal.

I. Fiber Optic Connectors
1. Fiber Optic Connectors shall not require the use of epoxy of polish.
2. Fiber Optic Connectors shall be of ceramic construction for 50 µm fiber at bandwidths of 4700 MHz and shall have a loss ≤ 0.5 dB.
3. Fiber Optic Connectors shall utilize the SC type connector.
4. Fiber Optic Connectors shall be anaerobic polished connectors or approved equal.

J. Fiber Patch Cords
1. The fiber patch cord shall be duplex and consist of buffered, graded-index fiber with a 50 µm core and a 125 µm cladding for multimode. The fiber cladding shall be covered by aramid yarn and a jacket of flame-retardant PVC.
2. The fiber patch cord shall be rated for 10 Gigabit Ethernet.

2.3 FIBER TERMINATION TOOLKIT

A. Provide a Fiber Termination Toolkit to the Government following the completion of the SCS installation. The Toolkit shall be compatible with the Connectors used for terminating the fiber cabling and shall have the necessary components to make at least 100 additional terminations.

B. The Toolkit shall contain hard copies of installation instructions as well as an installation video that illustrates the step-by-step procedure for installing the Fiber Optic Connectors.

C. The Toolkit shall have test equipment that is capable of determining if a Connector was installed correctly.

D. The Toolkit must be an approved installation system of the manufacturer of the fiber optic cabling and connectors.

E. The Toolkit shall be the Corning anaerobic polished type or equal.

F. CTC's shall be installed with at least 36" clear working space in front and behind cabinet.

G. CTC's shall have a slide-out shelf suitable for a laptop computer to be placed on it for system configuration/programming. The shelf shall be vented. The shelf shall be CPI 12335-719 or approved equal.

2.4 SOURCE QUALITY CONTROL

A. Factory Test:

1. While on the shipping reel, after cabling but before shipment, 100 percent of all fibers shall be tested for attenuation. Copies of the results shall be:
    a. Maintained on file.
    b. Attached to the cable reel in a waterproof pouch.
    c. Submitted to the CONTRACTOR and the ENGINEER before the delivery of the cable to the job site.
2. Conduct the flex test in accordance with FOTP-104, "Fiber Optic Cable Cyclic Flexing Test," except that the sheave diameter shall be a maximum diameter of 20X the cable OD. Test the cable in accordance with Test Conditions I and III of the FOTP.
3. The cable shall withstand 25 impact cycles. The average increase in attenuation for the fibers shall be <0.20 dB at 1550nm. The cable jacket shall not exhibit evidence of cracking or splitting. Conduct the test in accordance with FOTP-25, "Impact Testing of Fiber Optic Cables and Cable Assemblies."
4. The cable shall withstand a tensile load of 2700 N (600 pounds) without exhibiting an average increase in attenuation of greater than 0.10 dB. This test shall be conducted in accordance with FOTP-33, "Fiber Optic Cables and Cable Assemblies".
5. The cable shall withstand a simulated lightning strike with a peak value of the current pulse > 105kA. The test current used will be damped oscillatory with a maximum time-to-peak value of 15 us (which corresponds to a minimum frequency of 16.7 kHz) and a maximum frequency of 30 kHz. The time to half-value of the waveform envelope will be from 40 to 70 us. Conduct the test in accordance with the proposed FOTP-181, "Lightning Damage Susceptibility Test for Optic Cables with Metallic Components." In addition to the analysis criterion set forth in FOTP-181, the integrity of the buffer tubes (or analogous loose tube, i.e. core tube) and strength members must be intact after removal of the cable specimens for the test box.

PART 3 EXECUTION

3.1 EXAMINATION

A. The CONTRACTOR shall be responsible for verifying the condition of the conduit system before installation of the fiber optic cable or inner duct. A test mandrel shall be passed through all fiber optic conduit spans. The test mandrel shall be run in both directions.

B. The CONTRACTOR shall examine all materials and equipment before installation and verify they are free from physical damage and defects.

3.2 INSTALLATION

A. All Fiber optic system components shall be installed per the recommendations of the manufacturer.

B. Fiber optic cable shall be installed in continuous lengths without intermediate splices, except where approved by the ENGINEER in writing. The cable installation personnel shall be experienced with specific knowledge of the cable manufacturer's recommended procedures, and as a minimum shall conduct their work to conform to the following.

1. The fiber optic cable's strength elements shall be properly attached to a 600 lb breakaway swivel using Kellums pulling grips, minimum, 18-inches long.
2. Cable tensile limits and tension monitoring devices shall not exceed cable pull tension and bend limits.
3. All conduits shall be constantly lubricated during the pulling procedures.
4. Each pull box shall contain extra fiber optic cable for pull box slack.

C. The CONTRACTOR shall conform with the cable manufacturer's specifications, practices, and the following requirements.

1. When power equipment is used to install fiber optic cables, low speeds shall be used so that a rate of 30 meters per minute is not exceeded. The tensile and bending limitation for fiber optic cables shall not be exceeded under any circumstances. Large diameter wheels, pulling sheaves, and cable guides shall be used to maintain the specified bending radius. Tension monitoring shall be accomplished using commercial dynamometers or load-cell instruments. A nonfreezing type of swivel shall be inserted between the pulling line and cable pulling grip to prevent twisting under strain. The swivel shall be equipped with shear or tension pins with a breaking strength of 600 pounds.
2. No cable shall be pulled without a breakaway swivel.
3. All conduits shall have a lubricant applied at each conduit ingress and egress location and during the pull operation. Lubricant shall be poured or pumped into the end of the conduit at the feed location at a nominal application rate of 3 gallons per 1000 feet of cable. If the conduit is open at intermediate locations, then the appropriate proportion of lubricant shall be applied at each opening. As the cable is being pulled, lubricant shall be poured into the conduit at the feed location and at each intermediate location. Workmen shall be stationed at each intermediate location as required. After cable pulling, all excess lubricant that has collected shall be removed and the surrounding area cleaned.
4. Fiber optic cable shall be installed using a hydraulic capstan or winch equipped with a recording running line dynamometer graph which measures and records pulling tensions. The pulling equipment shall have "slip-load" capability to allow the winch to maintain a constant pulling force without taking up the winch line. The pulling equipment shall also be equipped with a hydraulic bypass that shall be set so that a maximum tension of 600 pounds is not exceeded. All equipment shall be designed to prevent a preset pulling tension from being exceeded. The pulling tension setpoint shall be determined by the fiber optic cable manufacturer. If during the pulling operation excessive tension is detected, all operations shall cease and the ENGINEER shall be notified.

5. The cable reel shall be positioned at the feed point in alignment with the raceway and in such a position that the cable can be passed from the top of the reel in a long, smooth bend into the raceway system. The use of a cable feeder is required.
6. The CONTRACTOR shall supply all bull wheels, blocks, split wheels, cable feeders, and necessary equipment required to provide a clean and safe operation. The cable shall not be allowed to travel over any wheel or block that has a radius less than the minimum radius allowed by the cable manufacturer.
7. The use of snatch blocks and rollers to guide the cable into the conduit at the feed point shall be minimized. The cable shall be fed slack by hand into the feed point and raceway without the use of rollers wherever possible. The cable reel shall be tended at all times and shall be turned by hand to provide the required cable slack. Under no circumstances shall the cable tension be allowed to turn the cable reel. A rim roller, with a wheel radius greater than the minimum cable bending radius shall be placed at the manhole or vault opening to prevent the cable from dragging on the manhole rim or steps.
8. A thorough visual inspection for flaws, breaks, and abrasions in the cable sheath shall be made as the cable leaves the reel, and the pulling speed shall be slow enough to permit the inspection. Damage to the sheath or finish of the cable shall be sufficient cause for rejecting the cable. Cable damaged in any way during installation shall be replaced by and at the expense of the CONTRACTOR. All cable shall be available for inspection by the ENGINEER continuously during installation. ENGINEER shall be notified in writing 5 days in advance of any installation.
9. If the cable becomes damaged during installation, the CONTRACTOR shall stop their operations and notify the ENGINEER immediately. The ENGINEER will determine whether to replace the entire reel of cable or to install a termination panel to eliminate the damaged section.
10. All pulls shall be documented by a graph which is annotated with the following information:
    a. Reel number
    b. Pull point ID.
    c. Date and time.
    d. Explanations for abnormalities in readings or interruptions.
    e. Sign-off by CONTRACTOR or ENGINEER.
11. Under no conditions shall the fiber optic cable be left exposed or unattended.

D. After the cables are installed and spliced, they shall be racked and spare conduits sealed. A minimum of 20 feet of fiber optic cable shall be stored at each end of one splice. Racking shall conform to the following.
    1. Cables shall be loosely secured in racked position with Ty-Raps or equal.
    2. Imprinted plastic coated cloth identification/warning tags shall be securely attached to the cables in at least two locations in each hand hole. Tags shall be by Brady or Thomas & Betts.

3. All coiled cable shall be suitably protected to prevent damage to the cable and fibers. Racking shall include securing cables to brackets and racking hardware that extend from the sidewalls of the hand hole.

4. When all cables at each hand hole are securely racked, unused conduits and void areas around conduit containing cables shall be sealed using the Semco or equal material.

E. Armored fiber optic cables containing metallic members shall be grounded per the requirements of Article 770 of the National Electrical Code.

F. Other cables shall be listed as nonconductive fiber cable.

3.3 FIELD QUALITY CONTROL

A. General:

1. The CONTRACTOR shall conduct tests of the fiber optic system.

2. All test results shall meet or exceed manufacturer specifications. Any fiber that does not meet or exceed manufacturer specifications shall be replaced at the CONTRACTOR's expense. Tests are to be performed on each fiber of each cable, and to be tested for breaks, abnormalities, and overall attenuation characteristics.

3. Before conducting any tests, the CONTRACTOR shall provide the ENGINEER with detailed descriptions of test procedures for review and approval. Pre-installation tests and Post-installation tests to be witnessed and signed off by ENGINEER and GOVERNMENT.

4. The CONTRACTOR shall provide the ENGINEER with a copy of the manufacturers' test procedures and quality assurance procedures for information. If the ENGINEER determines that these procedures are not adequate, the ENGINEER may require that additional tests be conducted by the CONTRACTOR before installation. Additional testing ordered by the ENGINEER will be paid for by the CONTRACTOR.

5. Testing shall be performed at four separate stages: (1) the factory, (2) after delivery but before installation, (3) after delivery to the job site but prior to installation, and (4) after installation and as part of final system testing.

6. The CONTRACTOR shall provide documentation certifying that the fiber optic cable has passed each testing stage. Provide separate documentation for each testing stage result.

7. Attenuation tests shall be performed with an Optical Loss Test Set capable and calibrated to show anomalies of 0.1 dB as a minimum. Multimode fibers shall be tested at 850 nm and 1300 nm. Single mode fibers shall be tested at 1310 and 1550 nm.

8. OTDR tests performed on fiver cables less than 100 meters shall be performed with the aid of a launch cable. OTDR pulse width settings shall be adjusted to a maximum setting of $1/1000^{th}$ of the cable length or 10 nanoseconds.

9. All tests required to ensure the satisfactory installation, adjustments, operation, and performance of all equipment and materials erected and installed under this specification, shall be performed by the CONTRACTOR.

10. The CONTRACTOR shall also furnish all test equipment, meters, instruments and miscellaneous equipment and perform all work required for the tests.

B. Test Reports:

1. The CONTRACTOR shall furnish the ENGINEER three copies of all test reports showing the results of all tests specified herein. Test forms shall clearly label the test type, the test location, test date, wavelength, index of refraction, cable identification, fiber type, fiber number, fiber color, and the result of the value of the tested parameter. All OTDR traces shall be supplied on printed hard-copy, and on 3-1/2 inch floppy disk media. Test reports shall state "PASS" or, 'NOT PASSED."

C. Site Test and Inspection:

1. Subsequent to the Post-Installation testing, the fiber network shall be placed into service and functional tested along with the control system and network components. Installed system tests are described in Section 40 10 00.

3.4 ADJUSTING

A. After completion of cable terminations, fiber cables shall be neatly dressed.

B. At the completion of construction, touch up the finish on all fiber patch panels and enclosures, as required.

3.5 CLEANING

A. After termination and before testing, all fiber optic connectors shall be cleaned. After cleaning, all un-terminated connectors shall be covered with a protective boot.

B. At the completion of construction, fiber enclosures shall be cleaned.

3.6 DEMONSTRATION

A. Testing shall be scheduled so that the ENGINEER or GOVERNMENT's representative witness the testing activities.

3.7 PROTECTION

A. All materials delivered to site shall be protected and stored in a suitable environment.

END OF SECTION

SECTION 16426
TERMINAL BLOCKS

PART 1 - GENERAL

1.1 SCOPE OF WORK:

A. This section covers terminal blocks for control and other wiring.

1.2 SUBMITTALS:

A. Products shall be submitted in accordance with Section 16 05 00, and elsewhere in the Contract Documents, prior to installation.

1.3 MANUFACTURERS:

A. Terminal blocks shall be Entrelec, Phoenix Contact, Weidmuller, or equal.

B. Surge protection blocks shall be MTL Surge Technologies, Series SD, or equal.

C. Power distribution blocks shall be Ilsco Corporation, or equal.

PART 2 - PRODUCTS

2.1 TERMINAL BLOCKS:

A. Terminal blocks shall mount on standard DIN rail, and be of the size required for conductors therein. A minimum of 25 percent spares shall be provided in each terminal box. No more than 2 conductors shall be allowed per termination. Jumper bar assemblies shall be installed for interconnecting terminal blocks, distributing power and signal commons. Terminal blocks shall be U.L. rated for 600 Volts, and 30 Amps, minimum.

B. Grounding terminal blocks shall be provided for instrumentation cable shields. The terminal blocks shall have distinctive 2-color bodies, and shall be mounted to the DIN rail with metal screw down type clamps, providing a positive ground connection. One grounding terminal block shall be installed for every 2 instrument cables terminated. Grounding terminal blocks shall be U.L. rated for 600 Volts, and 20 Amps, minimum.

C. Terminal blocks shall be available in a variety of colors, including red, green, blue, gray, black, yellow, and orange.

D. DIN mount fuse holders shall have blown fuse indicators for EC and AC circuits. Fuse holders shall be of the compression clamp type. Fuse holders shall be U.L. listed, and rated for 600 Volts. Fuse sizes shall not exceed the U.L. current rating for the fuse holders.

E. DIN rail shall be prepunched, zinc bichromate plated steel. Symmetrical DIN rail shall be 35 mmX7.5mm, minimum.

F. Terminal blocks for 4 to 20 milliamp signals shall have knife disconnect switches, and accessible test points for testing and measurement of current loop signals, without the need for removing wire terminations.

2.2 SURGE PROTECTION BLOCKS (SPB):

A. Analog inputs and outputs shall be terminated at surge protection blocks (SPB). He SPBs shall be designed for a working voltage of 32 volts, and shall be fused.

B. SPBs shall provide full hybrid line to line protection, and shall have a GDT rating of 10,000 A (8/20us pulse waveform).

C. SPBs shall be UL94 V-2 listed.

2.3 POWER DISTRIBUTION BLOCKS (PDB):

A. PDBs shall be Electro-tin plated and manufactured from high strength 6061-T6 aluminum alloy.

B. PDBs shall be UL Recognized rated 90º and CSA Certified.

C. PDBs shall provide flexibility in using the connector as an in line splice or to reduce conductor size.

D. PDBs shall be rated for 600 Volts and dual rated for Copper and Aluminum Conductor.

E. PDBs shall have the sizes and ratings per NEC.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Each terminal block and fuse holder shall be identified with the circuit number, or conductor number, corresponding to the identification appearing on the shop Drawings for the equipment, or system.

B. Terminal block and fuse holder markers shall be computer printed plastic-type, with permanent markings.

C. End clamps and end sections shall be installed on each terminal block and fuse holder assembly.

D. Terminal blocks for DC voltages shall be blue, and AC voltages shall be gray.

END OF SECTION

SECTION 16480
TESTING, CALIBRATION, AND COMMISSIONING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:
   1. Testing requirements that apply to all process control and instrumentation systems for the entire project.

B. Related Sections:
   1. The Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the CONTRACTOR and its Sub-Contractors to review all sections to ensure a complete and coordinated project.

1.02 REFERENCES

1.03 DEFINITIONS

1.04 (NOT USED)

1.05 SUBMITTALS

A. General:
   1. For each test described in Parts 2 and 3, herein, and described in other sections of Division 16, prepare and submit complete Test Plans, Test Procedures, Test Forms, Test Binders, and Test Reports, and other submittals, as specified below.
   2. Submit Manufacturer's Certifications and Manufacturer's Field Reports where required.
   3. Submit Test Plans, Procedures, Forms, and Binders for approval by the ENGINEER before scheduling or performing tests.
   4. Develop the PCIS system test submittals in consultation and cooperation with all applicable subcontractors.
   5. Additional Test Form and Test Procedure requirements are specified with individual test requirements.

B. Overall Test Plan:
   1. Develop and submit an overall testing plan for the PCIS. The Overall Test Plan to be reviewed and approved by the ENGINEER before detailed test plans, procedures, and forms will be reviewed.
   2. Describe the test phases, as they apply specifically to this project and each process system.
   3. Provide a preliminary testing schedule to show the sequence of tests and commissioning as they apply to each process system and each PLC.
   4. Provide a description of factory tests. Describe what equipment will be included, what testing equipment will be used, and the simulator that will be used.
   5. Provide examples of proposed forms and checklists.

C. Test Procedures:
   1. Develop and submit detailed test procedures to show that the integrated SCADA system hardware and software is fully operational and in compliance with the requirements of the Contract Documents.
   2. Provide a statement of test objectives for each test.
   3. Prepare specific procedures for each process system.
   4. Describe sequentially the steps to be followed in verifying the correct operation of each process system, including all features described in the loop descriptions, control strategies. Implied or generic test procedures are not acceptable.
   5. Specify who will perform the tests, specifically what testing equipment will be used (including serial numbers and NIST-traceable calibration), how the testing equipment will be used.
   6. Describe the expected role of the ENGINEER, as well as any requirements for assistance from OWNER's staff.
   7. Provide the forms and checklists to be used.

D. Test Forms:
   1. Provide test and calibration forms and checklists for each of the following:
      a. Calibration.
      b. Factory Demonstration Tests.
      c. Loop Validation Tests.
      d. Pre-commissioning Test.
      e. Performance Test.
   2. Test forms shall include the detailed test procedures, or shall include clear references to separate pages containing the complete test procedure applicable to each form. If references to procedures are used, the complete procedure shall be included with each test binder.
   3. Every page of each test form shall include project name, date, time, name of person conducting the test, signature of person conducting the test, and for witnessed tests, place for signature of person (ENGINEER and OWNER) witnessing the test.
   4. Some sample test forms are included at the end of this Section. These test forms show the minimum required test form content. They are not complete, and have not been customized for this project. The CONTRACTOR to develop and submit test forms customized for the project and meeting all of the specified test and submittal requirements.

E. Testing Binders:
   1. Sub-system to be tested, provide and submit a Test Binder containing all test procedures and individual test forms for the test. References to other documents for test procedures and requirements are not acceptable.
   2. Fill out in advance headings and all other information known before the test.
   3. Include applicable test plan information, as well as a list of all test prerequisites, test personnel, and equipment.
   4. Include or list reference material and provide separately at the time of the test.
   5. Record test results and verify that all test requirements and conditions have been met.

F. Factory Test Procedure additional minimal requirements:
   1. Prepare and submit a factory test procedure which includes:

a. Control system testing block diagram.
b. Estimated test duration.
c. Details on the simulator construction, components, and operation.

G. Test Reports:
1. At the conclusion of each test, submit a complete Test Report, including all test results and certifications.
2. Include all completed test binders, forms, and checklists.
3. Submission, review, and acceptance of each Test Report is generally required before the start of the sub-system.

1.06 QUALITY ASSURANCE

A. Test Personnel:
1. Furnish qualified technical personnel to perform all calibration, testing, and verification. The test personnel are required to be familiar with this project and the equipment, software, and systems before being assigned to the test program.

1.07 DELIVERY, STORAGE, AND PROTECTION

1.08 (NOT USED)

1.09 (NOT USED)

1.10 (NOT USED)

PART 2 - PRODUCTS

2.1 (NOT USED)

2.2 (NOT USED)

2.3 (NOT USED)

2.4 SOURCE QUALITY CONTROL

A. Factory Demonstration Test - General:
1. Before shipment to the project site, the complete PCIS system including all operator stations, servers, network equipment, printers, PCMs, PLCs, RTUs, LCPs, CCS, peripherals, communications equipment, and other SCADA equipment, shall be assembled, connected, and all software loaded for a full functional Factory Demonstration Test (FDT) of the integrated system.
2. Perform tests to show that the integrated system hardware and software is fully operational and in compliance with the requirements of the Contract Documents.
3. Additional factory tests are specified in other sections of Division 16.
4. The CONTRACTOR's test personnel shall be responsible for performing tests and recording results.

5. The FDT will be witnessed by the ENGINEER and/or other representatives of the OWNER.
6. Right of Observation: The OWNER retains the right to observe all factory test activities including any and all subsystem preparation, pretests, troubleshooting, retests, warm-up, and software modification and/or update.
7. The OWNER reserves the right to test any specified function, whether or not explicitly stated in the test submittal.
8. Costs for Repeating Testing: The CONTRACTOR shall pay for ENGINEER's and other OWNER's representatives' travel, subsistence, for witnessing the repetition of failed tests.
9. Correction of Deficiencies: Any deficiencies observed during the test shall be corrected and retested before completion of the test.
10. Any changes and/or corrections shall be noted on the test forms. ENGINEER shall witness the revisions and/or corrections prior to leaving the test site.
11. If the corrections and/or revisions are too extensive to be made while the ENGINEER is scheduled to be at the FDT test site, the FDT shall be, at the ENGINEER's sole discretion, considered failed, and the test shall be restarted at a later date. All costs for the re-test shall be borne by the CONTRACTOR.

B. Testing Simulation:
1. The FDT shall make use of hardware simulators that contain switches, pilot lights, variable analog signal generators, and analog signal level displays, which shall be connected to the I/O points within the SCADA System. All inputs and outputs shall be simulated and proper control and system operation shall be validated. Each switch, pilot light, display, etc. shall be labeled in accordance with the P&IDs so that a timely and thorough test of the complete system can be conducted.
2. The use of jumper wires, terminal block mounted pilot lights, and loose meters to act as or supply the functionality of a simulator shall not be allowed.
3. The hardware simulator may consist of a PLC, operating under a SCADA software package, or other approved software that has its I/O points wired to PLC's I/O points. Software operating on a PC may then act as the switches, pilot lights, variable analog signal generators, and analog signal level displays.

C. Panel Inspections:
1. The ENGINEER to inspect each control panel for completeness, workmanship, fit and finish, and compliance with the Contract Documents and the approved shop drawings.
2. Provide panel inspection forms as part of the Factory Demonstration Test procedures submittal.
3. Inspection to include, as a minimum: layout, mounting, wire and data cable routing, wire tags, power supply, components and wiring, I/O components layout (including terminals, wiring and relays), device layout on doors and front panels, and proper ventilation operation.

D. I/O Test:
1. Verify that I/O is properly wired to field terminals and is properly mapped into the PLC and the rest of the SCADA system, including all operator interface devices.

2. Test Methodology:
    a. Use the submitted and approved system simulator for this test.
    b. Discrete inputs: Apply appropriate input from simulator at panel terminal, observe input card indicator, observe data value at each indicated data address, observe data received on all operator interface displays (SCADA workstations and human machine interface (HMI) displays).
    c. Discrete outputs: Issue commands from operator interface screen to verify output card indicator light and measure response on simulator.
    d. Analog inputs: Apply appropriate analog input signal at panel terminals on simulator, observe data value at each indicated data address, and observe data properly received at each operator screen. Check each point at 0 percent, 50 percent, and 100 percent of scale.
    e. Analog outputs: Enter scaled values in the output buffer file, observe the output data file value, and measure appropriate response on simulator.
3. Test forms to include, but not be limited to:
    a. PLC and panel number.
    b. I/O Type.
    c. I/O tag name.
    d. Panel terminal block numbers.
    e. Rack/slot/number of I/O point.
    f. Check-off for correct response for each I/O point.
    g. Space for comments.
    h. Initial of individual performing test.
    i. Date test was performed.
    j. Witness' signature lines.

E. System Configuration Test:
1. Demonstrate and test the setup and configuration of all operator stations, servers, development stations, and peripherals.
2. Demonstrate all utility software and functions, such as virus protection, backup, optical drive burning, network monitoring, etc.
3. Demonstrate the proper operation of all peripheral hardware.
4. Demonstrate all general SCADA functions.
5. Demonstrate proper operation of log-on and other access security functions.
6. Test automatic fail over of redundant equipment.
7. Test Forms:
    a. For each test, list the specification page and paragraph of the function demonstrated, and provide a description of the function.
    b. List the specific tests and steps to be conducted.
    c. For each function, list all of the different sub-functions or ways the function can be used, and provide a test check-off for each:
        1) Include signature and date lines.

F. Post-testing:
1. After installing the cable and connectors, test all cables using the LAN certification to confirm the installation meets the requirements of the specification.

2. Provide test documentation that includes the cable number, total length of cable, a permanent hard copy, as well as an ASCII-formatted diskette copy of all traces.
3. After installing connectors:
    a. Perform cable end-to-end testing on all installed cables from both ends of the cable. Test shall include cable system performance tests and confirm the absence of wiring errors.
    b. Submit a signed test report presenting the results of the cable testing.
    c. Repair or replace any portions of the system not meeting TIA standards for a Category 5e installation. Repaired sections shall be retested.
    d. Submit 3 copies of all final documentation (including traces), using the approved test form, to the ENGINEER upon successful completion of the testing.

PART 3 - PRODUCTS

3.1 (NOT USED)

3.2 (NOT USED)

3.3 INSTALLATION

3.4 FIELD QUALITY CONTROL

A. General:
1. The OWNER reserves the right to test any specified function, whether or not explicitly stated in the test submittals.
2. Failure Testing:
    a) In addition to demonstrating correct operation of all specified features, demonstrate how the system reacts and recovers from abnormal conditions including, but not limited to:
        1) Equipment failure.
        2) Operator error.
        3) Communications sub-system error.
        4) Power failure.
        5) Process equipment failure.
        6) High system loading conditions.
3. Conduct testing Monday through Friday during normal working hours for no more than 8 hours per day. Testing at other times requires approval of the ENGINEER.

B. Manufacturer Services:

C. Sequencing:
1. See additional requirements in Article 1.09, Sequencing.

D. Calibration:

1. After installation but before starting other tests, calibrate and adjust all instruments, devices, valves, and system, in conformance with the component Manufacturer's instructions and in accordance with these Specifications.
2. Components having adjustable features are to be set carefully for the specific conditions and applications of this installation. Test and verify that components and/or systems are within the specified limits of accuracy.
3. Replace either individually or within a system, defective elements that cannot achieve proper calibration or accuracy.
4. Calibration Points:
   a) Calibrate each analog instrument at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent of span, using test instruments with accuracies traceable to National Institute of Testing Standards.
5. Field verify calibration of instruments that have been factory-calibrated to determine whether any of the calibrations are in need of adjustment.
6. Analyzer Calibration:
   a) Calibrate and test each analyzer system as a workable system after installation. Follow the testing procedures directed by the Manufacturers' technical representatives.
7. Complete instrument calibration sheets for every field instrument and analyzer.
8. Calibration Tags:
   a) Attach a calibration and testing tag to each instrument, piece of equipment, or system.
   b) Sign the tag when calibration is complete.

E. Industrial Network Testing:

1. Test remote operation.
   a) Verify and use HMIs, (if present) and confirm the proper operation of the field device:
   b) Stroke valves through outputs from the SCADA System, and confirm proper directional operation. Confirm travel limits and any feedback signals to the SCADA System.
   c) Exercise motors starters from the SCADA System and verify proper operation through direct field observation.
   d) Exercise solenoids and other field devices from the SCADA System and verify proper operation through direct field observation.
2. Include in the test forms:
   a) Analog input devices:
      1) Calibration range.
      2) Calibration data: Input, output, and error at each test value.
      3) Analog input associated PLC register address.
      4) Value in PLC register at each test point.
      5) Value displayed at each operator interface station (human machine interface displays and SCADA workstations).
   b) Analog output devices:
      1) Calibration range.
      2) Test value at each test point.
      3) Analog output associated PLC register address.
      4) Control variable value at field device at each test point.

5) Physical device response at each test point: Response to be actual valve position, or motor speed, etc.

c) Discrete instrument input devices:
1) Switch setting, contact action, and dead band.
2) Valve position switches: Response in the PLC as the valve is stroked from the PLC. Field observed actual valve position, and valve indicator position as the valve is stroked from the PLC.
3) Operator interface switches (control stations and other pilot devices) and associated response.
4) Starter and drive auxiliary device contact response.
5) Response of all other discrete inputs to the PLC.

d) Discrete output devices:
1) Observed response of field device to the discrete output from the PLC.
2) Observe the proper operation of Open, Close, Start, Stop, On, Off, etc.

e) Test equipment used and associated serial numbers.

F. Solids Handling Building HVAC testing and balancing.
1. ICSC shall provide support during HVAC testing and balancing.

3.5 (NOT USED)

3.6 (NOT USED)

3.7 DEMONSTRATION AND TRAINING

A. Performance/Reliability/Operational Tests:
1. After successful completion of the pre-commissioning test as accepted by the ENGINEER and OWNER, the performance test can proceed.
2. Complete training and instruction of the OWNER's personnel in conformance with paragraph 1.09 Sequencing and Scheduling.

B. The Performance Test may be performed concurrently with the 7-Day Operational Test.

C. General:
1. The performance test is part of the Work that must be completed as a condition of substantial completion for the entire project.
2. The complete PLC control and SCADA system must run continuously for the duration of the performance test. During this period, exercise all system functions, and log for cause of failure, any system interruption and accompanying component, subsystem, or program failure:
a) Include time of occurrence and duration of each failure.
3. Provide a competently trained technician or programmer on call for the project site during all normal working days and hours from the start of the performance test until final acceptance of the system. Response time to the project site:
a) 24 hours or less, for a major failure.
4. The Performance Test duration:
a) 7 days.

5. Test and use; the entire process control system under standard operating conditions.

D. Failures:
1. Classify failures as either major or minor.
a) Minor Failure:
1) A small and non-critical component failure or software problem that can be corrected by the OWNER's operators.
2) Log this occurrence but this is not a reason for stopping the test and is not grounds for non-acceptance.
3) Should the same or similar component failure occur repeatedly, this may be considered as grounds for non-acceptance.
4) Failure of one printer, or operator station is considered a minor failure providing all functions can be provided by backup equipment, i.e. alternate printers and operator station, and repairs can be made and equipment returned to service within 3 working days.
b) Major Failure:
1) Considered to have occurred when a component, subsystem, software control, or program fault causes a halt in or improper operation of the system and/or when a technician's work is required to make a repair or to re-initiate operation of the system.
2) Cause termination of the performance test.
3) Start a new acceptance test when the causes of a major failure have been corrected.
4) A failure is also considered major when failure of any control system that results in an overflow, underflow, overdose, or under dose condition occurs.

E. Technician Report:
1. Each time a technician is required to respond to a system malfunction he or she must complete a report which includes details concerning the nature of the complaint or malfunction and the resulting repair action required and taken.
2. If a malfunction occurs which clears itself or which the operator on duty is able to correct, no report is required or logged as specified above.
3. If a technician has performed work but no report is written, then a major failure is considered to have occurred.
4. Each report shall be submitted within 24 hours to the ENGINEER and the OWNER, or its representative.

3.8 (NOT USED)

3.9 SCHEDULES

A. Example Test Forms:
1. Example test forms are attached at the end of this Section. They may be used as a starting point for the development of project-specific test forms for this project.

2. The example test forms are not intended to be complete or comprehensive. Edit and supplement the forms to meet the requirements for testing and test forms specified in this Section and other Contract Documents.

		INSTALLATION AND CERTIFICATION CHECKLIST DOCUMENTATION	

INSTRUMENT LOOP NO. _____

SERVICE DESCRIPTION _____

A COPY OF LATEST ISSUE OF THE FOLLOWING DOCUMENTS ARE INCLUDED IN THIS INSTRUMENT INSTALLATION CERTIFICATION FILE:

- ☐ INSTRUMENT SPECIFICATION SHEETS (FOR ALL INSTRUMENTS IN THE LOOP)
- ☐ INSTRUMENT INSTALLATION DETAILS (FOR ALL INSTRUMENTS IN THE LOOP)
- ☐ INSTRUMENT LOOP WIRING DIAGRAMS
- ☐ INSTRUMENT INSTALLATION CERTIFICATION CHECKLIST
- ☐ SIZING CALCULATIONS
- ☐ INSTRUMENT INSTALLATION SCHEDULE (APPLICABLE PART)
- ☐ NAMEPLATE SCHEDULE (APPLICABLE PART)
- ☐ VENDOR LITERATURE CALIBRATION INFORMATION

	☐	☐
INSTRUMENT LOOP IS PART OF AN EQUIPMENT START UP/SHUTDOWN INTERLOCKS?	No	Yes

REMARKS: _____

CHECKED BY (COMPANY)		ACCEPTED BY (COMPANY)	
SIGNATURE		SIGNATURE	
DATE		DATE	

		SWITCHES INSTALLATION AND CALIBRATION CHECKLIST	

INSTRUMENT LOOP NO.

SERVICE DESCRIPTION

CHECK BELOW, WHEN COMPLETED:

- ☐ BENCH CALIBRATED PER SPEC SHEET
- ☐ VERIFIED PER P&ID NO
- ☐ CORRESPONDS TO SPECIFICATION SHEET NO.
- ☐ WIRING CORRECT PER INSTRUMENT LOOP DRAWING NO.
- ☐ INSTALLATION CORRECT PER DETAIL NO.
- ☐ ACCESSORIES ARE PRESENT AND PROPERLY INSTALLED
- ☐ INSTRUMENT IS ACCESSIBLE FOR MAINTENANCE OR REMOVAL
- ☐ ENGRAVED LAMINATED NAMEPLATE (NO SPELLING ERRORS) PERMANENTLY INSTALLED

INSTRUMENT LOOP IS PART OF AN EQUIPMENT START UP/SHUTDOWN INTERLOCKS?	☐ No	☐ Yes

FIELD CALIBRATION CHECK							
CONTACT NO.	FUNCTION	FOR SIGNAL	CONTACT IS TO	AT SPECIFIED VALUE FOR		ACTUAL TRIP POINT WAS…	
1	☐ ALARM	☐ INCR	☐ OPEN	SET PT =	_____	SET PT =	_____
	☐ S/D PERM	☐ DECR	☐ CLOSE	RESET =	_____	RESET =	_____
2	☐ ALARM	☐ INCR	☐ OPEN	SET PT =	_____	SET PT =	_____
	☐ S/D PERM	☐ DECR	☐ CLOSE	RESET =	_____	RESET =	_____
3	☐ ALARM	☐ INCR	☐ OPEN	SET PT =	_____	SET PT =	_____
	☐ S/D PERM	☐ DECR	☐ CLOSE	RESET =	_____	RESET =	_____
4	☐ ALARM	☐ INCR	☐ OPEN	SET PT =	_____	SET PT =	_____
	☐ S/D PERM	☐ DECR	☐ CLOSE	RESET =	_____	RESET =	_____

NOTE: PERM IS ABBREVIATED FOR PERMISSIVE

		SWITCHES INSTALLATION AND CALIBRATION CHECKLIST	

REMARKS:

CHECKED BY (COMPANY)	ACCEPTED BY (COMPANY)
SIGNATURE	SIGNATURE
DATE	DATE

		TRANSMITTER/CONTROLLER/INDICATOR INSTALLATION AND CALIBRATION CHECKLIST	

☐ No ☐ Yes

INSTRUMENT LOOP IS PART OF AN EQUIPMENT START UP/SHUTDOWN INTERLOCKS?

INSTRUMENT TYPE INDICATOR ☐ TRANSMITTER ☐ CONTROLLER ☐ ☐ OTHER DESCRIPTION

INSTRUMENT TAG NO. SERIAL NO.

SERVICE DESCRIPTION

BENCH CALIBRATION CHECK				
INPUT RANGE =			OUTPUT RANGE =	
HEAD CORRECTION =			☐ LINEAR	
CALIBRATED SPAN =			☐ SQUARE ROOT	
% CALIB SPAN	DESIRED VALUE	ACTUAL VALUE	EXPECTED VALUE	ACTUAL VALUE
0				
50				
100				

CHECK BELOW, WHEN COMPLETED:

☐ BENCH CALIBRATED PER SPEC SHEET

☐ VERIFIED PER P&ID NO _____

☐ CORRESPONDS TO SPECIFICATION SHEET NO. _____

☐ WIRING CORRECT PER INSTRUMENT LOOP DRAWING NO. _____

☐ INSTALLATION CORRECT PER DETAIL NO. _____

☐ ACCESSORIES ARE PRESENT AND PROPERLY INSTALLED

☐ INSTRUMENT IS ACCESSIBLE FOR MAINTENANCE OR REMOVAL

☐ ENGRAVED LAMINATED NAMEPLATE (NO SPELLING ERRORS) PERMANENTLY INSTALLED

FIELD CALIBRATION CHECK				
INPUT RANGE =			OUTPUT RANGE =	
% CALIB SPAN	DESIRED VALUE	ACTUAL VALUE	EXPECTED VALUE	ACTUAL VALUE
0				
50				
100				

		TRANSMITTER/CONTROLLER/INDICATOR INSTALLATION AND CALIBRATION CHECKLIST	

☐ DIRECT ☐ REVERSE

☐ ACTION VERIFIED AT 50% SPAN

☐ ACTION VERIFIED AT _____ SPAN

CONTROLLER SETTINGS

SETTING	GAIN	PB	RESET (INTEGRAL)	DERIV. (RATE)	HIGH LIMIT	LOW LIMIT	ELEV. ZERO	ZERO SUPP
PRE-TUNE								
POST-TUNE								

PRE-TUNE SETTINGS

	GAIN	PB	RESET (REPEAT/MIN)	RESET (MIN/REPEAT)	DERIVATION (MINUTES)
FLOW:	1.0	100	10	0.1	N/A
LEVEL	1.0	100	MIN.	MAX.	N/A
PRESSURE	2.0	50	2.0	0.5	N/A
TEMP.	4.0	25	0.1	10	OFF

REMARKS

_____

_____

_____

_____

_____

_____

_____

_____

_____

CHECKED BY (COMPANY) _____ ACCEPTED BY (COMPANY) _____

SIGNATURE _____ SIGNATURE _____

DATE _____ DATE _____

		ANALYZERS INSTALLATION AND CALIBRATION CHECKLIST	

☐ ☐

INSTRUMENT LOOP IS PART OF AN EQUIPMENT START UP/SHUTDOWN INTERLOCKS? NO YES

TYPE OF INSTRUMENT

_____

INSTRUMENT TAG NO. _____ SERIAL NO. _____

SERVICE DESCRIPTION

_____

CHECK BELOW, IF TRUE:

☐ BENCH CALIBRATED PER SPEC SHEET

☐ VERIFIED PER P&ID NO.

_____

☐ CORRESPONDS TO SPECIFICATION SHEET NO.

_____

☐ WIRING CORRECT PER INSTRUMENT LOOP DRAWING NO.

_____

☐ INSTALLATION CORRECT PER DETAIL NO.

_____

☐ ACCESSORIES ARE PRESENT AND PROPERLY INSTALLED

☐ INSTRUMENT IS ACCESSIBLE FOR MAINTENANCE OR REMOVAL

☐ ENGRAVED LAMINATED NAMEPLATE (NO SPELLING ERRORS) PERMANENTLY INSTALLED

REMARKS

_____

CHECKED BY (COMPANY) _____ ACCEPTED BY (COMPANY) _____

SIGNATURE _____ SIGNATURE _____

DATE _____ DATE _____

		CONTROL VALVES INSTALLATION AND CALIBRATION CHECKLIST	

☐ ☐

INSTRUMENT LOOP IS PART OF AN EQUIPMENT START UP/SHUTDOWN INTERLOCKS? NO YES

VALVE TAG NO. _____SERIAL NO. _____

☐ TRANSDUCER TAG NO. _____ SERIAL NO. _____

☐ SOLENOID TAG NO. _____ SERIAL NO. _____

☐ VOLUME BOOSTER TAG NO. _____ SERIAL NO. _____

☐ POSITIONER SERIAL NO. _____

SERVICE DESCRIPTION

_____

TRANSDUCER CHECK

INPUT RANGE =			OUTPUT RANGE =		
CALIBRATED SPAN =			CALIBRATED SPAN =		
BENCH					
SPAN	DESIRED	ACTUAL	SPAN	EXPECTED	ACTUAL
0%			0%		
50%			50%		
100%			100%		
FIELD					
SPAN	DESIRED	ACTUAL	SPAN	EXPECTED	ACTUAL
0%			0%		
50%			50%		
100%			100%		

CHECK BELOW, IF TRUE:

☐ BENCH CALIBRATED PER ABOVE

☐ VERIFIED PER P&ID NO. _____

☐ CORRESPONDS TO SPECIFICATION SHEET NO. _____

☐ VALVE SPECIFICATION NO. _____

☐ TRANSDUCER SPECIFICATION NO. _____

☐ SOLENOID SPECIFICATION NO. _____

☐ WIRING CORRECT PER INSTRUMENT LOOP DRAWING NO. _____

☐ INSTALLATION CORRECT PER INSTRUMENT INSTALLATION DETAILS_____

☐ VALVE DETAIL NO. _____

☐ TRANSDUCER DETAIL NO. _____

☐ SOLENOID DETAIL NO. _____

		CONTROL VALVES INSTALLATION AND CALIBRATION CHECKLIST	

☐ ACCESSORIES ARE PRESENT AND PROPERLY INSTALLED

☐ INSTRUMENT IS ACCESSIBLE FOR MAINTENANCE OR REMOVAL

☐ ENGRAVED LAMINATED NAMEPLATE (NO SPELLING ERRORS) PERMANENTLY INSTALLED

VALVE CHECK

FLOW CHECK	☐ PROCESS FLOW DIRECTION THRU THE VALVE IS CORRECT		
SAFETY CHECK	ON LOSS OF AIR VALVE FAILS ☐ OPEN ☐ CLOSE	ON LOSS OF POWER SOLENOID FAILS ☐ TO VENT ☐ TO VALVE	
]TRAVEL CHECK	FULL OPEN AT _____ PSI	FULL CLOSED AT _____ PSI	MEASURED TRAVEL _____ INCHES
SEATING CHECK	☐ ON BENCH ☐ IN-LINE	RESULTS	ACTUATOR BENCH SET

POSITIONER CHECK

VALVE FULL OPEN AT _____ PSI TO POSITIONER

VALVE FULL CLOSED AT _____ PSI TO POSITIONER

VOLUME BOOSTER CHECK

BYPASS VALVE (GAIN) ADJUSTING SCREW BACKED OUT _____ TURNS FROM CLOSED TO ENSURE QUICK BUT

STABLE OPERATION (TYPICALLY 1-1/2 TO 2 TURNS)

REMARKS

_____

_____

_____

_____

_____

_____

CHECKED BY (COMPANY) _____ ACCEPTED BY (COMPANY) _____

SIGNATURE _____ SIGNATURE _____

DATE _____ DATE _____

END OF SECTION

SECTION 16484
MOTOR STARTERS

PART 1 - GENERAL

1.1 SCOPE

Furnish all labor, materials, equipment, appliances, and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work:

A. Motor Control Systems.

1.2 APPLICABLE SECTIONS

A. The General Conditions, Supplementary Conditions, Special Conditions, Alternates and Addenda, applicable drawings and the technical specifications herein shall apply to all work under this Division 16, including but not limited to the following:

1. Section “Electrical General Requirement”.
2. Section “Fuses”.
3. Section “Grounding and Bonding”.
4. Section “Control Devices”.

B. The CONTRACTOR shall be familiar with all sections of these electrical specifications. He shall adapt his work to the work required of other trades to affect a complete and working system. Where this CONTRACTOR furnishes equipment, materials or installation which comprises a part of another CONTRACTOR's system, the item so furnished shall meet or exceed the requirements imposed on the other systems.

1.3 SHOP DRAWINGS/SUBMITTALS

A. Furnish complete working shop drawings of all control systems. Reference design documents for sequence, basic components, suggested piping, wiring, and dimensions. Submit manufacturer's data sheets for all equipment, devices and materials.

B. After initial review, make corrections requested and resubmit in clean format. Work only from final review set.

C. Maintain Record Drawings in the field. Clean up originals at completion of work and resubmit for OWNER's use in operation of the systems.

1.1 CONTROL DIAGRAMS

A. Control diagrams indicating the general control strategy are as shown on the Drawings. Actual circuitry will vary for the specific equipment furnished. Pilot light push-to-test wiring was omitted from the control diagrams for clarity.

B. Clarification of any function or device of any system not fully understood or recognized as being undefined should be requested from the ENGINEER during the bidding period.

1.4 CLEANING AND LUBRICATION

All equipment shall be thoroughly cleaned by the CONTRACTOR before final acceptance. The CONTRACTOR shall provide lubrication for all equipment furnished by him.

1.5 TESTING AND ADJUSTING OF SYSTEM

A. During the testing and adjusting of the various electrical, control, and instrumentation systems, the CONTRACTOR shall have a representative present and available to adjust controls as required. The integrity and accuracy of each function and control point shall be demonstrated and reported.

1.6 CODES AND STANDARDS

A. The following standards shall be considered to be part of this specification insofar as they give definitions and describe requirements and tests which equipment supplied shall meet. They shall be the latest edition, including any addenda, supplements, or revisions thereto, in effect at the time of award of the purchase order. The equipment shall also meet any laws or requirements of the city, state or other regulatory bodies having jurisdiction over such apparatus, unless otherwise specified.

1.	ANSI C57.13	Requirements for Instrument Transformers
		ANSI C89.1 (NEMA ST1) Specialty Transformers (except General Purpose Type)
3.	NEMA AB-1	Molded Case Circuit Breakers
		NEMA ICS1 General Standards for Industrial Control and Systems
		NEMA 1CS2 Industrial Control Devices, Controllers and Assemblies
6.	ANSI C1 (NFPA70)	National Electrical Code
		UL 489 Molded Case Circuit Breakers and Circuit Breaker Enclosures
8.	UL 508	Industrial Control Equipment
9.	UL 845	Standard for Motor Control Centers
10.	UL 1053	Ground Fault Sensing and Relaying Equipment
11.	MSHA	Mine Safety and Health Administration

PART 2 - PRODUCTS

2.1 MOTOR CONTROLS NOT IN MOTOR CONTROL CENTERS

A. Furnish NEMA 4X stainless steel with gasketed hinged door control cabinets to protect and conceal all control devices. Arrange components neatly to provide adequate maintenance opportunity and proper device function. Label all components, numerically code all piping and wiring. Terminate all wiring at labeled terminal blocks. Provide engraved plastic labels for all panel face devices.

2.2 MOTOR STARTERS NOT IN MOTOR CONTROL CENTER

A. Furnish stainless steel with gasketed hinged door control cabinets to protect and conceal all control devices. Arrange components neatly to provide adequate maintenance opportunity and proper device function. Label all components, numerically code all piping and wiring. Terminate all wiring at terminal blocks. Provide engraved plastic labels for all panel face devices.

A. Combination magnetic starters shall be sized as indicated on the Drawings and shall be equipped as follows:

1. Motor Circuit Protector.
2. NEMA contactor rating indicated, NEMA size 1 minimum.
3. Control power transformer sized per load installed plus 50% spare capacity. Shall include fused primary and secondary.
4. Solid state overload relay – SymCom Motor Saver 777, Square D Motor Logic Plus, or Ge Multilin, Allen Bradley or equal.
5. Pilot devices and controls as shown on Drawings.
6. NEMA rated enclosure as shown on the Drawings.

C. Manual motor starters shall have:

1. ON pilot light.
2. Overload Protection: Melting alloy type thermal overload relays where indicated or required.
3. NEMA rated enclosure as shown on the Drawings.

PART 3 - EXECUTION

3.1 WIRING

A. All control wiring, 120 volt and below, shall be installed in conduit and wiring boxes.

B. Use no wiring smaller than #14 AWG and no conduit smaller than ¾ inch.

3.2 SPARES

A. Provide one spare manual motor starter for each size and type used.

B. Provide one NEMA size 1 contactor.

END OF SECTION

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SECTION 16491

FUSES

PART 1 - GENERAL

1.1 SCOPE

A. Furnish all labor, materials, equipment, appliances, and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work:

B. Fuses.

C. Spare Fuse Cabinet.

1.2 APPLICABLE SECTIONS

A. The General Conditions, Supplementary General Conditions, Special Conditions, Alternates and Addenda, applicable drawings and the technical specifications including but not limited to the following:

1. Section “Electrical General Requirements”.

2. Section “Conductors and Cables”.

1.3 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Bussmann.

B. Other acceptable manufacturers: Gould Shawmut, Little Fuse.

C. All fuses shall be of one manufacturer. Fuses shall have a 200,000 ampere RMS symmetrical interrupting rating unless noted otherwise.

PART 2 - PRODUCTS

2.1 FUSE TYPES AND RATINGS

A. Fuses from 0 to 600 ampere for each circuit serving a single motor shall be UL Class RK5 dual-element Low Peak, LPN-RK (250 volt), LPS-RK (600 Volt).

B. All other fuses in the 0 to 600 ampere range shall be UL Class RK5, dual-element, time delay, low peak, LPN-RK (250 volt), LPS-RK (600 Volt).

C. Fuses larger than 600 ampere shall be UL Class L with time delay, Hi Cap, KRP-C.

D. High voltage fuses - see drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Motor circuits shall be fused. Fuses, 0 to 600 amperes, for 1.15 service factor motors shall be sized not exceeding 125% of motor full load amperes shown on nameplate. Fuses, 0 to 600 amperes, for all other motors shall be sized not exceeding 115% of motor full load

amperes. Fuses above 600 amperes for all motors shall be sized up to 150% of motor full load amperes. Abnormal motor starting conditions requiring over sizing shall be coordinated with motor manufacturer.

B. Spare fuses shall be furnished for all fuse types. Spares shall amount to 10% of installed fuses with a minimum of one set of each fuse type and ampere rating. The set shall equal the number of poles in the appropriate switch.

C. Provide Spare Fuse Cabinet equal to Bussmann for storing spare fuses. Mount on wall in Equipment Room as directed by the ENGINEER.

END OF SECTION

SECTION 16510
INTERIOR LUMINAIRES

PART 1 - GENERAL

1.01 SCOPE

A. Furnish all labor, materials, equipment, appliances and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work:

1. Interior luminaires and accessories.
2. Emergency lighting units.
3. Exit signs.
4. Ballasts.
5. Fluorescent lamp emergency power supply.
6. Lamps.
7. Luminaire accessories.

1.02 APPLICABLE SECTIONS

A. The General Conditions, Supplementary General Conditions, alternates and Addenda, applicable drawings and the technical specification including but not limited to the following;

B. Section “Electrical General Requirements”.

1.03 REFERENCES

A. ANSI C78.379 - Electric Lamps - Incandescent and Issued October 1993 High-Intensity Discharge Reflector Lamps - Classification of Beam Patterns.

B. ANSI C82.1 - Ballasts for Fluorescent Lamps -Specifications.

C. ANSI C82.4 - Ballasts for High-Intensity Discharge and Low Pressure Sodium Lamps (Multiple Supply Type).

D. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

E. NFPA 70 - National Electrical Code.

F. NFPA 101 - Life Safety Code.

1.04 SUBMITTALS FOR REVIEW

A. Section “Electrical General Requirements”.

B. Shop Drawings: Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

C. Product Data: Provide dimensions, ratings, and performance data.

1.05 SUBMITTALS FOR CLOSEOUT

A. Section “Electrical General Requirements”.

B. Submit manufacturer's operation and maintenance instructions for each product.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.

1.07 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Conform to requirements of NFPA 101.

C. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.08 EXTRA PRODUCTS

A. Section “Contract Closeout”.

B. Furnish 10% or a minimum of two of each lens type.

C. Furnish one case of replacement fluorescent lamps for each lamp type. Furnish two replacement lamps for each size HID lamp type and LED assembly.

D. Furnish 10% or a minimum of two of each ballast type or driver type.

PART 2 - PRODUCTS

2.01 LUMINAIRES

A. Furnish Products as scheduled.

B. Lighting Fixtures: Shall be as shown in the Lighting Fixture Schedule on the Drawings.

2.02 LAMPS

A. LAMPS: shall be provided for all lighting fixtures in accordance with the lighting fixtures schedule on the drawings. All lamps shall be new at time of final inspection and shall be manufactured by one of the following:

1. General Electric
2. Venture Lighting International
3. Phillips
4. Osram-Sylvania
5. As found in Schedules

B. Lamp Types: As specified for luminaire.

2.03 NOT USED

2.04 LED LUMINAIRE WARRANTY

A. Provide a written 5-year on-site replacement warranty for material, fixture finish, and

workmanship. On-site replacement includes transportation, removal, and installation of new products.

1. Include finish warranty to include failure and substantial deterioration such as blistering, cracking, peeling, chalking, or fading.
2. Material warranty must include:
   a. All drivers.
   b. Replacement when more than 10 percent of LED sources in any lightbar or subassembly(s) are defective or non-starting.

B. Warranty period must begin on date of beneficial occupancy. Provide the Contracting Officer with signed warranty certificates prior to final payment.

2.05 PROVIDE LUMINAIRE USEFUL LIFE CERTIFICATE

A. Submit certification from the manufacturer indicating the expected useful life of the luminaires provided. The useful life must be directly correlated from the IES LM-80 test data using procedures outlined in IES TM-21. Thermal properties of the specific luminaire and local ambient operating temperature and conditions must be taken into consideration.

2.06 LUMINAIRES

A. UL 1598, NEMA C82.77, and UL 8750. Provide luminaires as indicated in luminaire schedule and NL plates or details on project plans. Provide luminaires complete with light sources of quantity, type, and wattage indicated. Provide all luminaires of the same type by the same manufacturer. Luminaires must be specifically designed for use with the driver, ballast or generator and light source provided.

2.07 LED LUMINAIRES

A. Provide luminaires complete with power supplies (drivers) and light sources. Provide design information including lumen output and design life in luminaire schedule on project plans for LED luminaires. LED luminaires must meet the minimum requirements in the following table:

B. LED luminaires must also meet the following minimum requirements:

LUMINAIRE TYPE	MINIMUM LUMINAIRE EFFICACY (LE)	MINIMUM COLOR RENDERING INDEX (CRI)
LED TROFFER – 1 x 4300 x 1200 2 x 2600 x 600 2 x 4600 x 1200	90 LPW	80
LED Downlight	50 LPW	90
LED Track or Accent	40 LPW	80
LED Low Bay/High Bay	80 LPW	70
LED Linear Ambient	80 LPW	80

a. Luminaires must have a minimum 5-year manufacturer's warranty.

b. Luminaires must have a minimum L70 lumen maintenance value of 50,000 hours as calculated by IES TM-21, with data obtained per IES LM-80

requirements.

c. Luminaire drive current value must be identical to that provided by test data for luminaire in question.

d. Luminaires must be tested to IES LM-79 and IES LM-80 standards, with the results provided as required in the Submittals paragraph of this specification.

2.08 NOT USED

2.09 NOT USED

2.10 NOT USED

2.11 LUMINAIRES FOR HAZARDOUS LOCATIONS

In addition to requirements stated herein, provide LED luminaires for hazardous locations which conform to UL 844 or which have Factory Mutual certification for the class and division indicated.

2.12 DRIVERS, BALLASTS AND GENERATORS

2.13 LED DRIVERS

NEMA SSL 1, UL 8750. LED drivers must be electronic, UL Class 1, constant-current type and comply with the following requirements:

a. Output power (watts)and luminous flux (lumens) as shown in luminaire schedule for each luminaire type to meet minimum luminaire efficacy (LE) value provided.

b. Factor (PF) greater than or equal to 0.9 over the full dimming range when provided.

c. Current draw Total Harmonic Distortion (THD) of less than 20 percent.

d. Class A sound rating.

e. Operable at input voltage of 120-277 volts at 60 hertz.

f. Minimum 5-year manufacturer's warranty.

g. RoHS compliant.

h. Integral thermal protection that reduces or eliminates the output power if case temperature exceeds a value detrimental to the driver.

i. UL listed for dry or damp locations typical of interior installations.

j. Non-dimmable, or fully-dimmable to 1% using 0-10V, or 3 wire, control as indicated in luminaire schedule and on drawings.

2.14 NOT USED

2.15 NOT USED

2.16 LIGHT SOURCES

NEMA ANSLG C78.377, NEMA SSL 3. Provide type and wattage as indicated in luminaire schedule on project plans.

A. LED Light Sources

a. Correlated Color Temperature (CCT) of 3000 or 4000 degrees K as indicated.

b. Minimum Color Rendering Index (CRI) R9 value of 80.

c. High power, white light output utilizing phosphor conversion (PC) process or mixed system of colored LEDs, typically red, green and blue (RGB).

d. RoHS compliant.

e. Provide light source color consistency by utilizing a binning tolerance within a 3 step McAdam ellipse.

2.17 CONTROLS

A. Dual Technology Wall Mounted Occupancy Sensors: Spaces indicated on drawings shall be equipped with a dual technology occupancy sensor DT-100L as manufacturer by Wattstopper. The sensors shall be connected to a power supply as specified above. The sensor shall comply with the following specifications:

a. Shall utilize PIR and Ultrasonic technologies with an adjustable integrated light level sensor for 2.5 to 430 foot-candles. The output shall be a single-pole, double-throw isolated relay.

b. Shall utilize 40Khz +/- .006% ultrasonic frequency.

c. Shall provide an adjustable time delay of 15 seconds to 15 minutes and an LED indicator for both technologies.

d. Shall provide adjustable sensitivities, and shall be capable of installing two units per power pack.

e. Shall be UL listed with a 5 year warranty.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install suspended luminaires using pendants supported from swivel hangers. Provide pendant length required to suspend luminaire at indicated height.

B. Support luminaires independent of ceiling grid, if layin type ceilings or concealed spline ceilings ore used.

C. Locate recessed ceiling luminaires as indicated on reflected ceiling plan.

D. Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.

3.02 INSTALLATION OF LIGHTING FIXTURES

A. Install all lighting fixtures complete and ready for service, in accordance with the Fixture Schedule on the Drawings:

B. Wire all fixtures with fixture wiring of at least 150 degree C rating. Conductors in wiring channels of fixtures mounted in rows shall be the same size as the circuit wiring supplying the rows.

C. Install all fluorescent fixtures straight and true with reference to adjacent walls.

D. Install all lighting fixtures, including those mounted in continuous rows, so that the weight of the fixture is supported either directly or indirectly by a sound and safe structural member of the building, using adequate number and type of fasteners to ensure a safe installation. Screwed fastenings and toggles through ceiling or wall material are not acceptable. Provide suitable connectors or collars to connect adjoining fixtures in continuous rows.

E. Do not support fixtures from roof deck. Provide unistrut channels spanning space between roof joists to support fixtures and outlets.

F. Fixtures mounted in lay-in grid ceilings shall have safety support wires to structural roof members as detailed for seismic restraint.

G. All single outlets shall be properly centered in each room. Where two or more outlets occur, they shall be spaced uniformly and in straight lines with each other.

H. Provide plaster frames and support channels around ceiling openings for recessed fixtures. Securely fasten to ceiling structural members.

I. Terminate circuits for recessed fixtures in an extension outlet box adjacent to ceiling opening and connect to fixtures with flexible steel conduit.

J. Where lighting fixtures and other electrical items are shown in conflict with locations and structural members and mechanical or other equipment, provide all required supports and wiring to clear the encroachment.

3.03 ADJUSTING

A. Section “Contract Closeout”.

3.04 CLEANING

A. Contract Closeout: Cleaning installed work.

B. Clean electrical parts to remove conductive and deleterious materials.

C. Remove dirt and debris from enclosures.

D. Clean photometric control surfaces as recommended by manufacturer.

E. Clean finishes and touch up damage.

3.05 DEMONSTRATION AND INSTRUCTIONS

A. Section “Contract Closeout” - Starting of Systems: Demonstrating installed work.

B. Demonstrate luminaire operation for 12 hours.

3.06 PROTECTION OF FINISHED WORK

A. Re-lamp or repair/replace luminaires that have failed at substantial completion.

END OF SECTION

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SECTION 16520
AREA LIGHTING

PART 1 - GENERAL

1.01 SCOPE

A. Furnish all labor, materials, equipment, appliances and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work: Exterior area, façade and landscape lighting.

1.02 APPLICABLE SECTIONS

A. The General Conditions, Supplementary General Conditions, alternates and Addenda, applicable drawings and the technical specification including but not limited to the following;

B. Section “Electrical General Requirements”.

1.03 REFERENCES

(NEW)

1.04 SUBMITTALS FOR REVIEW

A. Section “Electrical General Requirements”.

B. Shop Drawings: Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

C. Product Data: Provide dimensions, ratings, and performance data.

1.05 SUBMITTALS FOR CLOSEOUT

A. Section “Electrical General Requirements”.

B. Submit manufacturer's operation and maintenance instructions for each product.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.

1.07 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Conform to requirements of NFPA 101.

C. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.08 EXTRA PRODUCTS

A. Section 260500 - Contract Closeout.

B. Furnish 10% or a minimum of two of each lens type.

C. Furnish one case of replacement fluorescent lamps for each lamp type. Furnish replacement lamps for each size HID lamp type and LED assembly.

D. Furnish 10% or a minimum of two of each ballast type or driver type.

1.09 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 189.1	(2014) Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - IP	(2013) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - SI	(2013) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2013) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM B108/B108M	(2015) Standard Specification for Aluminum-Alloy Permanent Mold Castings
ASTM B117	(2016) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM C1089	(2013) Standard Specification for Spun Cast Prestressed Concrete Poles
ASTM G154	(2016) Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

CALIFORNIA ENERGY COMMISSION (CEC)

CEC Title 24	(2008; Effective Jan 2010) California's Energy Efficiency Standards for Residential and Nonresidential Buildings

ILLUMINATING ENGINEERING SOCIETY (IES)

IES HB-10	(2011; Errata 2015) IES Lighting Handbook
IES LM-79	(2008) Electrical and Photometric Measurements of Solid-State Lighting Products
IES LM-80	(2015) Measuring Lumen Maintenance of LED Light Sources
IES RP-16	(2010; Addendum A 2008; Addenda B 2009; Addendum C 2016) Nomenclature and Definitions for Illuminating Engineering
IES RP-8	(2014) Roadway Lighting
IES TM-15	(2011) Luminaire Classification System for Outdoor Luminaires
IES TM-21	(2011; Addendum B 2015) Projecting Long Term Lumen Maintenance of LED Light Sources

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI ANSLG C78.41	(2006) For Electric Lamps--Guidelines for Low-Pressure Sodium Lamps
ANSI ANSLG C78.42	(2009; R 2016) For Electric Lamps: High-Pressure Sodium Lamps
ANSI C136.13	(2004; R 2009) American National Standard for Roadway Lighting Equipment, Metal Brackets for Wood Poles
ANSI C136.21	(2014) American National Standard for Roadway and

	Area Lighting Equipment - Vertical Tenons Used with Post-Top-Mounted Luminaires
ANSI C136.3	(2014) American National Standard for Roadway and Area Lighting Equipment Luminaire Attachments
ANSI C78.1381	(1998) American National Standard for Electric Lamps - 250-Watt, 70 Watt, M85 Metal-Halide Lamps
ANSI C82.4	(2002) American National Standard for Ballasts for High-Intensity-Discharge and Low-Pressure Sodium (LPS) Lamps (Multiple-Supply Type)
ANSI/ANSLG C78.43	(2013) American National Standard for Electric Lamps - Single-Ended Metal-Halide Lamps
ANSI/NEMA C78.LL 1256	(2003; R 2015) Procedures for Fluorescent Lamp Sample Preparation and the Toxicity Characteristic Leaching Procedure (TCLP)
NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ANSLG C78.377	(2015) American National Standard for Electric Lamps— Specifications for the Chromaticity of Solid State Lighting Products
NEMA ANSLG C78.380	(2007) Electric Lamps - High Intensity Discharge Lamps, Method of Designation
NEMA ANSLG C78.44	(2008) For Electric Lamps - Double-Ended Metal Halide Lamps
NEMA ANSLG C82.11	(2011) Lamp Ballasts - High-Frequency Fluorescent Lamp Ballasts
NEMA ANSLG C82.14	(2006) Lamp Ballasts Low-Frequency Square Wave Electronic Ballasts -- for Metal Halide Lamps
NEMA C136.10	(2010) American National Standard for Roadway and Area Lighting Equipment-Locking-Type Photocontrol Devices and

	Mating Receptacles--Physical and Electrical Interchangeability and Testing
NEMA C136.20	(2012) American National Standard for Roadway and Area Lighting Equipment - Fiber Reinforced Composite (FRC) Lighting Poles
NEMA C136.31	(2010) American National for Roadway and Area Lighting Equipment - Luminaire Vibration
NEMA C78.LL 3	(2003; R 2015) Electric Lamps - Procedures for High Intensity Discharge Lamp Sample Preparation and the Toxicity Characteristic Leaching Procedure
NEMA C82.77	(2002) Harmonic Emission Limits - Related Power Quality Requirements for Lighting Equipment
NEMA ICS 2	(2000; R 2005; Errata 2008) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2011) Industrial Control and Systems: Enclosures
NEMA IEC 60529	(2004) Degrees of Protection Provided by Enclosures (IP Code)
NEMA WD 7	(2011; R 2016) Occupancy Motion Sensors Standard

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1029	(1994; Reprint Dec 2013) High-Intensity-Discharge Lamp Ballasts
UL 1310	(2011; Reprint Dec 2014) UL Standard for Safety Class 2 Power Units
UL 1598	(2008; Reprint Oct 2012) Luminaires

UL 773	(1995; Reprint Jul 2015) Standard for Plug-In, Locking Type Photocontrols for Use with Area Lighting
UL 773A	(2016) Standard for Nonindustrial Photoelectric Switches for Lighting Control
UL 8750	(2015; Reprint Nov 2016) UL Standard for Safety Light Emitting Diode (LED) Equipment for Use in Lighting Products
UL 916	(2007; Reprint Aug 2014) Standard for Energy Management Equipment
UL 935	(2001; Reprint Aug 2014) Standard for Fluorescent-Lamp Ballasts

1.10 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.11 LED LUMINAIRE WARRANTY

Provide Luminaire Useful Life Certificate.

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

a. Provide a written five year on-site replacement warranty for material, fixture finish, and workmanship. On-site replacement includes transportation, removal, and installation of new products.

    1. Finish warranty shall include warranty against failure and against substantial deterioration such as blistering, cracking, peeling, chalking, or fading.

    2. Material warranty shall include:

        (a) All power supply units (drivers).

        (b) Replacement when more than 10 percent of LED sources in any lightbar or subassembly(s) are defective or non-starting.

b. Warranty period must begin on date of beneficial occupancy. Contractor shall provide the

Contracting Officer signed warranty certificates prior to final payment.

1.13 ELECTRONIC BALLAST/DRIVER WARRANTY

Furnish the electronic ballasts/drivers manufacturer's warranty. The warranty period shall not be less than five (5) years from the date of manufacture. Ballast/driver assembly in the lighting fixture, transportation, and on-site storage shall not exceed twelve (12) months, thereby permitting four (4) years of the five (5) year warranty to be in service and energized. The warranty shall state that the malfunctioning ballast/driver shall be exchanged by the manufacturer and promptly shipped to the using Government facility.

The replacement ballast/driver shall be identical to, or an improvement upon, the original design of the malfunctioning ballast.

PART 2 - PRODUCT

2.01 LUMINAIRES

A. Furnish Products as scheduled.

B. Lighting Fixtures: Shall be as shown in the Lighting Fixture Schedule on the Drawings.

2.02 GENERAL REQUIREMENTS

A. Housings for luminaires shall be die cast, extruded, or fabricated aluminum. Fabricated aluminum housings shall have all seams and corners internally welded to resist weathering, moisture and dust.

B. Luminaires shall be rated for operation within an ambient temperature range of minus 30 degrees C minus 22 degrees F to[40 degrees C 104 degrees F][50 degrees C 122 degrees F].

C. Luminaires shall be UL listed for wet locations per UL 1598. Optical compartment for LED luminaires shall be sealed and rated a minimum of IP65 per NEMA IEC 60529.

D. LED luminaires shall produce a minimum efficacy as shown in the following table, tested per IES LM-79. Theoretical models of initial raw LED lumens per watt are not acceptable.

Application	Luminaire Efficacy in Lumens per Watt
Exterior Pole/Arm-Mounted Area and Roadway Luminaires	65
Exterior Pole/Arm-Mounted Decorative Luminaires	65

Exterior Wall-Mounted Area Luminaires	60
Bollards	35
Parking Garage Luminaires	70

E. Luminaires shall have IES distribution and NEMA field angle classifications as indicated in luminaire schedule on project plans per IES HB-10.

F. Housing finish shall be baked-on enamel, anodized, or baked-on powder coat paint. Finish shall be capable of surviving ASTM B117 salt fog environment testing for 2500 hours minimum without blistering or peeling.

G. Luminaires shall be fully assembled and electrically tested prior to shipment from factory.

H. The finish color shall be as indicated in the luminaire schedule or detail on the project plans.

I. Luminaire arm bolts shall be 304 stainless steel or zinc-plated steel.

J. Lenses shall be constructed of clear or frosted tempered glass polycarbonate vandal-resistant lenses as indicated.

K. The wiring compartment on pole-mounted, street and area luminaires must be accessible without the use of hand tools to manipulate small screws, bolts, or hardware.

L. Incorporate modular electrical connections, and construct luminaires to allow replacement of all or any part of the optics, heat sinks, power supply units, ballasts, surge suppressors and other electrical components using only a simple tool, such as a manual or cordless electric screwdriver.

M. Luminaires shall have a nameplate bearing the manufacturer's name, address, model number, date of manufacture, and serial number securely affixed in a conspicuous place. The nameplate of the distributing agent will not be acceptable.

2.03 LUMINAIRE LIGHT SOURCES

2.04 LED LIGHT SOURCES

A. Correlated Color Temperature (CCT) shall be in accordance with NEMA ANSLG C78.377:

1. Nominal CCT: 4000 degrees K: 3985 plus or minus 275 degrees K

B. Color Rendering Index (CRI) shall be:

1. Greater than or equal to [70] [__] for 4000 degrees K light sources.

C. Color Consistency:

1. Manufacturer shall utilize a maximum 4-step MacAdam ellipse binning tolerance for color consistency of LEDs used in luminaires.

2.05 LUMINAIRE DRIVERS

A. LED POWER SUPPLY UNITS (DRIVERS)

B. UL 1310. LED Power Supply Units (Drivers) shall meet the following requirements:

1. Minimum efficiency shall be 85 percent.
2. Drive current to each individual LED shall not exceed 600 mA, plus or minus 10 percent.
3. Shall be rated to operate between ambient temperatures of minus 30 degrees C minus 22 degrees F and 40 degrees C 104 degrees F[50 degrees C 122 degrees F].
4. Shall be designed to operate on the voltage system to which they are connected, typically ranging from 120 V to 480 V nominal.
5. Operating frequency shall be: 50 or 60 Hz.
6. Power Factor (PF) shall be greater than or equal to 0.90.
7. Total Harmonic Distortion (THD) current shall be less than or equal to 20 percent.
8. Shall meet requirements of 47 CFR 15, Class B.
9. Shall be RoHS-compliant.
10. Shall be mounted integral to luminaire. Remote mounting of power supply is not allowed.

11. Power supplies in luminaires mounted under a covered structure, such as a canopy, or where otherwise appropriate shall be UL listed with a sound rating of A.

12. Shall be dimmable, and compatible with a standard dimming control circuit of 0 - 10V or other approved dimming system.

13. Shall be equipped with over-temperature protection circuit that turns light source off until normal operating temperature is achieved.

2.06 LED LUMINAIRE SURGE PROTECTION

A. Provide surge protection integral to luminaire to meet C Low waveforms as defined by IEEE C62.41.2, Scenario 1, Location Category C.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install luminaires as detailed on the drawings or to poles as directed.

3.02 INSTALLATION OF LIGHTING FIXTURES

A. Install all lighting fixtures complete and ready for service, in accordance with the Fixture Schedule on the Drawings:

B. Wire all fixtures with fixture wiring of at least 150 degree C rating.

C. Install all fixtures straight and true with site equipment, sidewalks, etc.

3.03 ADJUSTING

A. Section “Contract Closeout”.

3.04 CLEANING

A. Section “Contract Closeout”: Cleaning installed work.

B. Clean electrical parts to remove conductive and deleterious materials.

C. Remove dirt and debris from enclosures.

D. Clean photometric control surfaces as recommended by manufacturer.

E. Clean finishes and touch up damage.

3.05 DEMONSTRATION AND INSTRUCTIONS

A. Section “Contract Closeout” - Starting of Systems: Demonstrating installed work.

B. Demonstrate luminaire operation for 12 hours.

3.06 PROTECTION OF FINISHED WORK

A. Re-lamp or repair luminaires that have failed at substantial completion.

3.07 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.08 FIELD QUALITY CONTROL

Upon completion of installation, verify that equipment is properly installed, connected, and adjusted. Conduct an operating test after 100 hours of burn-in time to show that the equipment operates in accordance with the requirements of this section.

END OF SECTION

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SECTION 16700

INSTRUMENTS GENERAL

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish, install, test, and place in operation process instrumentation (flow elements, level transmitters, etc.) as scheduled herein together with all signal converters, transmitters, isolators, amplifiers, etc. to interface with all instrumentation, panels, controls, and process equipment control panels with the process control system as shown on the Drawings and as specified. Mounting of associated transmitters, indicators, power supplies, brackets, and appurtenances shall be provided as specified herein and shown on the Drawings.

B. It is the intent of this Specification and the Contract Documents that all process taps, isolation valves, nipples, penetrations, embedded instrumentation supports, conduit, wiring, terminations, and the installation of the process instrumentation on process lines shall be provided under this Contract.

C. Taps and connections for primary process sensors shall be sized to suit each individual installation and the requirements of the instrument served. It is the Contractor's responsibility to ensure that the location, supports, orientation, and dimensions of the connections and taps for instrumentation as such as to provide the proper bracing, the required accuracy of measurement, protection of the sensor from accidental damage, and accessibility for maintenance while the plant is in operation. Isolation valves shall be provided at all process taps.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Process Control and Instrumentation Systems

B. Division 16.

1.3 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
API RP550	Manual on Installation of Refinery Instruments and Control Systems, Part I – Sections 1 Through 13
ISA S20	Specification Forms for Process Measurement and Control Instrumentation, Primary Elements, and Control Valves
ISA S51.1	Process Instrumentation Terminology

1.4 GENERAL INFORMATION AND DESCRIPTION

A. These Specifications are intended to give a general description of what is required, but do not cover all details which will vary in accordance with the requirements of the equipment furnished.

They are, however, intended to cover the furnishing, the shop testing, the delivery, and complete installation and field testing of all instruments and appurtenances whether specifically mentioned in the Specification or not.

B. The instruments shall be furnished and installed with all necessary accessory equipment and auxiliaries whether specifically mentioned in these Specifications or not. The installations shall incorporate the highest standards for the type of service shown on the Drawings including loop testing of the entire installation and instruction of operating personnel in the care, operation, calibration, and maintenance of all instrumentation.

C. All instrumentation shall be of first class workmanship and shall be entirely designed and suitable for the intended services. All materials used in fabricating the equipment shall be new and undamaged.

PART 2 - PRODUCTS

2.1 GENERAL

A. All instrumentation supplied shall be the manufacturer's latest design. Unless otherwise specified, all instruments shall be solid state, electronic, using enclosures to suit specified environmental conditions. Microprocessor-based equipment shall be supplied unless otherwise specified. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks as shown on the Drawings or as required.

B. Equipment installed in hazardous areas shall meet Class, Group, and Division as shown on the Drawings, to comply with the National Electric Code.

C. All instruments shall return to accurate measurement without manual resetting upon restoration of power after a power failure.

D. Unless otherwise shown or specified, local indicators shall be provided for all instruments. Where instruments are located in inaccessible locations, local indicators shall be provided and shall be mounted as specified in paragraph 3.1.B. All indicator readouts shall be linear in process units. Readouts of 0-100% shall not be acceptable, except for speed and valve position. Floating outputs shall be provided for all transmitters.

E. Unless otherwise specified, field instrument and power supply enclosures in corrosive environments shall be 316 stainless steel, fiberglass, or PVC coated copper free cast aluminum NEMA 4X construction.

F. Where separate elements and transmitters are required, they shall be fully matched, and unless otherwise noted, installed adjacent to the sensor. Special cables or equipment shall be supplied by the associated equipment manufacturer.

G. Electronic equipment shall utilize printed circuitry and shall be coated (tropicalized) to prevent contamination by dust, moisture, and fungus. Solid-state components shall be conservatively rated for long term performance and dependability over ambient atmospheric fluctuations. Ambient conditions shall be –15 to 50 degrees C and 10 to 100 percent relative humidity, unless otherwise specified. Field mounted equipment and system components shall be designed for installation in dusty, humid, and corrosive service conditions.

H. All devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and shall consist of equipment models which are currently in production. All equipment provided, where applicable, shall be of modular construction and shall be capable of field expansion.

I. All non-loop powered instruments and equipment shall be designed to operate on a 60 Hz alternating current power source at a nominal 117 V, plus or minus 10 percent, except where specifically noted. All regulators and power supplies required for compliance with the above shall be provided. Where equipment requires voltage reduction, constant voltage transformers shall be supplied.

J. All analog transmitter and controller outputs shall be isolated, 4-20 milliamps into a load of 0-750 ohms, unless specifically noted otherwise. All switches shall have double-pole, double-throw contacts rated at a minimum of 600 VA, unless specified otherwise.

K. Materials and equipment used shall be U.L. approved wherever such approved equipment and materials is available.

2.2 ACCESSORIES

A. Isolation Valves – Valves shall be full port ball valves with ASTM A276, Type 316 stainless steel trim and body and with Teflon seats and packing. Valves shall be Parker CPI, Whitey, Hoke, or equal.

B. Gage Valves – Gage valves shall be machined from ASTM A276 bar stock and shall be provided with 1/2-inch NPT connections and integral bleed valve. Valves shall be Anderson, Greenwood & Company M9530, Hoke 6801L8Y, or equal.

C. Root Valves – Root valves shall be ASTM A276, Type 316 stainless steel bar stock with 1/2-inch NPT male process connection and three 1/2-inch NPT female instrument connections. One instrument connection shall be provided with an ASTM A276, Type 316 stainless steel bleed valve. ASTM A276, Type 316 stainless steel plugs shall be provided for unused ports. Lagging type units shall be provided for insulated vessels and pipes. Root valves shall be Anderson, Greenwood & Company M5 AVS-44, Hoke 6802L8Y, or equal.

D. Manifolds – Manifolds shall be three-valve bar-stock type. Manifold body shall be machined from 316 stainless steel bar stock. Valves shall be globe configuration with 316 stainless steel ball seats and Teflon stem packing. Manifolds shall be designed for direct mounting to differential pressure transmitters in place of the flanges normally furnished. Fabricated manifolds or manifolds employing needle or soft seat valves are not acceptable. Purge taps, 1/8-inch NPT shall be furnished on manifolds where water purge is specified. Manifolds shall be Anderson Greenwood M4TVS, Hoke 8123F8Y, or equal.

E. Tubing – Instrument tubing between the process connection and instruments shall be 1/2-inch x 0.065-inch seamless annealed ASTM A269, Type 316 stainless steel. Tubing fittings shall be Type 316 stainless steel. Fittings shall be of the swage ferrule design and shall have components (nut, body and ferrule system) interchangeable with those of at least one other manufacturer. Flare and ball sleeve compression type are not acceptable. Fittings shall be Parker CPI, Crawford Swagelok, Hoke Gyrolok, or equal.

F. Chemical Seals

1. Diaphragm – Seal shall be the diaphragm type with flushing connection, Type 316 stainless steel body and Type 316L diaphragm unless otherwise specified. Seal shall be Mansfield and Green Type SG, Ashcroft Type 101, or equal.

2. Annular Ring – Seal shall be the in-line full stream captive sensing liquid type. Metallic wetted parts shall be Type 316 stainless steel. Flexible cylinder shall be Buna-N unless otherwise specified. Seals shall be rated 200 psig with not more than 5-inch WC hysteresis. Seals shall be Ronningen-Petter Iso-Ring, Red Valve series 40, or equal.

3. Fill Fluid – Chemical seals and associated instruments shall be factory filled as follows: Instrument side of seal, capillary tubing, and instrument shall be evacuated to an absolute pressure of 1.0 Torr or less; filled; and sealed. Unless otherwise specified, fill fluid shall be silicone oil, Dow Corning DC200, Syltherm 800, or equal.

G. Bushings and Thermowells – Bushings or thermowells shall comply with SAMA PMC17-10. Temperature taps shall be 1/2-inch NPT, and lagging extensions shall be provided on insulated vessels or pipes. Thermowells and bushings shall be machined from Type 316 stainless steel bar stock unless otherwise specified.

H. Purge Assemblies

1. Air – Air purge assembly shall consist of a constant-differential relay, needle valve, check valve and 0.2 to 2.0 scfh rotameter. Assembly shall be Moore Products 62VA, Fischer & Porter 10A3137N-3BR2110, or equal.

2. Water – Water purge assembly shall consist of a strainer, constant-differential regulator, needle valve, check valve, and 20 to 200 cc/m rotameter. Assembly shall be Moore Products 63BD4A, Fischer & Porter 10A3137N-53BR2110, or equal. Strainer shall be 155 micron wye-type, ASCO 8600A2, Crane, or equal.

2.3 POWERED INSTRUMENTS GENERAL REQUIREMENTS

A. Powered instruments are those instruments which require power (120 VAC or 24 VDC loop power) to operate. Each instrument includes an element or analyzer and a transmitter/controller.

B. Transmitters shall be 4 to 20 milliampere output two-wire type with operating power derived from the transmission circuit. Transmitter shall support an external load of 0 to 600 ohms or greater without requiring trimming resistors with a transmission circuit power supply of 24 volts. Transmitter output shall be galvanically isolated from the process and the transmitter case. Time constant of transmitters used for flow or pressure measurement, including level transmitters used for flow measurement, shall be adjustable from 0.5 to 5.0 seconds. Transmitter output shall increase with increasing measurement except where "reverse action" is specified in the instrument schedule.

C. Electrical parts of transmitter and/or primary element mechanisms shall, as a minimum be housed in enclosures meeting NEMA 250, Type 4 requirements. Where electrical mechanisms are located outdoors or in areas specified as corrosive, enclosures shall meet NEMA 250, Type 4X requirements.

D. Transmitters located outdoors shall be provided with surge protectors: Rosemount Model 470A, Taylor 1020FP, or equal.

E. Where two-wire transmitter is located in an area classified as hazardous, it shall be made safe by means of an intrinsic safety barrier. Intrinsic safety barriers for two-wire transmitters shall be of the active, isolating, loop powered type. Barrier shall be Measurement Technology LTD. type MT3042, Stahl 9005/01-252/100/00, or equal.

F. Where four-wire transmitters are permitted, they shall be provided with a loop powered signal current isolator connected in the output signal circuit. Isolator shall provide galvanic isolation of milliampere transmission signals from transmitters with inadequately isolated output circuits. Isolator shall be housed in a NEMA 250, type 4/7 conduit body and shall derive its operating power from the signal input circuit. Input and output signals shall be 4 to 20 milliamperes, and error shall not exceed 0.1 percent of span. Input resistance shall not exceed 550 ohms with an output load of 250 ohms. Isolator shall be Moore Industries SCX/4-20MA/ 4-20/MA/6.5DC/-RF(EX).

2.4 PROCESS SWITCHES GENERAL REQUIREMENTS

A. Contact outputs used for alarm actuation shall be ordinarily closed and shall open to initiate the alarm. Contact outputs used to control equipment shall be ordinarily open and shall close to start the equipment. Contacts monitored by solid state equipment such as programmable controllers or annunciators shall be hermetically sealed and designed for switching currents from 20 to 100 mA at 24 volts DC. Contacts monitored by electromagnetic devices such as mechanical relays shall be rated NEMA ICS 2, designation B300. Double barriers shall be provided between switch elements and process fluids such that failure of one barrier will not permit process fluids into electrical enclosures. Switch electrical enclosures shall be rated NEMA 250, type 4 minimum. Contacts in Class 1, Division 1 areas and monitored by solid-state circuits shall be made safe by suitable intrinsic safety barriers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General – Equipment shall be located so that it is accessible for operation and maintenance. Electrical work shall be performed in compliance with all applicable local codes and practices. Where these specifications and the Drawings do not delineate precise installation procedures, API RP550 shall be used as a guide to installation procedures.

B. Equipment Mounting and Support

1. Field equipment shall be wall mounted or mounted on two-inch diameter aluminum pipe stands welded to a 10-inch square, ½-inch thick aluminum steel baseplate. Instruments attached directly to concrete shall be spaced out from the mounting surface not less than ½-inch by use of phenolic spacers. Expansion shields in walls shall be used for securing equipment or wall supports to concrete surfaces. Unless otherwise noted, field instruments shall be mounted between 48 and 60 inches above the floor or work platform.

2. Embedded pipe supports and sleeves shall be schedule 40, 304 stainless steel pipe, with stainless steel blind flange for equipment mounting as shown on the Drawings.

3. Materials for miscellaneous mounting brackets and supports shall be 304 stainless steel.

4. Pipe stands, mounting brackets, and supports shall comply with the requirements of Division 5.

5. Where transmitters are supported from process piping, leveling saddles shall be provided. Transmitters shall be oriented such that output indicators are readily visible.

C. Control and Signal Wiring – Electrical, control, and signal wiring connections to transmitters and elements mounted on process piping or equipment shall be made through liquid-tight flexible conduit. Conduit seals shall be provided where conduits pass from classified to unclassified areas.

3.2 CLEANING AND ADJUSTMENT

A. General

1. The Contractor shall comply with the requirements of Division 1 and all instrumentation and control system tests, inspection, and calibration requirements for all instrumentation and controls provided under this Contract and specified herein. The Engineer, or his designated representative(s), reserve the right to witness any test, inspection, calibration, or start-up activity. Acceptance by the Engineer of any plan, report, or documentation relating to any testing or commissioning activity specified herein shall not relieve the Contractor of his responsibility for meeting all specified requirements.

. The Contractor shall provide the services of factory trained technicians, tools, and equipment to field calibrate, test, inspect, and adjust each instrument to its specified performance

requirement in accordance with manufacturer's specifications and instructions. Any instrument which fails to meet any contract requirements, or any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the Engineer, at no cost to the Owner. The Contractor shall bear all costs and provided all personnel, equipment, and materials necessary to implement all installation tests and inspection activities for equipment specified herein.

B. Field Instrument Calibration Requirements

1. Each instrument shall be calibrated at 0, 25, 50, 75, and 100 percent of span using test instruments to simulate inputs and read outputs. Test instruments shall be rated to an accuracy of at least five times greater than the specified accuracy of the instrument being calibrated. Where applicable, such test instruments shall have accuracies as set forth by the National Bureau of Standards.
2. The Contractor shall provide a written calibration sheet to the Engineer for each instrument, certifying that it has been calibrated to its published specified accuracy. This sheet shall include but not be limited to date, instrument tag numbers, calibration data for the various procedures, name of person performing the calibration, listing of published specified accuracy, permissible tolerance at each point of calibration, calibration reading as finally adjusted within tolerance, defect noted, corrective action required, and corrections made.
3. If doubt exists as to the correct method for calibrating or checking calibration of an instrument, the manufacturer's recommendations shall be used as an acceptable standard, subject to approval of the Engineer.
4. Upon completion of calibration, devices calibrated hereunder shall not be subjected to sudden movements, accelerations, or shocks, and shall be installed in permanent protected positions not subject to moisture, dirt, and excessive temperature variations. Caution shall be exercised to prevent such devices being subjected to overvoltages, incorrect voltages, overpressures, or incorrect air. Damaged equipment shall be replaced and recalibrated at no cost to the Owner.
5. Upon completion of instrumentation installation, the Contractor shall perform a loop check. The Contractor shall submit final loop test results with all instruments listed in the loop. Loop test results shall be signed by all representatives involved for each loop test.

END OF SECTION

SECTION 16706
PLC PROGRAMMING SOFTWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. General requirements for application software to be used in conjunction with the specified PLC hardware.

B. General:

1. The control system logic program shall reside at the PLC level. Software shall be provided and by installed and programmable by the Programming Contractor.

C. Related Sections:

1. Contract documents are a single integrated document, and as such all Division and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all Sections to ensure al complete and coordinated project.

1.2 SUBMITTALS

A. Furnish complete product data, operating manuals, manufacturer's certifications, and other submittals as described.

B. Additional Requirements:

1. Product Data:
   a. Programming languages.
   b. Operating system requirements.
2. Control logic:
   a. Fully annotated copy of programmed PLC logic.
   b. Cross-referenced index of all PLC registers or points.

1.3 QUALITY ASSURANCE

A. System Compatibility.

1. The software must be the standard operating software system designed specifically for use with the PLC hardware.
2. The software must be furnished and developed by the manufacturer of the PLC hardware.

1.4 WARRANTY

A. Provide extended 2 year manufacturer's warranty support as follows:

1. Dedicated technical support department or handled by programming staff or distributor.
2. Telephone hours for support shall be 24 hours, 7 days per week.
3. Email and web support addresses.
4. Document download via website.
5. Field services.

1.5 MAINTENANCE

A. Provide system upgrades and maintenance fixes for a period of two years from substation completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Programming Software: The following, not equal:
   1. As needed to program Modicon M340 PLC and selected compatible OIT.

2.2 MANUFACTURED UNIT

A. PLC Programming Software:
   1. The PLC based control system software package shall be able to monitor and/or control PLC's via the PLC data network.
      a. It shall contain diagnostics to collect troubleshooting and performance data and display it in easy to understand graphs and tables.
      b. It shall also monitor devices at each drop on the PLC data network for proper communications.
      c. It shall provide the ability to program all PLC on the PLC data network from the Engineer's Console.
   2. All PLC programming shall be accomplished using a standard software package developed for this purpose.
   3. The software package shall be installed on the hard disk of the portable PLC programming terminal, as well as the Engineers Console, EC.
   4. Operating System
      a. Microsoft Windows XP.
   5. The PLC programming software shall be suitable for the PLCs furnished under Section 17720.
   6. All programming, monitoring, searching, and editing shall be accomplished using this PLC programming software.
      a. It shall be usable both online, while connected to the PLC, and offline .

b. The PLC programming software shall display multiple series and parallel contacts, coils, timers, counters, and mathematical functions blocks.

c. The software shall be able to monitor the status of all inputs, outputs, timers, counters and coils.

d. It shall have the capability to disable/force all inputs, outputs and coils to simulate the elements of the ladder logic by means of color change.

e. It shall include a search capability to locate any address or element and its program location.

f. PLC status information, such as error indication and amount of memory remaining shall be shown on the CRT screen.

7. The PLC programming software shall support the following programming languages:

   a. Ladder diagram

   b. Function block diagram

   c. Structured text

   d. Sequential function chart

8. The PLC programming software shall have the capability to generate a PLC program printout, which is fully documented.

   a. Fully documented program listings shall have appropriate rungs, address, and coils shown with comments to clarify to a reader what the segment of the program accomplishes.

   b. There shall be a comment for each and every rung of the program explaining the control function accomplished in said rung.

   c. Each contact, coil, etc shall have a mnemonic associated with it that describes its function

   d. The Tag and Loop identification as contained in the P&IDs shall be used whenever possible. Identify each input and output with a name consistent and identifiable with the corresponding equipment.

      1) If additional internal coils, timers, etc are used for a loop they shall contain the loop number.

   e. A fully documented listing shall also include a cross-reference report of program addresses.

9. Operating system software shall function automatically without operator intervention, except as required to establish file names and similar information.

   a. The real-time operating system software shall be the standard uncorrupted product of the PLC manufacturer and shall provide the following minimum functions:

      1) Respond to demands from a program request.

2) Dynamic allocation of the resources available in the PLC. These resources shall include main memory usage, computation time, peripheral usage, and I/O channel usage.

3) Allotment of system resources on the basis of task priority levels such that a logical allocation of resources and suitable response times are assured.

4) Queuing of request in order of priority if one or more requested resources are unavailable.

5) Resolution of contending requests for the same resources in accordance with priority.

6) Service requests for execution of one program by another.

7) Transfer data between programs as requested.

8) Management of all information transfers to and from peripheral devices.

9) Control and recovery from all program fault condition.

10) Diagnose and report real-time hardware device errors.

10. Program Execution:

a. Program execution shall be scheduled on a priority basis.

1) A multilevel priority interrupt structure is required.

2) A program interrupted by a higher priority program shall be entered into a list of pending programs.

3) Its execution shall be resumed once it becomes the currently highest priority program.

4) The system shall allow periodic programs to be scheduled.

5) The allocation of resources to a time-scheduled program shall be based on its relative priority and the availability of resources.

6) Initiation of programs shall, as a minimum, be activated in the following ways:

a) In response to external interrupts.

b) At a scheduled time of the day.

c) On an elapsed time interval basis.

d) On request by another program

11. Start-up and Restart:

a. Software shall be provided which initializes and brings a PLC or any microprocessor based hardware unit from an inactive condition to a state of operational readiness.

b. Initialization shall include determination of system status prior to start -up of initializing operating system software and initializing application software.

c. Initialization shall also include the loading of all memory-resident software, initializing timers, counters, and queues, and initialization of all dynamic database values.

12. Shutdown:
    a. The software shall provide an orderly shutdown capability for shutdowns resulting from equipment failure, including PLC processor failure, primary power failure, or a manually entered shutdown command.
    b. When the loss of primary power is sensed, a high -priority hardware interrupt shall initiate software for an immediate, orderly shutdown.
    c. When a shutdown occurs in response to a command or malfunction, the software shall control the affected hardware quickly and automatically to a secure state.
    d. The failure of the PLC shall be detected at the operator interface level.
13. Diagnostics:
    a. Diagnostic programs shall be furnished with the PLC software package to detect and isolate hardware problems and assist maintenance personnel in discovering the causes for system failures.
    b. The manufacturer's standard diagnostic routines shall be used as much as possible.
    c. Diagnostic software and test programs shall be furnished for each significant component in the control system.
    d. Diagnostic routines shall test for power supply, central processing unit, memory, communications and I/O bus failures as a minimum.
14. Calendar/Time Program:
    a. The calendar/time program shall update the second, minute, hour, day, month, and year in the operating system and transfer accurate time and date information to all system level and application software.
    b. Variations in the number of days in each month and in leap years shall be handled automatically by the program.
    c. The operator shall be able to set or correct the time and date from any operator interface, only at the highest security level.
    d. The calendar/time program shall be year 2000 compliant.
15. Algorithms:
    a. PLC software shall support the implementation of algorithms for the determinations of control actions and special calculations involving analog and discrete data.
    b. Algorithms shall be capable of outputting positional or incremental control outputs or providing the product of calculations.
    c. Algorithms shall include alarm checks where appropriate.

       As a minimum, the following types of algorithms shall be provided:

       1) A calculator algorithm, which performs functions such as summing several variables, raising to a power, roots, dividing, multiplying, and subtracting.

2) A switch algorithm, which reads the current, value from its input address and stores it as the value of its output address. Two types of switches shall be accommodated, two outputs with one input and one output with two inputs.

3) A three -mode Proportional -Integral -Derivative, PID, controller

4) algorithm, with each of the three modes independently adjustable.

5) The algorithm shall support both direct and reverse acting modes.

6) Algorithms for lead, lag, dead time, and ratio compensators.

7) Algorithms to perform integration and totalization of analog process

8) variables.

d. All flow rates and run status inputs shall be totalized within the PLC/RTU registers.

B. Analog Database:

1. A comprehensive database shall be furnished for the analog inputs, calculated values, control modules, and outputs.

   a. In addition, spare database points shall be provided for future expansion.

2. One integrated database can be utilized for all types of analog points or separate databases for each type, in either case the database for each point shall include all specified aspects.

3. All portions of the database shall be available for use by the display, report, and other specified software modules.

4. All of the data fields and functions specified below shall be part of the point definition database at the operator interface. It shall be possible to define new database points through the point display specified below as well as modifying defined points through these displays. This point definition and modification shall include all of the features and functions defined below. The analog database software shall support the following functions and attributes.

   a. Analog Input Signal Types:

      1) Software shall be provided at the RTUs and PLCs to read variable voltage/current signals and pulse duration/frequency type analog input signals.

   b. Input Accuracy:

      1) Inputs shall be read with an accuracy of ±0.05 percent full scale or better.

      2) No data conversion errors shall exceed ±0.05 percent full scale.

      3) Pulse accumulation error shall not exceed :tone (1) count of actual input count at a scan rate of once a minute.

      4) The system accuracy stated above shall be maintained for a period of at least one year without adjustments.

   c. Validity Checking:

1) All analog inputs shall be checked to determine whether they are within a valid measurement range as determined by the zero and span limits of the input.

2) If a signal is outside of its valid range, a flag shall be set to indicate an over/under range condition and the signal shall be clamped at its minimum or maximum value, as appropriate.

3) The validity checking shall allow for up to 2 percent zero drift and automatically damp the signal at its maximum/minimum value if it is within this two percent range, adjustable, without setting the invalid signal flag.

4) It shall be possible to clamp a signal to its zero value based on an external event, ie. drive a pump flow signal to zero when the pump is off.

d. Blocking:

1) It shall be possible to inhibit or block the scanning and/or processing of any analog input through the operator interface.

2) For any input so blocked, it shall be possible for the operator to manually enter a value to be used as the input value.

e. Filtering:

1) Each analog input shall be provided with a first order lag digital filter with an adjustable filter factor.

f. Linearizing:

1) Where analog inputs require square root extraction or other linearization, means shall be provided to condition the filtered data before the process of scaling and zero suppression take place.

g. Calculated Values:

1) Means shall be provided to allow for pseudo-inputs calculated by algebraic and/or Boolean expressions utilizing real inputs, other calculated value, constants, etc.

2) These values shall be handled the same as real inputs in terms of record keeping, alarming, etc.

h. Scaling and Zero Suppression:

1) A conversion program shall be provided to convert input values into engineering units in a floating point format.

2) Alarms:

3) An alarm program shall be provided to check all analog variables against high-high, high, low, and low-low alarm limits.

4) When an analog value exceeds a set limit, it shall be reported as an

5) alarm based on individually set priority level for each alarm point

6) There shall be an adjustable hysteresis band in order to prevent

7) excessive alarms when a variable is hovering around an alarm limit.

8) Return to normal shall also be reported.

9) It shall be possible to inhibit alarms based on external events, ie. lock-out low pump flow alarm when the pump is off.

i. Averages:

1) There shall be provided a program to calculate and store hourly, daily, and monthly averages of analog variables.

2) Averages shall be continuously computed, ie. the average for the current period to the present point in time shall be stored in memory and available for use in displays, etc.

3) Hourly averages shall be updated each minute or at the polling interval for the selected variable.

4) Daily averages shall be updated at least once each hour and shall be calculated using the results of the hourly averages.

5) Monthly averages shall be updated at least once each day and shall be calculated using the results of the daily averages.

6) At the end of each averaging period, the average values for the period shall be stored on the hard disk for historical record keeping and the present period average register shall be reset to the present value of the variable.

7) The active database shall include the present period average and previous period average for each variable and averaging period.

j. Totals:

1) There shall be provided a program to calculate and store hourly, daily, and monthly totalization of analog variables.

2) There shall be a scaling factor assignable to each variable to convert

3) to the appropriate units based on a one-minute totalizing interval.

4) A separate factor shall be assignable for each totalizing interval.

5) Variables for which totalization is inappropriate shall have scaling

6) factors of zero.

7) At the end of each totalizing period, the totalized values for the period shall be stored on the hard disk for historical record keeping and the present period totalization register shall be reset to zero.

8) 6) The active database shall include the present period total and previous period

k. Totals

1) There shall be provided a program to determine and store the maximum and minimum values of analog variables and their time of occurrence during the hour, the day, and the month.

2) At the end of each period, the maximum and minimum values for the period shall be stored on the hard disk for historical record keeping and the present period maximum and minimum registers shall be reset to the present value of the variables.

3) The active database shall include the present period maximum and minimum values and the previous period maximum and minimum values for each variable and period.

l. Engineering Units:

1) Software shall be provided to allow the system and the operator to convert all the measured analog variables to any desired engineering units.

2) The operator shall be able to view displays and generate reports of any measured variable in one or more engineering units such as flow in GPM, MGD, CFS and Acre-Feet per day.

3) The conversion of the engineering units shall be preprogrammed, and if not pre-programmed, the operator shall be able to program new engineering unit conversions by using simple methods, ie. multiplication of the database attributes by a constant.

4) The programming method shall be at a level and compatible with the specified training of the operator and the OWNER'S personnel.

5) New conversions shall not require the services of a special programmer and/or special, high-level, programming training.

m. Control Modules:

1) For each control function configured, whether processed at the RTU, PLC, or operator interface, there shall be maintained a file of necessary data including input values, setpoints, constants, intermediate calculated values, output value and limit clamps, etc.

2) Input and output assignments, setpoints, and constants shall be adjustable by the operator through the operator interface.

3) Control algorithms shall provide for manual control and output values shall be adjustable by the operator.

n. Analog Outputs:

1) Analog outputs shall be maintained as part of the database.

2) These outputs shall be adjustable manually by the operator through the operator interface or through automatic control algorithms.

5. Some of the above functions may be better accomplished in the Data Acquisition and Graphic Display Software package, it is the responsibility of the ICSC to optimize the location of the various functions between all software packages.

C. Digital Database:

1. A comprehensive database shall be furnished for the digital inputs, calculated points, control logic, and outputs.

a. In addition, spare database points shall be provided for future expansion to match the spare I/Os.

2. One integrated database can be utilized for all types of digital points or separate databases for each type, in either case the database for each point shall include all specified aspects.
3. All portions of the database shall be available for use by the display, report, and other specified software modules.
4. All of the data fields and functions specified below shall be part of the point definition database at the operator interface.
    a. It shall be possible to define new database points through the point display specified below as well as modifying defined points through these displays. This point definition and modification shall include all of the features and functions defined below. A copy of those portions of the database that are necessary for execution at the RTU and/or PLC shall be maintained at the RTU and/or PLC. The digital database software shall support the following functions and attributes.
        1) Digital Input Signal Types:
            a) Software shall be provided to allow for single, two state, and dual, three state, inputs.
        2) Noise Rejection:
            a) Input bounce filter shall be provided through software if not furnished with input hardware.
        3) Blocking:
            a) It shall be possible to inhibit or block the scanning and/or processing of any digital input through the operator interface.
            b) For any input so blocked, it shall be possible for the operator to set the state of the input.
        4) Calculated Points:
            a) Means shall be provided to allow for pseudo-inputs calculated from boolean expressions.
        5) Status and Alarm:
            a) Each digital point shall be assigned a priority level for change of state reporting as an alarm.
        6) Totals:
            a) There shall be provided a program to calculate and store daily and monthly run time, in hours and tenths, and number of start totals of digital inputs.
            b) At the end of each totalizing period, the totalized values for the period shall be stored on the hard disk for historical record keeping and the present period totalization register shall be reset to zero.

c) The active database shall include the present period totals and the previous period totals for each input and totalizing period.

d) There shall also be provided a non-resetting, lifetime, run time and number of start totalizer provided for each input.

7) Digital Outputs:

a) Digital outputs shall be maintained as part of the database.

b) Software shall be provided to allow for single, two state, and dual, three state, output types.

c) Output change of state shall be reported as described for inputs.

d) It shall be possible for outputs to be set manually by the operator through the operator interface or automatically through control logic and sequences.

5. Some of the above functions may be better accomplished in the Data Acquisition and Graphic Display Software package, it is the responsibility of the ICSC to optimize the location of the various functions between all software packages.

D. General Control Functions

1. 1.Analog Control Functions:

a. PID, lead/lag, signal select, alarm, limit, delay, and time base.

b. The control system shall be furnished complete with a library of mathematical/calculation software to support averaging, weighted average, addition, subtraction, multiplication, division, square root extraction, exponential, AND, OR, NAND, NOR, XOR and NXOR functions.

c. All math utilities shall be linkable to process data points or manual inputs via control block configuration.

d. By linking control blocks to data points, the math library shall support system unit conversion and calculation requirements.

2. Discrete Control Functions:

a. AND, OR, NOT, EXCLUSIVE OR, comparators, delays and time base.

3. Software Support:

a. All control and logic functions shall be retained in firmware at each RTU and PLC and in RAM at the operator interface.

b. Each function shall be called as required by the configured controls to perform the intended function.

4. Control and Status Discrepancies:

a. A discrepancy/fail alarm shall be generated for any pump, valve, or final control element if a discrepancy exists between a system or operator command and the device status.

b. For example, the system commands to start (call), and the pump fails to start (run status report back), within predetermined operator programmable time delay (time disagree), then a discrepancy (fail) alarm shall be generated.

c. Involuntary change in the device's status shall also generate an alarm.

1) For example, a pump starts when not commanded to do so, or a pump shuts down while running even though it still has a command to run.

d. Each command, status and alarm shall cause the color of the symbol to change.

e. Because many discrete final control elements have a cycle time in excess of the scan interval, each control output shall have an associated delay period selected to be longer than the operating period of the control element.

1) Delay periods for each final control element shall be adjustable at the operator interface.

2) All time delays shall be listed in the final documentation.

5. Some of the above functions may be better accomplished in the Data Acquisition and Graphic Display Software package, it is the responsibility of the ICSC to optimize the location of the various functions between all software packages.

E. Control Configuration:

1. Software shall be provided to allow control strategies to be developed and their operation initiated through the operator interface.

2. Standardized control point displays shall allow for defining the control functions including the function type, input/output addresses, set points and tuning constants, etc.

3. In a similar manner, it shall be possible to link separate control functions together into an integrated control strategy.

4. It shall be possible to download operational/control set points developed at any operator interface to any PLC or RTU for operational implementation.

5. It shall also be possible to define and implement operational/control set points locally at the PLC or RTU and to upload them to the Operator interface for operational record keeping.

6. Control configurations shall be performed on-line at the operator interface, but the PLC or RTU may be taken off-line when being configured or downloaded.

2.3 SOURCE QUALITY CONTROL

PART 3 - EXECUTION

3.1 EXAMINATION

3.2 INSTALLATION

A. All tags used and/or assigned as part of the application programming work provided by the Programming Contractor shall use the Tag and Loop identifications found on the P&IDs.

3.3 TRAINING

A. The training shall be performed by pre-approved and qualified representatives of the Programming Contractor and or manufacturer of the local operator interface software. A representative of the Programming Contractor may perform the training only if the representative has completed the manufacturer's training course for the PLC programming software.

END OF SECTION

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SECTION 16707- CONTROL SYSTEMS
NETWORK EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE

A. Sections Includes

1. Materials and equipment used in process control and LAN networks including:

a. Network switches.

b. Other data network hardware.

B. Furnish a complete operating data network as indicated on the Drawings, as shown on the cable or system block diagrams; and as specified herein.

C. The process control LAN and the business office LAN shall be separate networks as shown on the Drawings. Some equipment required for the business office LAN shall be provided by the Owner at a future date.

D. Related Sections: The Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to ensure a complete and coordinated project.

1.2 REFERENCES

A. TIA/EIA Standards:

1. TIA/EIA-568-B (Series), Commercial Building Telecommunications Standards.
2. TIA/EIA-569 (Series), “Commercial Building Standard for Telecommunications Pathways and Spaces”
3. IEEE Series 802 standards.

1.3 DEFINITIONS

1.4 SUBMITTALS

A. Furnish complete Product Data, Shop Drawings, Test Reports, Operating Manuals, Record Drawings, Manufacturer’s certifications, Manufacturer’s Field Reports, and other submittals as specified.

B. Additional Requirements

1. Product Data:

a. Complete Manufacturer’s brochures for each item of equipment. Mark up to clearly show options and components to be provided, and cross out any options or components that will not be provided.

b. Include information on all test equipment.

c. Manufacturer's operation and installation instructions.

2. Shop Drawings:

a. Complete set of drawings including but not limited to:

1) System block diagram showing relationship and connections between devices provided under this Contract. Include manufacturer and model information, and address settings.

2) Network riser diagram.

3) Network port diagram, which physically locates all ports, within the facility, and identifies their patch panel and switch port.

4) Construction drawings for all equipment cabinets, including dimensions, identification of all components, preparation and finish data, nameplates.

5) Electrical connection diagrams.

6) Complete grounding requirements.

3. Test Reports

a. As noted herein.

b. Signed test results as described in Part 3 of this Section.

c. Test results shall include:

1) Narrative describing the test procedures followed.

2) Block diagram of test set up.

3) Manufacturer's information on test equipment used.

4) Detailed test results.

5) A narrative summarizing the results of the testing and identifying any further action required.

1.5 DELIVERY, STORAGE AND HANDLING

A. Store all network equipment in a dedicated structure with space conditioning to meet the recommended storage requirements provided by the manufacturer:

1. Replace any network equipment components that are not stored in strict conformance with the manufacturer's recommendation.

1.6 PROJECT OR SITE CONDITIONS

A. Network equipment shall be suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, ambient temperature, and humidity conditions.

1.7 WARRANTY

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Ethernet Switches: - Office Network -

1. Managed Enterprise Ethernet Switches:
    a. Manufacturers – One of the following:
        1) The part number shall match those existing in the treatment plant, or approved by OWNER.
2. Performance:
    a. Latency: Less than 10.2 microsecond.
    b. Switch fabric speed: 18.3 Gbps, minimum.
    c. Address Table Size: 8,000 entries, minimum.
    d. Gigabit throughput.
3. Environment:
    a. Operating Temperature Range: 32 to 131 Deg Fahrenheit.
    b. Humidity: 15 to 95 percent, non-condensing.
4. Capable of performing basic switching without special programming or configurations. Additional features available through software setup includes but not limited to:
    a. Port Monitoring.
    b. Remote switch management.
    c. Port Security.
    d. Switch Meshing.
    e. Rapid Spanning Tree protocol.
5. Capable of adding or swapping modules without interrupting the network.
6. Modules:
    a. 10/100 Base-TX:
        1) Protocl: IEEE 802.3 Type 10Base_T; 802.3u Type 100base-TX.
        2) Auto-sensing
        3) Connector: RJ-45 – CAT 6.
        4) 24 ports per module.
    b. Fiber optic 100-Base-FX.
        1) Protocl: IEEE 802.3u 100Base-FX.
        2) Full Duplex
        3) Metallic MT-RJ type connectors for use with 62.5 micron multimode optical fiber.

4) 6 ports per module

c. 100/100-Base-T:

1) Protocol: IEEE 802.3u Type 100Base; 802.3ab Type 1000Base-T.

2) Auto-sensing.

3) Connector: RJ-45 CAT 6.

4) 1 port per module.

d. Fiber Gigabit-SX:

1) Protocol: IEEE 802.3z Type 1000Base-SX.

2) Full duplex.

3) Metallic SC-type connectors for use with 62.5 micron multimode optical fiber.

e. Provide modules required to provide network connections as indicated on the Drawings.

1) As required to provide the number of connections required plus 20 percent spare ports of each type used.

7. Spare Parts:

a. Provide the following spare components:

1) One spare module of each type provided.

2) One spare Ethernet switch backplane.

3) One spare Ethernet switch power supply.

B. Ethernet Switches: - SCADA Network -

1. Process Floor Ethernet Switches:

a. Manufacturers – One of the following:

1) N-Tron 7014FX2.

2) Cisco 2950 Series.

3) No Equal.

b. Properties:

1) Hardware

a) Power Supply

(1) Provide redundant power supplies.

(2) 24VDC, 350 Watts/per power supply.

2) Performance

a) Switch fabrix speed: 8 GBPS, minimum

3) Environment:

a) Operating Temperature Range: 32 to 131 Degrees Fahrenheit.

b) Humidity: 15 to 95 percent, non-condensing.

4) Capable of performing basic switching without special programming or configurations. Additional features available through software setup includes but not limited to:

a) Remote switch management.

b) Port security

c) Rapid spanning tree protocol.

5) Metallic SC-type connectors for use with 62.5 micron multimode optical fiber.

a) Provide modules required to provide network connections as indicated on the Drawings.

(1) As required to provide the number of connections required plus 20 percent spare ports of each type used.

6) RJ45 connectors for use with Cat 5e or Cat 6 cable.

7) Mounting:

a) DIN Rail.

2. Power Over Ethernet (POE)

a. Manufactures

1) The part number shall match those existing in the treatment plant, or approved by OWNER.

2) Phoenix Contact.

b. Properties:

1) Four pair of two RJ45 10/100BaseTX copper ports.

a) One RJ45 connects to an existing network.

b) Other RJ45 in the pair can send data and up to 15.4 Watts of power.

2) The data on all four pairs are isolated from each other.

3) Redundant power inputs.

4) 2 million hour MTBF.

5) -40ºC to 85ºC operating temperature range.

6) ESD protection.

7) RFI immunity.

8) POE Network devices shall be sized with the count of ports and wattage overall and of each port necessary for all end devices.

C. Fiber Optic Panel

1. LIU – Light Interface Unit.

a. Manufactures:

1) The part number shall match those existing in the treatment plant, or approved by OWNER.

b. Properties:

1) 2 CCH panels minimum.

2) 24 fiber capacity minimum.

3) Corning PWH-02P

2.2 ACCESSORIES

A. Provide duplex patch cords to connect the interface cards provided with the associated patch panels.

B. Uninterruptable Power Supply (UPS)

1. Provide one UPS for each networking enclosure.
2. UPS shall power all components in networking enclosure and all workstations and servers.
3. As shown on the Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Upon delivery to the site, examine all cables and components for damage.

3.2 INSTALLATION

A. All racks shall be level and plumb.

B. Install Velcro wrap on all cable bundles within the network/enclosure.

C. All cables and equipment shall be installed in strict conformance with the manufacturer's recommendations.

1. Cables shall be installed avoiding sharp bends.
2. Install cable using lubricant designed for cable pulling.
3. Cable ties or other cable supports shall be installed without crimping the LAN cables.
4. Install LAN cables without splices.
5. Installed bend radii shall not exceed 4 times the cable diameter.
6. Terminate all pairs at the jack and the patch panel.

D. Install cables a minimum of 40 inches away from electrical motors and transformers.

E. Install cables a minimum of 12 inches away from fluorescent lighting.

F. Individual pairs will be untwisted less than 0.5” at termination points.

G. All cables and terminations shall be labeled with cable designations as described in the Division 16 specifications.

H. Each data port shall be individually labeled with its patch panel/switch port ID.

1. Labeling must be printed – no handwritten labels will be allowed.

I. At the completion of the wiring installation, the Engineer will be provided with the following documentation:

1. A plan-view of the premise(s) showing the jack numbering scheme.
2. A printed certification report for the entire wiring installation showing compliance with all ANSI/EIA/TIA specifications for data cable.
3. Reports such as those generated by Fluke DSP cable certification equipment meet this requirement.

3.3 FIELD QUALITY CONTROL

A. LAN Cable Testing:

1. Testing scope: Test all installed LAN cables.
2. Test plan and witnessing: Obtain Engineer’s approval for the test procedures as part of the submittal process. Arrange for the Engineer to witness all testing. Submit a request for witness 15 days (minimum) prior to the proposed test date.
3. Pre-testing:
    a. Test individual cables before installation.
        1) Prior to physical placement of the cable, the installer shall test each cable while on the spool with a LAN certification test device.
        2) Before the cable is installed the installer shall check that the cable conforms to the Manufacturer’s attenuations specification and that no damage has been done to the cable during shipping or handling.
        3) The test shall be fully documented and the results submitted to the Engineer, including a hard copy of the all traces, prior to placement of the cable.
        4) The Engineer shall be notified if a cable fails to meet specification and the cable shall not he installed unless otherwise directed by the Engineer.
4. Test Equipment
    a. LAN Certification equipment used for the testing shall be capable of testing Category 6 cable installation to TIA proposed level III accuracy.
    b. Tests performed shall include:
        1) Near end cross talk
        2) Attenuation

3) Equal level far end cross talk

4) Return loss

5) Ambient noise

6) Effective cable length

7) Propagation delay

8) Continuity/loop resistance

c. LAN certification test equipment shall be able to store and produce plots of the test results.

d. Manufacturers – One of the following:

1) Agilent Technologies, WireScope 350.

2) Or approved equal.

3.4 ADJUSTING

A. Perform all firmware installations, configuration and other set up, as required, to place the network into proper operation.

3.5 PROTECTION

A. Protect all network equipment after installation and before commissioning. Replace any hardware damaged prior to commissioning.

1. The Engineer shall be the sole party responsible for determining the corrective measures.

END OF SECTION

SECTION 16710

CONTROL SYSTEMS – PANELS, ENCLOSURES AND COMPONENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for:

1. Design, fabrication and assembly requirements for all instrumentation enclosures, control panels and components provided under this contract, including but not limited to:

a. Custom built instrumentation and control panels, including PCMs, PLCs, LCPs, Instrument Junction boxes (IJBs) and power junction boxes (PJBs) etc.

b. Control panels furnished as part of equipment systems specified in other Divisions, such as vendor control panels (VCP) and chemical feed panels.

c. Control components.

d. Control panel fabrication and installation.

e. Interfaces between control panels and the SCADA/PLC System.

B. Related Sections:

1. The Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the CONTRACTOR and its Subcontractors to review all sections to ensure a complete and coordinated project.

1.2 REFERENCES

A. Specific References:

1. National Electrical Code (NEC): NFPA 70.

2. National Electrical Manufacturer's Association (NEMA):

a. NEMA 250 - Enclosures for Electrical Equipment (1,000 Volts Maximum).

b. NEMA ICS 6 - Enclosures for Industrial Control and Systems.

3. Underwriters Laboratories Inc. (UL):

a. UL 50 - Enclosures for Electrical Equipment.

b. UL 508 - Industrial Control Equipment.

c. UL 508A - Standard for Industrial Control Panels.

1.3 DEFINITIONS

A. Specific Definitions:

1. The term “panel” in this Section is interchangeable with the term “enclosure.”

1.4 SYSTEM DESCRIPTION

A. Provide enclosures suitable for the location and environmental conditions in which they are located, unless otherwise indicated.

B. Panel Dimensions:

1. Minimum dimensions are scalable from or as indicated on the Drawings and are based upon manufacturer's non-certified information. It is the responsibility of the Contractor or Manufacturer to design and size all panels:

a. Size panels to provide space for all equipment, wiring, terminations, and other items in the panel, including space for future build out.

b. Panel sizes that substantially deviate (± 3 inches in any dimension) from the sizes shown on the Drawings must be approved by the ENGINEER.

c. Maximum panel depth: 30 inches, unless otherwise indicated.

C. Structural Design:

1. Completed and installed panel work shall safely withstand "seismic requirements". Enclosures and internal equipment shall be braced to prevent damage from specified forces.

1.5 SUBMITTALS

A. Provide a two phase control panel hardware submittal, for each control panel and enclosure being provided on this project, including but not limited to:

1. Product Data:

a. Enclosure construction details and NEMA type.

b. Manufacturer's literature and specification data sheets for each type of basic material to be installed within or on the panel or enclosure.

2. Shop Drawings:

a. Scaled, detailed exterior panel (front and side views) and interior panel layout showing equipment arrangement and dimensional information:

1) Provide draft for review and approval of ENGINEER. The ENGINEER has the authority to substantially alter initial panel layouts.

b. Complete nameplate engraving schedule.

c. Structural details of fabricated panels.

3. Calculations – Seismic considerations

a. Provide installation details based on calculated shear and tension forces:

1) Calculations shall be signed and sealed by a Professional Engineer licensed in the state where the cabinets and panels will be installed.

b. For assembled enclosures and other equipment with a weight of 200 pounds or more, provide calculations for:

1) Weight including panel internal components.

2) Seismic forces and overturning moments.

3) Shear and tension forces in connections.

4. Calculations – Heat Release

a. Cooling Calculations, to include but not limited to:

1) Highest expected ambient temperature for the enclosure's location

2) Internal heat load:

3) Exposure to direct sunlight.

4) Dimensions of the enclosure in inches.

5) Maximum desired temperature inside the enclosure.

B. Phase I shall be the Control Panel Hardware submittal which shall include but not be limited to:

1. Enclosure construction details and NEMA type.
2. Finish, including color chart for ENGINEER selection of color.
3. Layout.
4. Power circuits.
5. Signal and safety grounding circuits.
6. Fuses.
7. Circuit breakers.
8. Signal circuits.
9. Internally mounted instrumentation.
10. PLCs.
11. SCADA system components.
12. Face plate mounted instrumentation components.
13. Internal panel arrangements.
14. External panel arrangements.
15. Construction drawings drawn to scale which define and quantity.
16. The type and gage of fabrication steel to be used for panel fabrication.
17. The ASTM grade to be used for structural shapes and straps.
18. Panel door locks and hinge mechanisms.
19. Type bolts and bolt locations for section joining and anchoring.
20. Details on the utilization of “UNISTRUT” and proposed locations.
21. Stiffener materials and locations.
22. Electrical terminal box and outlet locations.

23. Electrical access locations.

24. Print pocket locations.

25. Writing board locations.

26. Lifting lug material and locations.

27. Physical arrangement drawing drawn to scale which define and quantity the physical groupings comprising:

28. Control panel sections.

29. Auxiliary panels.

30. Subpanels.

31. Racks.

32. Cutout locations with nameplate identifications shall be provided.

33. A bill of material which enumerates all devices associated with the control panel.

C. Phase II shall be the Control Panel Wiring Diagram submittal which shall include but not be limited to:

1. Schematic/Elementary diagrams shall depict all control devices and circuits and their functions.

2. Wiring/Connection diagrams shall locate and identify:

3. Electrical devices.

4. Terminals.

5. Interconnecting wiring.

6. These diagrams shall show interconnecting wiring by lines, designate terminal assignments, and show the physical location of all electrical and control devices.

7. Interconnection diagrams shall locate and identify all external connections between the control panel/control panel devices and associated equipment.

8. These diagrams shall show interconnecting wiring by lines, designate terminal assignments, and show the physical location of all panel ingress and egress points.

9. Control sequence diagrams shall be submitted to portray the contact positions or connections required to be made for each successive step of the control action.

D. Testing plans, forms, procedures, and other testing submittals.

1.6 QUALITY ASSURANCE

A. Assemble panels, enclosures, and rack systems along with all internal and external devices, wiring, equipment, and materials in a facility that is recognized by Underwriters Laboratories to assemble and certify UL-labeled control panels:

1. Provide all components and equipment with UL508 listing.

2. All control panels shall be UL 508A labeled, unless the equipment in the panel and the design in the contract documents cannot be reasonably modified to meet the requirements for UL508A labeling.

1.7 DELIVERY, STORAGE AND HANDLING

A. Crate all panels for shipment using a heavy framework and skids:

1. Provide factory-wrapped waterproof flexible barrier material for covering materials, where applicable, to protect against physical damage in transit.

2. Provide suitable shipping stops and cushioning material for all instruments shipped with the panel to prevent damage due to mechanical shock during shipment.

3. Provide each separate panel unit with removable lifting lugs to facilitate handling.

B. Ship all panels by dedicated air ride van, unless otherwise specified or approved.

1.8 PROJECT OR SITE CONDITIONS

A. Environmental Suitability:

1. Provide all control panels and instrument enclosures that are suitable for operation in the site conditions associated with the locations designated in the Contract Documents or as indicated on the Drawings including, but not limited to, material compatibility, site altitude, site seismic, ambient temperature, and humidity conditions.

2. Intrinsically safe.

1.9 SEQUENCING

1.10 WARRANTY

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. As listed below in the individual component paragraphs.

B. Provide instruments and other components performing similar functions of the same type, model, or class, and from one Manufacturer.

2.2 MATERIALS

A. Construct and finish enclosures using materials capable of withstanding the mechanical, electrical, and thermal stresses, as well as the effects of humidity and corrosion that are likely to be encountered in normal service:

1. Enclosures shall have the following properties:

a. NEMA 1: Steel.

b. NEMA 4: With gasketed door, rain-tight.

1) Outdoor: Stainless steel.

2) Indoor: Stainless steel.

c. NEMA 4X: With gasketed door, rain-tight.

1) Outdoor: Stainless steel.

2) Indoor: Stainless steel.

d. NEMA 12: Polycarbonate or fiberglass reinforced polyester (FRP) with gasketed door, dust-tight.

e. NEMA 7: Cast aluminum.

B. Bolting Material:

1. Commercial quality 1/2-inch diameter, plated carbon steel hex-head grade 5 bolts, nuts and washers, with unified coarse (UNC) threads.

2. Carriage bolts shall be used for attaching end plates.

3. All other bolted joints shall have S.A.E. standard lock washers.

2.3 MANUFACTURED UNITS

A. Panels/Enclosures:

1. Manufacturers:

a. One of the following:

1) Rittal.

2) Hoffman Engineering.

3) Saginaw Control & Engineering.

4) Prior-approved equal.

2. Panel assembly:

a. General guidelines for panel fabrication include:

1) Continuous welds ground smooth.

2) Exposed surfaces free of burrs and sharp edges.

3) Base formed of heavy channel iron, either galvanized or powder coated, minimum 1/2 inch holes at 12 inch spacing to accommodate anchoring of freestanding enclosures to floor.

b. Construct enclosure and mounting panel using stretcher level sheet metal having minimum thickness not less than the following sizes (U.S. Standard Gauge):

Enclosure Height (inches)	Minimum Enclosure Steel Thickness (gauge)	Minimum Back Mounting Panel Thickness (gauge)
Up to 57	12	12
57 – 69	12	10
69 – 82	12, except 10 on back	10
82 or more	10	10

1) Use heavier sheet metal to meet seismic requirements as specified.

c. Construct supporting frame structure with angled, channeled, or folded rigid section of sheet metal, rigidly attached to and having essentially the same outer dimensions as the enclosure surface and having sufficient tensional rigidity to resist the bending moments applied via the enclosure surface when it is deflected.

d. Provide stiffeners for back mounting panels in enclosures larger than 4 feet. In addition, secure the panels in place by collar studs welded to the enclosure.

e. Doors construction:

1) Turned-back edges suitably braced and supported to maintain alignment and rigidity without sagging.

2) Sufficient width to permit door opening without interference with rear projection of flush mounted instruments.

3) Heavy gauge, piano type, continuous stainless steel hinges.

4) Oil resistant neoprene sealing gasket and adhesive to seal cover to enclosure.

5) Gasket installed to seal against roll lip on the enclosure opening.

f. Latches:

1) For panels, other than large types NEMA 4 and 4X, each door provided with a 3-point latching mechanism and padlocking handle with rollers on the ends of the latch rods. Latch rods connected to a common door handle, hold doors securely, forming a compressed seal between door and gasket, at the top, side, and bottom.

2) Include an oil-tight key-locking, 3-point latching mechanism on each door:

a) Provide 2 keys per panel.

b) All locks keyed the same.

3) For large type NEMA 4 and NEMA 4X cabinets, not available with 3-point latching hardware, provide multiple clips and padlock hasps.

g. Panel cut-outs:

1) Cut, punch, or drill cut-outs for instruments, devices, and windows. Smoothly finish with rounded edges.

2) Allow a minimum of 3 inch envelope around all devices.

3) Reinforce around cut-outs with steel angles or flat bars for the following:

a) Large panel cutouts; for example, openings for local operator interfaces.

b) Pilot device groupings, where the removed metal exceeds 50 percent of the available metal.

3. In addition to the requirements specified above, the following requirements for NEMA 4X stainless steel enclosures apply:
   a. Minimum 14 gauge stainless steel.
   b. Captive stainless steel cover screws threaded into sealed wells.
   c. Finish: Unpainted, brushed finish.
   d. Specifically designed for use with flange-mounted disconnect handles where required or as indicated on the Drawings.
4. In addition to the requirements specified above the following requirements for NEMA 4X non-metallic enclosures apply:
   a. Fiberglass construction.
   b. 10 gauge plate steel reinforcing on the sides, top, and bottom.
   c. All seams sealed.
   d. Fiberglass hinges with no exposed metal parts.
   e. Captivate stainless steel door screws.
   f. Provisions for internal, sidewall, mounting panels either by welded channels to the interior, or by welded collar studs.
   g. Provide aluminum mounting panels.
   h. Non-metallic enclosures are not an acceptable substitute for stainless steel unless indicated on the Drawings.
5. Outdoor Panels. Supplementary requirements for panels located outdoors are as follows:
   a. All enclosures located outdoors shall be explicitly designed and rated for outdoor service by the manufacturer.
   b. Finish: Other than stainless steel and fiberglass, the finish shall be outdoor-rated, baked powder coated over dip-coated primer.
   c. Door hardware: stainless steel.
   d. Bases: Heavy channel, gasketed iron bases, flanges up, for anchoring to pad.
   e. Provide rain canopy and sun shield.
6. Arrangement of Components:
   a. Arrange panel internal components for external conduit and piping to enter into panel either from above or below.
   b. Arrange panel instruments and control devices in a logical configuration associating pushbutton and selector switches with related readout devices, or as indicated on the Drawings.

c. Mount internal control components on an internal back-panel. Devices may be mounted on the side-panel only by special permission from the ENGINEER.

d. Group cables, and firmly support wiring to the panel. Provide minimum 8 inches clearance between terminal strips or wiring duct and the base of the enclosure for conduit and wiring space.

e. All control panel mounted operator interface devices shall be mounted between 3 feet and 6 feet above finished floor.

7. Grounding:

a. Provide the following equipment grounding system:

1) Equipment grounding conductors and equipment bonding jumpers.

2) Equipment grounding conductor terminals.

3) Conductive structural parts of the enclosure.

b. Ensure the continuity of the equipment grounding system by effective connections through conductors or structural members.

c. Size ground wires in accordance with NEC and UL Standards, unless noted otherwise.

d. Provide equipment ground bus with lugs for connection of all equipment grounding wires.

e. Connect all exposed, noncurrent-carrying conductive parts, devices, and equipment shall be connected to the equipment grounding circuit.

f. Provide an equipment grounding terminal for each incoming power circuit, in the vicinity of the phase conductor terminal.

g. Design so that removing a device does not interrupt the continuity of the equipment grounding circuit.

h. Identify equipment grounding conductor terminals with the word “GROUND,” the letters “GND” or the letter “G,” or the color green.

i. Connect the door stud on the enclosures to an equipment-grounding terminal within the enclosure using an equipment-bonding jumper.

j. Signal (24 VDC) Grounding: Terminate each drain wire of a signal (shielded) cable to a unique grounding terminal block, or common ground bus at the end of the cable as shown on the Loop Drawings.

1) Bond multi-section panels together with an equipment grounding conductor or an equivalent grounding bus sized in accordance with NEC Table 250.122.

2) Bond together all PLC or RTU racks (remote or local) processor racks, and conductive enclosures of power supplies and connect to the equipment grounding circuit.

k. Protection:

1) Provide disconnecting, short-circuit, and overcurrent protection for all control panels.

2) Select and apply protective devices with proper consideration given, but not limited to the following:

   a) System maximum available fault current at the point of application.

   b) Interrupting rating of the protective device.

   c) Voltage rating of the system.

   d) Load and circuit characteristics:

      1. Normal operating current.

      2. Inrush characteristics.

      3. Thermal withstand capability (I^2t).

      4. Magnetic withstand capability (I_p).

   e) Current-limiting ability of the protective device.

   f) Coordination of the protective devices to each other.

3) Provide a separate protective device for each 120 VAC powered electrical device.

4) Each 120 VAC Control Loop and Instrument shall have an individual circuit breaker within its respective control panel and clearly identified for function.

5) Each 120 VAC and 24 VDC PLC output shall have its own individual fuse external of the I/O card with blown fused indication:

   a) Size external fuse to open before any I/O card mounted fuses.

6) Provide a protective fuse device for each PLC discrete output coordinated to open before the protective device on the PLC I/O card.

7) Protective devices shall be located on the back mounting panel and identified by a service nameplate in accordance with the wiring diagrams.

8) Provide dedicated single pole circuit breakers, one for the panel lighting luminaire(s), and one for the panel receptacle(s):

   a) 15 amperes, 120VAC.

9) The power entrance to each panel shall be provided with a surge protection device. Surge protectors shall be nominal 120 volts ac with a nominal clamping voltage of 200 volts. Surge protectors shall be a non-faulting and non-interrupting design with a response time of less than 0.5 nanoseconds in normal mode and less than 5 nanoseconds in normal mode Peak surge current capability shall be rated for at least 15,000 amps, line to neutral, line to ground and neutral to ground.

l. Manufacturer: Control Concepts Model IC + 130/IC + 130WL rated 30 amps, or as directed.

8. Conductors and Cables:

a. Power and Control Wiring:

1) Materials: Stranded, soft annealed copper.

2) Insulation: 600V type MTW.

3) Minimum Sizes:

a) Primary power distribution: 12 AWG.

b) Secondary power distribution: 14 AWG.

c) Control: 16 AWG.

4) Color:

a) AC power (line and load): BLACK.

b) AC power (neutral): WHITE.

c) AC control: RED.

d) DC power and control: BLUE.

e) Ground: GREEN.

b. Signal Cables:

1) Materials: Stranded, soft annealed copper.

2) Insulation: 600V, PVC outer jacket.

3) Minimum Size: 16 AWG paired triad.

4) Overall aluminum shield (tape).

5) Copper drain wire.

6) Color:

a) 2 Conductor:

b) Positive (+): BLACK.

c) Negative (-): WHITE, RED.

7) 3 Conductor:

a) Positive (+): BLACK.

b) Negative (-): RED.

c) Signal: WHITE.

8) Insulate the foil shielding and exposed drain wire for each signal cable with heat shrink tubing.

9. Conductor Identification:

a. Identify all conductors and cables with wire markers.

b. Readily identified without twisting the conductor.

10. General Wiring Requirements:

a. Wiring Methods: Wiring methods and materials for panels shall be in accordance with the NEC requirements for General Purpose (no open wiring) unless otherwise specified.

b. Install all components in accordance with the manufacturer's instructions included in the listing and labeling.

c. Where the electrical power supply voltage to the control panel is more than 120 VAC, provide the panel with a control power transformer and flange mounted disconnect. The disconnect shall be mechanically interlocked with the control enclosure doors so that no door can be opened unless the power is disconnected. Interlocking shall be reactivated automatically when all the doors are closed.

d. Control panels supplied with 120 VAC:

1) Provide an internal breaker with the line side terminals covered by a barrier.

2) Provide a nameplate prominently positioned on the control panel identifying the location of the power source and a warning statement requiring that the source be disconnected before opening the door to the enclosure.

3) Provide a nameplate on the cover of the control panel identifying all sources of power supply and foreign voltages within the control panel.

4) Provide transformers, protective devices, and power supplies required to convert the supply voltage to the needed utilization voltage.

5) Provide surge protection device on input supply power.

6) Provide nonmetallic ducts for routing and organization of conductors and cables:

a) Size ducts for ultimate build-out of the panel, or for 20 percent spare, whichever is greater.

b) Provide separate ducts for signal and low voltage wiring from power and 120 VAC control wiring:

1. 120 VAC: Grey colored ducts.

2. 24 VDC: White colored ducts.

7) Cables shall be fastened with cable mounting clamps or with cable ties supported by any of the following methods:

a) Screw-on cable tie mounts.

b) Hammer-on cable tie mounting clips.

c) Fingers of the nonmetallic duct.

8) The free ends of cable ties shall be cut flush after final adjustment and fastening.

9) Provide supports at the ends of cables to prevent mechanical stresses at the termination of conductors.

10) Support panel conductors where necessary to keep them in place.

11) Wiring to rear terminals on panel-mount instruments shall be run in nonmetallic duct secured to horizontal brackets run adjacent to the instruments.

12) Conductors and cables shall be run from terminal to terminal without splice or joints. Exceptions:

a) Factory applied connectors molded onto cables shall be permitted. Such connectors shall not be considered as splices or joints.

13) The control panel shall be the source of power for all 120 VAC devices interconnected with the control panel including, but not limited to:

a) Solenoid valves.

b) Instruments, both mounted in the control panel and remotely connected to the control panel.

e. Thermal Management:

1) Provide heating, cooling, and dehumidifying devices in order to maintain all instrumentation and control devices to within a range.

2) Air Conditioning:

a) Cooling:

1. Provide filtered, fan forced type cooling system for each control cabinet.

2. Size fans, louvers and filters to maintain a cabinet temperature no more than 10°F above ambient electrical room temperature.

3. Cooling system includes the following components:

4. Ventilation fans with louver and filter.

5. Relief air louvers.

6. Thermostat.

7. 5 micron air filters for each opening.

b) Heating:

1. Provide all panels located in areas that is not climate controlled with thermostatically controlled strip heaters; except, where all of the following conditions apply:

2. The panel is not supplied with 120 VAC power.

3. There are no electronics or moisture-sensitive devices in the enclosure.

4. The panel is smaller than 38 inches high.

3) Enclosure Temperature Sensor:

a) Wall mount RTD sensor to measure internal cabinet temperature.

b) Platinum RTD.

c) 4-20 mA output.

d) Sensor and electronic enclosure.

e) Accuracy: ±2.0 degrees Fahrenheit.

1. Manufactured by:

a. Omega, EWS series

b. TCS Basys Controls, TS Series

2.4 COMPONENTS

A. Panel Meters:

1. Digital:

a. Self-contained instruments that display process signals directly in engineering units.

b. Suitable for panel mounting.

c. LED display:

1) 0.56-inch height.

2) Multi-range capabilities.

3) Integral provisions for scaling.

4) Switch programmable decimal points.

5) NEMA 4/IP65 sealed front metal bezel.

d. Current and Voltage indicators:

1) 3 1/2 - digit.

e. Accuracy:

1) AC/DC volts: ± (0.1 percent of reading + 2 digit).

2) DC current:

a) 4 - 20mA: ± (0.1 percent of reading + 1 digit).

b) 0 - 10V: ± (0.1 percent of reading + 1 digit).

3) Ratings, protection, and indication:

a) Maximum applied voltage: 300 VAC/VDC.

f. Operating voltage: 120 VAC.

g. Operating temperature: 0 degrees Celsius to 60 degrees Celsius.

1) Manufacturer, One of the following

a) Red Lion.

B. Manual Operator Interface Devices:

1. General:
    a. Provide operator pushbuttons, switches, and pilot lights, from a single manufacturer.
    b. Size:
        1) 30.5mm.
    c. Lamp Color:
        1) On/Running/Start/Open: Green.
        2) Close/Off/Stop: Red.
        3) Power: White.
        4) Alarm: Red.
        5) Status or Normal Condition: White.
        6) Opened: Amber.
        7) Closed: Blue.
        8) Failure: Red.
2. Indoor and Outdoor Areas:
    a. NEMA type 4/13.
    b. Heavy duty.
    c. Pushbutton:
        1) Contacts rated:
            a) NEMA A600.
        2) Furnish one spare normally open and normally closed contact with each switch.
        3) Provisions for locking in the OFF position where lockout provisions are indicated on the Drawings.
        4) Manufacturer: One of the following:
            a) Allen Bradley Type 800T.
            b) Square D Class 9001 Type K.
            c) General Electric Type CR104P.
            d) IDEC TWTD.
    d. Selector switches:
        1) Contacts rated:
            a) NEMA A600.
            b) Knob type:
        2) Manufacturer: One of the following
            a) Allen Bradley Type 800T.
            b) Square D Class 9001 Type K.

c) General Electric Type CR104P.

d) IDEC TWTD.

3) Furnish one spare normally open contact and normally closed contact with each switch.

4) Provisions for locking in the OFF position where lockout provisions are indicated on the Drawings.

e. Pilot lights:

1) Type:

a) LED for all interior installations.

b) Full Voltage for exterior installations.

2) Push to Test.

3) LED Lamp.

4) Manufacturer: One of the following

a) Allen Bradley Type 800T.

b) Square D Class 9001 Type K.

c) General Electric Type CR104P.

d) IDEC TWTD.

3. Corrosive Areas:

a. NEMA 4X.

b. Exterior parts of high impact strength fiberglass reinforced polyester.

c. Pushbutton:

1) Contacts rated:

a) NEMA A600.

2) Manufacturer: One of the following:

a) Cutler Hammer Type PB2.

b) Square D Class 9001 Type SK.

c) Allen Bradley Type 800H.

d) IDEC TWTD.

d. Selector switches:

1) Contacts rated:

a) NEMA A600.

b) Knob Type:

2) Manufacturer: One of the following:

a) Cutler Hammer Type E34.

b) Square D Class 9001 Type SK.

c) Allen Bradley Type 800H.

d) General Electric Type CR104P.

e) IDEC TWTD.

e. Pilot lights:

1) Type:

a) LED for all interior installations.

b) Full Voltage for exterior installations.

2) Corrosion resistant.

3) Push to test.

4) Manufacturer: One of the following:

a) Cutler Hammer Type E34.

b) Square D Type SK.

c) Allen Bradley Type 800H.

4. Hazardous (Classified) Areas/Class I Division I:

a. NEMA 7.

b. High impact strength fiberglass reinforced polyester.

c. Pushbutton:

1) Contacts rated:

a) NEMA B600.

b) Contacts contained within a hermetically sealed chamber.

c) UL listed and labeled for Class I Division 2 areas.

2) Manufacturer: One of the following

a) Allen Bradley Type 800H.

d. Selector switches:

1) Contacts rated:

a) NEMA B600.

b) Contacts contained within a hermetically sealed chamber.

c) UL listed and labeled for Class I Division 2 areas.

d) Knob Type:

2) Manufacturer: One of the following:

a) Allen Bradley Type 800H.

e. Pilot lights:

1) Type:

a) LED for all interior installations.

b) Full Voltage for exterior installations.

2) Corrosion resistant.

3) UL listed and labeled for Class I Division 2 areas.

4) Push to test.

5) Manufacturer: One of the following:

a) Allen Bradley Type 800H.

5. Potentiometer and Slide wire Transmitters:

a. Provide a DC output in proportion to a potentiometer input.

b. Potentiometer input:

1) 100 ohms to 100K ohms.

2) Impedance ≥ 1M ohms.

3) Zero Turn-Up: 80 percent of full scale input.

4) Span Turn-Down: 80 percent of full scale input.

c. Field configurable output:

1) Voltage and Current: All conventional current loops and voltage control signals.

d. Accuracy including linearity and hysteresis ± 0.1 percent max at 25 degrees Celsius.

e. Operating temperature: 0 degrees Celsius to 55 degrees Celsius.

f. Supply power: 9 to 30 VDC.

g. Manufacturer: One of the following:

1) Phoenix Contact.

C. Signal isolators and converters:

1. Furnish signal isolators that provide complete isolation of input, output, and power input:

a. Minimum isolation level: 1.5 kV AC/50 Hz for at least 1 minute.

b. Signal input: All conventional current loops and voltage control signals.

c. Signal output: All conventional current loops and voltage control signals.

d. Operating voltage: As shown on the Drawings.

e. Adjustable span and zero.

f. Accuracy: ± 1.0 percent of span.

g. Ambient temperature range: -20 degrees Celsius to +65 degrees Celsius.

h. DIN rail mounting on 35mm rail.

i. Wire connection: Pluggable terminal blocks.

D. Relays:

1. General:
    a. For all types of 120 VAC relays, provide transient surge protection across the coil of each relay.
    b. For all types of 24 VDC relays, provide a free-wheeling diode across the coil of each relay.
2. General Purpose:
    a. Magnetic control relays.
    b. NEMA A300 rated:
        1) 300 Volts.
        2) 10 Amps continuous.
        3) 7,200 VA make.
        4) 720 VA break.
    c. Plug-in type.
    d. LED indication for relay energized.
    e. Coil voltages: As indicated on the Drawings.
    f. Minimum poles: 2PDT.
    g. Touch safe design: All connection terminals to be protected against accidental touch.
    h. Enclose each relay in a clear plastic heat and shock-resistant dust cover.
    i. Quantity and type of contact shall be as shown on the Drawings or as needed for system compatibility.
    j. Sockets for relays shall have screw-type terminals.
    k. Provide additional (slave/interposing) relays when the following occurs:
        1) The number or type of contacts shown exceeds the contact capacity of the specified relays.
        2) Higher contact rating is required in order to interface with starter circuits or other equipment.
    l. DIN rail mounting on 35mm rail.
    m. Ice Cube type relays shall be provided with retainer clips to secure relay in socket.
    n. Integrated label holder for device labeling.
    o. Manufacturer: One of the following:
        1) Phoenix Contact PLC series.
        2) Potter and Brumfield Type KRP or KUP.
        3) IDEC R* series. (* = H, J, R, S, U).
        4) Allen Bradley Type 700 H Series.
        5) Square D Type K.

6) Turck

3. Machine Tool Relays:
   a. Magnetic industrial relays.
   b. NEMA A600 rated:
      1) 600 Volts.
      2) 10 Amps continuous.
      3) 7,200 VA make.
      4) 720 VA break.
   c. Coil voltage: As indicated in the Contract Documents.
   d. Convertible contact cartridges to convert any contact from a normally open to a normally closed configuration.
   e. Contact cartridges shall have a clear cover for visual inspection.
   f. Contact material shall be fine grade silver.
   g. Minimum number of poles: 4 Type “A” or Type “B”, or as indicated on the Drawings, plus 1 spare.
   h. Machine tool type.
   i. Touch safe design: All connection terminals to be protected against accidental touch.
   j. Integrated label holder for device labeling.
   k. DIN rail mounted on 35mm rail.
   l. Manufacturer: One of the following
      1) Allen Bradley type 700P.
      2) Square D type 8501XO.
      3) Cutler Hammer D15 series.
4. Latching:
   a. Magnetic latching control relays.
   b. NEMA B300 rated:
      1) 300 Volts.
      2) 10 Amps continuous.
      3) 3,600 VA make.
      4) 320 VA break.
   c. Plug-in type.
   d. DIN rail mounting on 35mm rail.
   e. Coil voltage: 120 VAC.
   f. Minimum poles: 2PDT; as indicated on the Drawings, plus 1 spare.

g. Touch safe design: All connection terminals to be protected against accidental touch.

h. Clear cover for visual inspection.

i. Provide retainer clip to secure relay in socket.

j. Manufacturer:

1) One of the following, or equal:

a) Square D type 8501 Type K.

b) IDEC TWTD.

5. Time Delay:

a. Provide time delay relays to control contact transition time.

b. NEMA A300 rated:

1) 300 Volts.

2) 10 Amps continuous.

3) 7,200 VA make.

4) 720 VA break.

c. Plug-in type.

d. DIN rail mounting on 35mm rail.

e. Coil voltage: as indicated in Contract Documents.

f. Provide Electronic type with on-delay, off-delay, and on/off delay.

g. Minimum poles: 2PDT; as indicated on the Drawings, plus minimum 1 spare.

h. Units shall include adjustable dial with graduated scale covering the time range in each case.

i. Minimum timing range: 0.1 seconds to 10 minutes.

j. Manufacturer: One of the following:

1) Agastat type Series 7000.

2) Allen Bradley type 700HR.

E. Terminal blocks:

1. Din rail mounting on 35mm rail.

2. Suitable for specified AWG wire.

3. Rated for 30 amperes at 600 Volts.

4. Screw terminal type.

5. Provide mechanism to prevent wire connection from loosening in environments where vibration is present. This mechanism shall not cause permanent deformation to the metal body.

6. Finger safe protection for all terminals for conductors.

7. Construction: Polyamide insulation material capable of withstanding temperature extremes from - 40 degree Celsius to degree 105 Celsius.
8. Terminals: Plainly identified to correspond with markings on the diagrams:
    a. Permanent machine printed terminal identification.
9. Identify terminals suitable for use with more than 1 conductor.
10. Position:
    a. So that the internal and external wiring does not cross.
    b. To provide unobstructed access to the terminals and their conductors.
11. Provide minimum 25 percent spare terminals.
12. Manufacturer: One of the following:
    a. Phoenix Contact UK5 Series.
    b. Entrelec M4/6.
    c. Allen Bradley Series 1492.
13. Wire duct:
    a. Provide flame retardant plastic wiring duct, slotted with dust cover.
    b. Type:
        1) Wide slot.
        2) Narrow slot.
        3) Round hole.
    c. Manufacturer: One of the following:
        1) Panduit.
14. Fuses (holders) and circuit breakers:
    a. Fuse holders:
        1) Modular type:
            a) DIN rail mounting on 35mm rail.
            b) Touch safe design: All connection terminals to be protected against accidental touch.
            c) Incorporates blown fuse indicator.
        2) Provide nameplate identifying each fuse:
            a) In accordance with Section 16075.
        3) Manufacturer: One of the following:
            a) Phoenix Contact.
            b) Entrelec.
            c) Allen Bradley 1492-FB Series B.
15. Control Circuit Breakers:

a. DIN rail mounting on 35mm rail.

b. Manual OPEN-CLOSE Switch.

c. Rated 250 VAC.

d. Interrupt Rating: As indicated on the Drawings.

e. Current ratings: As indicated on the Drawings.

f. Provide nameplate identifying each circuit breaker, refer:

1) In accordance with Section 16075.

g. Manufacturer: One of the following:

1) Phoenix Contact.

2) ABB.

3) Allen Bradley Series.

4) Square D.

5) Entrelec.

F. Transient / Surge Protection Devices:

1. Provide Surge Protection Device (SPD) for Power Entrances:

a. Nominal 120 VAC with a nominal clamping voltage of 200 Volts.

b. Non-faulting and non-interrupting design.

c. A response time of not more than 5 nanoseconds.

2. Control Panel Power System Level Protection, non-UPS powered:

a. Design to withstand a maximum 10 kA test current of a 8/20µs waveform according to ANSI/IEEE C62.41.1-2002 Category C Area.

b. Provide both normal mode noise protection (between current carrying conductors) and common mode (between current carrying conductor and neutral) surge protection.

c. DIN rail mounting.

d. Attach wiring to the SPD by means of a screw type cable-clamping terminal block:

1) Gas-tight connections.

2) The terminal block: Fabricated of non-ferrous, non-corrosive materials.

e. Visual status indication of MOV status on the input and output circuits.

f. Dry contact rated for at least 250 VAC, 1 Amp for remote status indication.

g. Meeting the following requirements:

1) Response time: ≤ 100 ns.

2) Attenuation: ≥ - 40dB at 100 kHz as determined by a standard 50 ohms insertion test.

3) Safety approvals:

a) UL 1283 (EMI/RFI Filter).

b) UL 1449 2nd Edition.

h. Manufacturer: One of the following:

1) Phoenix Contact type SFP TVSS/Filter.

2) Liebert Accuvar series.

3) Islatrol.

3. Data and Signal Line Protectors – Panel Mounted:

a. Surge protection minimum requirements: Withstand a 10 kA test current of a 8/20µs waveform in accordance with ANSI/IEEE C62.41.1-2002 Category C Area.

b. DIN rail mounting on 35mm rail (except field mounted SPDs).

c. SPD's consisting of 2 parts:

1) A base terminal block.

2) A plug protection module:

a) Replacing a plug shall not require the removal of any wires nor interrupt the signal.

b) Base and plug shall have the ability to be coded to accept only the correct voltage plug.

d. SPD Manufacturer: One of the following:

1) Phoenix Contact Plugtrab Series.

2) Joslyn JMD Series.

4. Data and Signal Line Protectors – Field Mounted:

a. Surge protection minimum requirements: Withstand a minimum 10 kA test current of a 8/20µs waveform in accordance with ANSI/IEEE C62.41.1-2002 Category C Area.

b. Manufacturer: One of the following:

1) Phoenix Contact type SFP TVSS/Filter.

c. SPD Manufacturer: One of the following:

1) Phoenix Contact Pipetrab.

2) Boxtrab.

3) Joslyn JMD Series.

G. Power supplies:

1. Design power supply systems so that either the primary or backup supply can be removed, repaired, and returned to service without disrupting the system operation.

2. Convert 120 VAC to 24 volt DC or other DC voltages required or as indicated on the Drawings.

3. Provide backup 24 VDC power supply units to automatically supply the load upon failure of the primary supply.

4. Provide power supplies configured as fully redundant units consisting of 2 power supplies connected with an automatic switchover unit with alarm contacts monitored by the PLC and alarmed in SCADA.

5. Sized to provide 40 percent excess rated capacity.

6. UL508C listed to allow full rated output without de-rating.

7. Provide fuse or short-circuit protection.

8. Provide a minimum of 1 set of dry contacts configured to change state on failure for monitoring and signaling purposes.

9. Output regulation: ± 0.05 percent for a 10 percent line change or a 50 percent load change:

    a. With remote voltage sensing.

10. Operating temperature range: 0 degrees Celsius to 50 degrees Celsius.

11. Touch safe design: All connection terminals to be protected against accidental touch.

12. DIN rail mounting on 35mm rail.

13. Provide self-protecting power supplies with a means of limiting DC current in case of short circuit.

14. Manufacturer: One of the following:

    a. Phoenix Contact Quint series.

    b. IDEC PS5R series.

    c. Sola.

    d. Acopian.

    e. Puls.

H. Intrinsic Safety Barriers:

1. Transformer isolated barrier:

    a. Containing a transformer to provide complete:

        1) Isolation between the safe and hazardous areas for loop powered devices.

        2) 3-way isolation between the safe area, hazardous area and power supply powered devices.

    b. Resistor for current limitation.

    c. Fuses for short circuit protection.

    d. Provide barriers with pluggable connectors that are coded for easy replacement.

e. Transmission error shall be less than or equal to 0.1 percent of full scale.

f. DIN rail mounted on 35mm DIN rail.

g. Approvals:

1) FM.

2) UL 913 & 1604.

2. Types:

a. Switch Isolators:

1) Designed and approved for use with discrete inputs.

2) Supply Power: 20-30VDC.

3) Output to track input.

4) With an LED in the cover to indicate the status of the input.

5) With a selector switch to change the logic of the input.

6) Input - dry contact.

7) Output - SPDT relay.

b. Transmitter and Converters for use with 4-20 mA signals without Hart® communications capability:

1) Designed and approved for use with 4-20 mA analog signals.

2) Designed for powering 2 and/or 3 wire transmitters in hazardous locations and repeating and/or generating the current to the safe area.

3) Supply voltage: 20-30VDC.

c. Transmitter and converters for use with 4-20 mA signals with Hart® communications capability:

1) Designed and approved for use with 4-20 mA analog signals.

2) Designed for powering 2 and/or 3 wire transmitters in hazardous locations and repeating and/or generating the current to the safe area.

3) In addition, transfer digital signals from the hazardous area to the safe area.

4) Complete bi-directional communication between a smart transmitter located in the field and the suitable equipment located in the safe area.

5) Supply voltage: 20-30VDC.

3. Manufacturer: One of the following:

a. Phoenix Contact ME Series.

b. Pepperl + Fuchs.

c. Turck.

I. Disconnects and starters:

1. Flange Mounted Main Disconnect:

a. Rated 22KAIC or as required by the short circuit and coordination study specified in Section 16305, whichever is larger:

1) Size in accordance with the NEC, total connected horsepower and associated locked rotor current, and provide larger unit if needed based on any of these criteria.

b. Interlocked with the door of the control panel so that the door of the panel cannot be opened with the disconnect switch in the closed position, with defeater.

c. Door mounted disconnects are not acceptable.

d. Manufacturer: One of the following:

1) Allen Bradley - 1494.

2) Cutler Hammer - C361/C371.

3) ITE - FH011.

4) Square D - Class 94222.

2. Magnetic Motor Starters:

a. Minimum 22 KAIC or as required by the Short Circuit and Coordination study, which ever is larger.

3. Integral Self-Protected Starters:

a. In conformance with the requirements.

J. Limit Switches:

1. NEMA-4X.

2. AC contact rating 120V, 10A.

3. DC contact rating 125V, 0.4A.

4. DeviceNet Compatible as indicated in the drawings.

5. Provide robust actuation mechanism not prone to degradation.

6. Provide complete actuator mechanism with all required hardware.

7. Allows for contact opening even during contact weld condition.

8. UL approved.

9. Operating Temperature Range: -18 degrees to +110 degrees Celsius (0 degrees to 230 degrees Fahrenheit).

10. Manufacturer:

a. Allen Bradley 802.

b. Honeywell HDLS.

c. Omron D4.

d. Eaton E47, E49, E50.

e. ABB equal.

2.5 ACCESSORIES

A. Provide panels with an inside protective pocket to hold the panel Drawings. Ship panels with 1 copy of accepted Shop Drawings including, but not limited to, schematic diagram, connection diagram, and layout drawing of control wiring and components in a sealed plastic bag stored in the panel drawing pocket.

B. All enclosures which will have a computer mounted inside shall have a shelf to support the computer tower.

C. Provide 15 inch floor stands or legs where needed or as indicated on the Drawings.

D. Provide a folding shelf for enclosures that contain programmable controllers. The shelf shall be mounted on the inside surface of the door, capable of supporting a laptop computer.

E. Tag or identifying number of the panel as indicated on the Drawings.

1. Provide in accordance on all internal and external instruments and devices.

2. Provide a nameplate with the following markings that is plainly visible after installation:

a. Manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the panel can be identified.

b. Supply voltage, phase, frequency, and full-load current.

c. Short-circuit current rating of the panel based on one of the following:

1) Short-circuit current rating of a listed and labeled assembly.

2) Short-circuit current rating established utilizing an approved method.

F. Provide a window kit where indicated on the Drawings. The window shall meet the following requirements:

1. Safety plate glass.

2. Secured by rubber locking seal.

3. Allow full viewing of devices issuing visual process data or diagnostics.

G. Luminaires:

1. Provide 1 luminaire, on the interior of the panel, located every 4 feet of enclosure width, spaced evenly along the top-front of the enclosure door opening(s):

a. Covered or guarded.

b. LED 40W max.

c. Manual On-Off switches.

H. Receptacles:

1. Provide one duplex receptacle located every 4 feet of enclosure width, spaced evenly along the back mounting panels.

2. GFCI, 125-volt, single-phase, 15-ampere.

2.6 FINISHES

A. Finishes:

1. Metal surfaces of panels shall be prepared by chemical cleaning and mechanical abrasion in accordance with the finish manufacturer's recommendations to achieve a smooth, well-finished surface.

2. Scratches or blemishes shall be filled before finishing. One coat of zinc phosphate shall be applied per the manufacturer's recommended dry film thickness, and allowed to dry before applying the finish coat.

3. Finish coat shall be a baked polyester urethane powder, aliphatic air-dry polyurethane, or epoxy enamel to meet NEMA rating specified application.

4. Exterior of enclosures located outdoors shall be UV resistant polyester powder coating. Total dry film thickness shall be 3 mils, minimum.

B. Colors:

1. Exterior color of panels mounted indoors shall be manufacturer's standard light gray.

2. Exterior of panels mounted outdoors shall be manufacturer's standard white.

3. Panel interiors shall be manufacturer's standard white.

2.7 SOURCE QUALITY CONTROL

PART 3 - EXECUTION

3.1 EXAMINATION

3.2 INSTALLATION

A. Any components or panels damaged during installation shall be replaced.

B. Install enclosures so that their surfaces are plumb and level within ± 1/8 inch over the entire surface of the panel; anchor securely to wall and structural supports at each corner, minimum. Direct attachment to dry wall is not permitted.

C. Install the enclosure per guidelines and submitted installation instructions to meet the seismic requirements at the project site.

D. Provide floor stand kits for wall-mount enclosures larger than 48 inches high.

E. Provide 3-1/2 inch high concrete housekeeping pads for free-standing enclosures.

F. Install gasket and sealing material under panels with floor slab cutouts for conduit:

1. Undercoat floor mounted panels.

G. Provide a full size equipment-grounding conductor in accordance with NEC included with the power feeder. Terminate to the incoming power circuit-grounding terminal.

H. All holes for field conduits, etc. shall be cut in the field, there shall be no additional holes, factory cut holes, or hole closers allowed. Incorrect holes, additional holes, or miss-cut holes shall require that the entire enclosure be replaced.

I. Control panels that are adjacent to motor control centers shall be fully wired to the motor control centers using wireways integral to the motor control center or additional conduits as needed. These interconnections are not shown or reflected on the conduit schedule, but shall be shown on the Loop Drawings prepared by the CONTRACTOR.

3.3 FIELD QUALITY CONTROL

3.4 CLEANING

A. Clean area during construction.

3.5 PROTECTION

END OF SECTION

SECTION 16711

PROGRAMMABLE LOGIC CONTROLLER (PLC)

PART 1 - GENERAL

1.1 SCOPE

A. Furnish all labor, material, equipment, appliances, and perform all operations in connection with providing a complete and operable programmable logic controller (PLC) system in accordance with this section of the specifications and applicable drawings and subject to the terms and conditions of the Contract.

B. The SUPPLIER shall furnish a PLC control system utilizing Schneider Modicon M340 family of hardware as specified herein. No like, equal, or equivalent products will be considered.

C. The SUPPLIER shall furnish PLC programming software.

E. The CONTRACTOR'S programmer shall work in conjunction with the contractor to train the owner on the PLC system. The contractor shall train the owner on all hardware. The programmer shall train on PLC programming, SCADA programming, operations, fault clearing, start-up and shutdown procedures, etc.

F. The SUPPLIER and the CONTRACTOR will be one and the same for this contract. There will not be a separate contract for PLC programming.

1.2 APPLICABLE SECTIONS

A. The General Conditions, Supplementary General Conditions, Special Conditions, alternates and Addenda, applicable drawings and the technical specification herein shall apply to work under this Section.

1.3 APPLICABLE REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI X3.64 (1979) Additional Controls for Use with American National Standard Code for Information Interchange

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

EIA232-D (Jan. 1987) Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange

EIA RS-485 (1983) Standard for Electrical Characteristics of Generators and Receivers for Use in Balanced Multipoint System

FEDERAL COMMUNICATIONCOMMISSION (FCC)

FCC Part 68 (July 1986) Connection of Terminal Equipment to the Telephone Network

THE INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC. (IEEE)

IEEE No. 100 (1988) IEEE Standard Dictionary of Electrical and Electronic Terms

IEEE C57.13 (1978) Instrument Transformers

IEEE C62.41 (1980) Surge Voltages in Low-Voltage AC Power Circuits

IEEE 802.3 Carrier Sense Multiple Access/Collision Detection (CSMA/CD)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1985; Incl. Rev. I and 2; ICS-6) Enclosures for Electrical Equipment

NEMA ICS 1 (1988) General Standards for Industrial Controls and Systems

UNDERWRITERS LABORATORIES, Inc. (UL)

UL 50 Enclosures for Electrical Equipment

UL 508 Industrial Control Equipment

1.4 SUBMITTALS

A. Provide complete submittal information for the PLC system. Include manufacturer's data for each part, Bill of Materials, panel fabrication drawings including elevations and complete wiring diagrams with wire and terminal numbers for local and remote terminations. Remote terminations may be submitted with the operational and maintenance information in lieu of the initial equipment submittals.

B. Provide operational and maintenance information.

1.5 RELATED SECTIONS

A. Static Un-Interruptible Power Supply

B. Control Devices

C. Appendix A

PART 2 - PRODUCTS

2.1 PROGRAMMABLE LOGIC CONTROLLER SYSTEM

A. The PLC system shall be Schneider Electric Modicon M340. Provide hardware types as identified in Table 1-1.

TABLE 1-1 PLC HARDWARE

	Part Number
Modicon M340 CONTROL PROCESSOR	
ETHERNET PORT	
I/O Cards compatible with Modicon M340	

Note: System to be installed per manufacturer recommended procedures and installation guidelines. Provide necessary hardware, accessories, fittings, cable, etc. for a complete and functioning system.

2.2 PLC ENCLOSURE AND ACCESSORIES

A. PLC Enclosure and Accessories: The PLC enclosure shall house the power supplies, PLC processor, analog input and output modules, discrete input and output modules, communication module, operator interface terminal (OIT), UPS, thermostatically controlled vent fan and louvers, heater with thermostat, light with integral door switch, relays, terminal blocks, and ancillary components. In addition, provide 25% spare back panel space and space for additional cards as indicated. The PLC shall be equipped with the following accessories, at a minimum:

1. Enclosure: The PLC shall be housed in a NEMA type12 enclosure with a lockable 3-point latch, and an interior swing out panel. The enclosure, swing out panel, vent fan, heater, and light shall be manufactured by Hoffman, or equal.
2. Redundant Power Supplies: Power supply hardware shall include a PLC power supply and redundant 24VDC power supplies as required for Inputs and Outputs (I/O). The redundant power supplies shall be 100 watt, minimum.
3. Fusing: Individual I/O loops shall be individually fused. Fuse holders shall be indicating type.
4. I/O Terminal Blocks: Field wiring DIN rail type terminal blocks. 25% spare terminal blocks shall be provided. Discrete and analog I/O terminals shall be segregated by I/O type.
5. Plastic Snap-On Cover Wire Management Systems: These shall be sized to accommodate all wiring with 25% spare capacity.
6. UPS System: A panel mounted UPS shall be included in each PLC cabinet. The UPS's shall be sized to provide at least 30 minutes of run time for the PLC and all system I/O. UPS systems shall be as specified elsewhere.
7. Transient Voltage Surge Suppression (TVSS): The TVSS system shall protect all power wiring within the PLC enclosure. The TVSS shall be a branch panel model.
8. Work Light and Outlet: A work light utilizing a 32 watt self ballasted compact fluorescent lamp or equal with an integral door operated switch shall be mounted within the enclosure. Enclosures over 4' wide shall include a light in each 4' section. A 20 amp, 120 volt duplex grounded power outlet shall be mounted within the PLC enclosure.
9. Ground Terminals: A screw type bonding terminal strip to which all ground bonding shall take place for all signal reference, TVSS, safety bonding etc. This grounding terminal shall accept a #6 copper ground bonding conductor. 25% spare terminals shall be provided.
10. Enclosure Labeling: The enclosure shall carry a phonetic label indicating the enclosure name, label all pilot devices on the swing out panel, and label all I/O termination modules, relays, power supplies, etc. Internal wiring shall be labeled at each terminal and each terminal shall be labeled, all labeling names and/or numbers shall be reflected on the panel fabrication drawings.

11. Separate Power Warning Signs: The enclosure shall receive power from external sources and shall be labeled with the source of where the external power is derived. Each circuit providing power to the cabinet shall be indicated.

B. Operator Interface Terminal (OIT/HMI): An OIT/HMI shall be mounted in the PLC enclosure swing-out panel. The OIT shall be 7" touchscreen or nearest available size compatible with PLC equipment, with keypad, 24VDC power, color graphics, and Ethernet communications operating from the terminal server with terminal services client software.

1. Provide OIT programming software to the OWNER, registered in OWNER's name.

2. Provide a programming cable for connection to a Personal Computer for the transfer of files.

2.3 INPUT/OUTPUT MODULES

A. Analog transmitters and receivers have 4 to 20 mA signals. Discrete (on/off) inputs (DI) originate from dry contacts. For discrete outputs (DO), provide interposing relays with dry contacts. Refer to the PLC Input / Output Point List, Appendix A, for required inputs and outputs.

B. The discrete input modules shall be 24 VDC.

C. The discrete output modules shall be isolated relay contacts suitable for operating interposing relays. Each discrete output module shall include fuses and fuse blown indicators.

D. The analog input (AI) modules shall be suitable for accepting 4 to 20 mA from 2, 3, or 4 wire transmitters. The input power shall be from an internal or external 24-volt dc power supply. The analog to digital converter shall have a 10-bit minimum resolution with an overall accuracy of $\pm$ .5% at 60ºC.

E. The analog output (AO) modules shall be 4 to 20 mA signals suitable for driving into a 0 to 600 ohm load without load adjustments. The digital to analog converter shall have a 10 bit minimum resolution with an overall accuracy of $\pm$ 2% to 60ºC. The output power shall be from an internal or external, 24 volt dc power supply provided by the SUPPLIER. If the PLC processor fails, the analog outputs shall retain their present value.

F. Discrete PLC I/O modules shall have individual LED status lights for each I/O point. All discrete and analog modules shall have terminal blocks for termination of the I/O wires. Individual I/O points shall be capable of withstanding low energy common mode transients to 1,500 volts.

2.6 PLC START-UP

A. Each PLC shall have start-up software that causes automatic commencement of operation without human intervention, including start-up of all connected I/O functions. A restart program based on detection of power failure shall be included in the software. Upon restoration of power, the program shall restart all equipment and restore all loads to the state at time of power failure, or to the state as commanded by time programs or other overriding programs. The restart program shall include start time delays between successive commands to prevent demand surges or overload trips. The start-up software shall initiate operation of self-test diagnostic routines. If the data base and application software are no longer resident or if the clock cannot be read, the PLC shall not restart and

systems shall remain in the failure mode indicated until the necessary repairs are made. If the data base and application programs are resident, the PLC shall resume operation after an adjustable time delay of from 0 to 600 seconds. The start-up sequence for each device shall include a unique time delay setting when system operation is initiated.

B. Programming software for the PLC shall be provided by the contractor. The programming of the PLC shall be performed by the contractor. All loop testing and debugging shall be performed by the Contractor.

PART 3 - EXECUTION

3.1 PANEL FABRICATION

A. Install each item in accordance with manufacturer's recommendations and in accordance with the Contract Documents.

B. The panel shall be fabricated and UL Listed as an assembly by a qualified panel shop.

3.2 FACTORY TESTING

A. A factory conducted test shall be preformed at the manufacturer's facility upon the completed fabrication of the PLC system. The factory test shall demonstrate the successful operation of inputs and outputs from the field terminal blocks to the PLC. Provide signal generators and measuring devices as needed for a complete and through test.

B. Hardware and software components of the PLC System shall be thoroughly tested and "burned in" by the SUPPLIER. Inform the OWNER 10 working days prior to the testing of the equipment. The OWNER shall witness these tests before shipment to the site.

C. Panel fabrication drawings shall be updated based on the factory test and a current set of drawings shall be shipped with the panel.

D. The SUPPLIER shall be responsible for all transportation, meals, accommodation, and expenses for the OWNER's representative witnessing the factory test.

3.3 OWNER TRAINING

A. Provide the services of a factory trained, manufacturer's representative for instruction of the OWNER's personnel. The training shall include basic PLC and OIT operation overview, I/O module normal and fault condition indications, and equipment maintenance, troubleshooting, and replacement.

B. The operation and maintenance manuals shall be included as a part of the instruction to the OWNER's personnel.

END OF SECTION

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SECTION 16720

MAGNETIC FLOW METERS

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish, test, install, and place into satisfactory operation the magnetic flowmeter systems, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Process Control and Information Systems

B. Instruments, General

PART 2 - PRODUCTS

2.1 MAGNETIC FLOWMETERS

A. Acceptable Manufactures are:
   a. Endress Hauser.
      1) Filter Supplied (2) 16" Flow Meter Model: 5W4C4H-AAELHA0DHA1KGA.
      2) Filter Supplied (1) 10" Backwash Flow Meter Model: 5W4C2F-AAILHA0DHA1KGA.
      3) Filter Supplied (1) 6" Filter-to-waste Meter Model: 5W4C1F-AAILHA0DHA1KGA+AA.
      4) Contractor Supplied (1) 10" Well 12 Flow Meter replacement Model: 5W4C2F-AAILHA0DHA1KGB (0.2% Accuracy)
      5) Contractor Supplied (1) 10" Water Vault Flow Meter Model: 5W4C2F-AAILHA0DHA1KGA
   b. No Substitutions.

B. Process connections shall be flanged, ANSI B16.5, Class 150, raised face.

C. Well Building flow meter shall have local digital display and 4-20 mA HART, pulse/frequency, switch output to the control panel. Transmitter shall be mounted in a NEMA 4X compact aluminum coated enclosure. The meters shall have a hard rubber liner, 316 SS electrodes, and 150 lb flanges. Power supply shall be 110-240VAC/24VAC/DC with ½-inch threaded NPT electrical connection. Flow meter shall be capable of recording forward and reverse instantaneous and totalized flows with ±0.2% accuracy with zero lay length before and after the meter.

D. Magnetic flow meter shall be provided as a system consisting of a flow tube and separate converter/ transmitter complete with interconnecting cables. Converter/transmitter shall be suitable for full-scale flow rates from 3.0 to 30 feet per second. System error shall not exceed the greater of 0.5 percent of rate or 0.1 foot per second. Flow tubes located in lined or non-conductive pipelines shall be provided with grounding spools or swages fabricated from ASTM A312, Type 316 stainless steel. Grounding spools or swages inside diameter shall be 1/16 inch smaller than flow tube inside diameter. Where pipe run size is different from specified flow tube size, uniformly diverging swages with a total angle between walls not exceeding 15 degrees shall be provided. Excitation power requirements shall not exceed 100 volt-amperes.

E. Flow tubes size 0.5 through 6 inches shall be ceramic lined wafer-style ductile-iron body with platinum electrodes. Flow tubes larger than 6 inches shall be cast aluminum full-body flanged construction with 316L stainless steel electrodes. Unless otherwise specified, liner shall be polyurethane.

F. The transmitter shall contain all electronics associated with the magnetic flow meter system. Enclosure shall be NEMA 4 cast aluminum compartment for power, field connections and calibration adjustments separate from digital circuitry. Transmitter shall contain means to calibrate the metering system without use of external calibration units. The transmitter shall contain self-diagnostics and shall be interchangeable with other units of the same type without special re-calibration. Transmitter shall include an integral 3-digit LCD flow indication calibrated in process units. Adjustable dampening shall be provided. Provision for accepting an external contact to force signal output to zero shall be provided. Where pulse frequency output is specified, pulse frequency shall cut out at flows below 2 percent of maximum range. The signal cable between the primary element and transmitter shall be provided by the system manufacturer. A sufficient length of cable shall be provided for installation of a continuous run between the primary element and the transmitter.

G. Remote mounted display/transmitters shall be provided where indicated on the drawings. Flow tubes with integral display/transmitters shall be provided where indicated on the drawings.

H. Magnetic flow meter shall be capable of meeting the specified accuracy requirement with zero lay lengths upstream and downstream from the meter.

PART 3 - EXECUTION

3.1 REQUIREMENTS

END OF SECTION

SECTION 16750

PRESSURE TRANSMITTER

PART 1 - GENERAL

1.0 THE REQUIREMENT

A. The Contractor shall furnish, test, install, and place into satisfactory operation the pressure transmitters, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.1 RELATED WORK SPECIFIED ELSEWHERE

A. Process Control and Information Systems

B. Instruments, General

PART 2 – PRPDUCTS

2.1 PRESSURE TRANSMITTERS

A. Manufacturer

1. Rosemount
2. Dwyer
3. Siemens
4. Emerson
5. Ashcroft
6. Evoqua (USFilter)
7. In Water Valve Vault, Pressure transmitter PT-PSI-105A and PT-PSI-105B shall be 24VCD, 4-20mA, 0-200 psig, Rosemount 2088G3S22A1M4

B. Submersible Level Transmitters

1. Submersible pressure transducer shall be, Dwyer PBLTX, or Evoqua A1000 or equal with Intrinsically Safe barrier for Classified areas. Power supply shall be loop powered 24VDC. Process connection shall be 1/2-inch female NPT flange adapter. Signal output shall be 4 to 20 mA.
2. Transmitter shall be provided with span to match maximum depth of vessel.
3. Transmitter shall be non-clogging and damage resistant to floating solids, suitable for wastewater applications.
4. Transmitter shall be intrinsically safe or loop powered from an intrinsically safe source for classified areas.

C. Gauge Pressure Trasnmitters

1. Power supply shall be 24VDC, powered from PLC panel power supply. Process connection shall be 1/2-inch female NPT flange adapter. Signal output shall be 4 to 20 mA.

2. Pressure transmitter shall be capacitance or resonant-wire type. Unless otherwise specified, wetted parts shall be ASTM A276, type 316 stainless steel. Span shall be adjustable over a 6:1 or greater range. Over range capacity without affecting calibration shall be not less than 200 percent of maximum specified range. Volumetric displacement shall not exceed 0.01 cubic inch over the specified span. Fill fluid unless otherwise specified shall be silicone oil. Adjustable dampening

shall be provided. External zero adjustment shall be provided. Accuracy shall be 0.25 percent of span or better for spans greater than 5 inches water column and 0.5 percent of span or better for spans less than or equal to 5 inches water column.

3. Transmitter shall be provided with the following adjustable range:

Adjustable range of transmitter, water column Span specified in the instrument schedule, water column

Adjustable range of transmitter, water column	Span specified in the instrument schedule, water column
0.5 to 6 inches	0.5 to 5.5 inches
5 to 30 inches	5.5 to 27.5 inches
25 to 150 inches	27.5 to 137.5 inches
125 to 750 inches	137.5 to 750 inches

Higher ranges and spans shall be provided as specified in the instrument schedule. Transmitter for spans less than or equal to 25 psig shall be provided with one 1/2-inch flanged process connection and two 1/4-inch drain/vent ports, one plugged and one provided with bleed valve. Transmitter shall be provided with an evacuated sealed chamber and reference diaphragm shall be provided with a weatherproof, bug proof atmospheric vent. Transmitters for spans greater than 25 psig shall be similar except designed for gage pressure service, and overpressure rating shall be greater than the lesser of 2000 psig and 150 percent of maximum range.

PART 3 - EXECUTION

3.1 REQUIREMENTS

END OF SECTION

SECTION 16751
PROCESS CONTROL STRATEGIES

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. This section includes the process control strategies for this Contract. Together with the process input/output schedule, the equipment specifications (including control strategies for local equipment control panels), and the Drawings, the process control strategies describe the required operation, monitoring, and control of the treatment facilities included in this Contract. The Contractor shall provide all equipment, and services necessary to implement all functions described herein.

B. The Contractor shall be responsible for furnishing functioning systems as described herein. The functional descriptions contain requirements for furnishing and installing labor and materials that may not appear elsewhere in the contract documents.

1.2 GENERAL DESIGN INFORMATION

A. Indicator lights on all MCCs, control panels, starter enclosures, interfaces, etc. shall conform to the following color convention:

Condition	**Color**
Running/Open	Red
Auto	White
Ready/Stopped/Off/Closed	Green
Fail	Amber
Alarm	Amber
Generic Status	Blue or White

B. Running status shall be provided from auxiliary contacts provided with the motor starter. Auto status shall be defined as HOA switch in Auto position. Ready status shall be defined as in remote or auto mode with all interlocks satisfied (no failure conditions present). Stopped and Off status shall be defined as all interlocks satisfied (no failure conditions present), except for no remote or auto mode. Failed status shall be defined as motor overload and/or any other shutdown mode such as over torque, over temperature, low oil pressure, high vibration, etc.

C. A discrepancy failure shall be indicated through the control system for any drive, motor, instrument, etc. that should be running or providing a reading but for which the PLC is not receiving a run status signal or valid reading. An example is a motor which is commanded to run by the control system but is not subsequently detected as running. An adjustable time delay shall be provided for each motor to allow time for the motor to start and satisfy all interlocks.

D. Manual start/stop, open/close, speed/position adjustment, etc., from the Operator work

stations shall be provided for all equipment controlled by the control system.

E. Where devices such as temperature, moisture, and/or vibration sensors, over- or under-pressure protection, space heaters, etc. are provided with process equipment and their associated motors under the various sections of Division 11, the Contractor shall provided all required interconnecting wiring between those devices and their associated MCCs, motor starters, VFDs, local control panels, etc.

F. Where setpoints, operating limits, and other control settings are provided by the process control strategies, these settings shall be initial settings only and shall be used for assistance in the initial startup of the plant. All such settings shall be fully adjustable, and based on actual operating conditions, the Contractor shall make all necessary adjustments to provide smooth, stable operation.

G. The control system shall be capable of receiving inputs of initial run-times for existing and proposed equipment. Initial run-time shall not automatically assumed to be zero.

H. All PLC-controlled equipment shall be provided with adjustable start and stop delays in the control logic. Unless otherwise specified, these delays shall be initially set at one minute. Unless otherwise specified, all equipment shall automatically restart after a power failure utilizing adjustable start delay timers in the MCCs and equipment control panels. All PLC control strategies shall be based upon automatic restart after a power failure and shall return to a normal control mode upon restoration of power either by generator or by utility.

I. All setpoint control shall be by PID control algorithms. Where only proportional control is specified, tuning constants shall be used to reduce the integral and derivative functions to zero. All PLC-controlled variable speed equipment shall be provided with individual speed control PID modules in the PLC which shall be cascaded with the overall setpoint PID modules as required. All setpoints, sequence timers, sequence orders, dead bands, PID tuning parameters, PLC delay timers, variable speed operating range limits, and similar control constants shall be accessible and alterable from the Operator work stations.

J. All pumping systems which contain a wetwell shall be provided with a level sensor in the wetwell to automatically shut down the pumps on low level. The low level shutoff shall bypass PLC control (where applicable) and shall be hardwired directly to the pump starter, VFD, MCC or other control circuitry. The Contractor shall supply all required interposing relays and associated circuitry to multiplex the shutdown signal from the single float switch to all pumps at a given wetwell. The low level shutoff shall also be transmitted to the PLC for alarm logging.

K. All setpoints, alarms, etc. based upon an analog input signal or field variable shall be provided with time delays and dead bands to prevent nuisance tripping of controls and alarms.

L. Elapsed run time shall be determined through the run status input to the PLC.

    1. Elapsed run time shall be displayed at the SCADA level for each and every motor controlled through the PLC system.

    2. Individual elapsed run time accumulation may be reset by the operator after entering a password if the proper security level is associated with said password.

    3. Elapsed run time shall be displayed as 99,999.9 hours after which the elapsed

run time registers shall recycle to 0.0 hours.

4. Provisions shall be made to allow the operator to enter a start value for runtime accumulation.

5. Elapsed run time shall be accumulated and stored in PLC registers and not in the SCADA system.

M. PID control algorithms.

1. PID control algorithms shall have operator selectable slew rates for setpoints that will allow the setpoint to slowly ramp to its final value in order to minimize system disturbance.

a. Individual setpoint slew rates shall be set at a local HMI if available as well as through the SCADA system.

2. Each PID control algorithm shall have a face plate associated with the individual PID control algorithm that shall be displayed at its associated HMI and at the SCADA terminal. Said face plate shall have the following functions:

a. Display Output, CV.

b. Display Setpoint, SP.

c. Display Process Variable, PV.

d. Allow for operator selection of Automatic or Manual control of Output.

e. Under manual control of output allow the Operator to enter the desired output value.

f. Allow for input of the three PID tuning parameters.

N. Programmable settling and proving timers shall be provided in all control sequences for starting and stopping of pumps, in order to let the process settle down before proceeding with any additional control functions.

1. These timers shall be imbedded in the PLC logic, tuned in the field, and listed separately as part of the software submittal and O & M manual.

O. Status indication:

1. All status indication shall match existing status indication in the treatment plant.

P. HMI development shall match existing HMI design requirements in the treatment plant.

Q. Control software and/or hardware shall be so configured and designed as to monitor for loss of analog signal (signal <4 mA), analog signal too large (signal > 20 mA), or rate of signal change too fast (individual rate parameter for each analog input signal to be imbedded in software), when any of these conditions are detected the control system shall alarm this condition, and close the appropriate valve and or stop the appropriate motor in order to prevent the process from running away.

R. The manual control mode shall be completely manual and under the operator control, there shall be no programmed interlocks requiring completion of a previous step before operating a device, unless specifically identified in the individual loop descriptions as occurring in the

manual mode.

S. Number of starts shall be accumulated for each motor.

1. The number of starts for the current day shall be moved into a register and held as the previous day's number of starts at 0:01 hours each day.

2. The number of starts for the current day shall be moved entered into the historical data base time and date stamped at 0:01 hours each day.

3. The current day number of starts shall be reset at 0:01 hours each day.

T. Alarm/Fault Indication/Acknowledgement

1. All Alarm/Fault indication and acknowledgement shall match existing plant system.

U. Historization

1. All values shall be historized on the SCADA side consistent with the owner's existing historization strategy. Consult with owner for historization requirements.

b. Power failure.

1. The control system upon sensing a power failure including when switching to Generator shall store, within, the PLC memory the current status of all equipment, i.e. ON or OFF.

2. Upon restoration of power the control system shall then sequence ON all equipment that was running prior to the power failure condition following the same load step sequences as start-up.

3. For Pump Cycling algorithms, the selected stand-by pump shall not be cycled into operation, or an operating pump into stand-by, but shall keep the same cycle selection for all pumps.

c. PLC System Status

1. There shall be indication within the HMI of the PLC system and communications status. The indication and/or alarm shall match existing indication and/or alarm in the treatment plant.

d. Analog device calibration override.

1. Provide a SCADA screen for each and every analog input that allows the Operator to access said analog input to:

a. Disable the analog input in the PLC control system.

b. Enter a value for the analog input from the SCADA system to the PLC.

c. Hold the last analog input value while the actual analog input is disabled.

2. Provide a SCADA screen for each and every analog output that allows the Operator to access said analog input to:

a. Force an output value entered from the SCADA system to the PLC.

b. Hold the last analog output value while the programmed output is disabled.

PART 2 – PRODUCTS

2.1 CONTROL LOOP DESCRIPTIONS

A. CONTROLLER NAMES

There will 6 controllers on site. For the purposes of clarification within this document, they will be referred to by familiar names.

1. The existing PLC controlling the Booster will be referred to as "BOOSTER PLC". The new replacement Booster PLC will be referred to as the "NEW BOOSTER PLC".
2. The existing PLC controlling Well 12 will be referred to as "WELL 12 PLC". The new replacement Well 12 PLC will be referred to as the "NEW WELL 12 PLC".
3. The new Filter system controller provided and programmed by the filter vendor will be referred to as the "FILTER CONTROLLER"
4. The new Hypochlorite system controller in the new filter building that is provided and programmed by the hypochlorite system vendor will be referred to as the "FILTER BUILDING HYPOCHLORITE CONTROLLER"
5. The new Hypochlorite system controller in the new Well 12 building that is provided and programmed by the hypochlorite system vendor will be referred to as the "WELL 12 BUILDING HYPOCHLORITE CONTROLLER"
6. The new PLC in the filter building is for SCADA purposes to coordinate and provide signals to the other controllers in the filter building. It also provides control and alarms for the building valves, and security. It will be referred to as the "FILTER BUILDING PLC".

B. BOOSTER PLC.

1. The Booster PLC will be replaced with a new PLC with a Modicon M340 to match the GHID standard.
2. The programming and I/O will match the existing programming and I/O, like for like.
3. The additional inputs and SCADA functionality for the Booster PLC include:
    a. AI: AT-30-101A FREE CHLORINE. Historize and report Free Chlorine measurements. Coordinate with GHID for High and Low alarm setpoints.
    b. AI: AT-30-101B TOTAL CHLORINE. Historize and report Total Chlorine measurements. Coordinate with GHID for High and Low alarm setpoints.
    c. AI: AT-30-101C WATER PH. Historize and report Water PH measurements. Coordinate with GHID for High and Low alarm setpoints.
    d. AI: AT-30-101D WATER TEMPERATURE. Historize and report Water Temperature. Coordinate with GHID for High and Low alarm setpoints.
    e. {CCD 1} The new ATS that feeds the Well building will alarm if ATS is not in the Normal position.
    f. NEW CODE IN BOOSTER BUILDING PLC SHALL PREVENT ANY BOOSTER PUMP FROM OPERATING WHILE THE BOOSTER BUILDING ATS IS IN GENERATOR POSITION AND THE WELL PUMP IS RUNNING EXCEPT IF THE MANUAL TRANSFER SWITCH IS ON TEMPORARY GENERATOR POSITION. BOTH BOOSTER PUMPS SHALL STOP WHEN THE WELL PUMP COMMAND IS INITIATED. IN OTHER WORDS, THE WELL PUMP IS NOT INHIBITED BY THE OPERATION OF THE BOOSTER PUMPS, BUT THEY CANNOT BOTH BE RUNNING AT THE SAME TIME. CONSIDER ANY RUN-DOWN TIME IF NEEDED TO ENSURE NO POWER IS BEING

DRAWN FROM BOOSTER AND WELL AT THE SAME TIME. THIS NEW CODE SHALL PREVENT BOOSTER PUMP OPERATION IN ALL CASES INCLUDING IN MANUAL. THIS MAY REQUIRE EITHER ADDITIONAL CODE AND/OR ADDITIONAL WIRING TO ACHIEVE.

C. WELL 12 PLC
   1. The Well 12 PLC will be replaced with a new PLC with a Modicon M340 to match the GHID standard.
   2. The programming and I/O will match the existing programming and I/O, like for like.
   3. WATER VAULT

I/O	TYPE	DESCRIPTION
AI	PT	WATER VAULT SYSTEM PRESSURE
AI	FT	TANK FILL FLOW
AI	YI	TANK FILL VALVE POSITION
DI	FQ	TANK FILL FLOW TOTALIZER
DI	NA	WATER VAULT INTRUSION
AO	YC	TANK FILL VALVE

The Tank Fill Valve although an analog device will function as OPEN and CLOSE commands. When open, it fills the tank. When the tank is full, the valve will close completely until the booster pump(s) empty the tank to the minimum fill line for refilling the tank. The analog position feedback will alarm for a difference between command and feedback positions within a bandwidth for a delay. There is provision for future control to use the valve as a pressure control valve. If during testing of the system with all wells it is found that the well VFD response to under/over pressure is not fast enough, then the valve will be programmed to act quickly to pressure changes, with wells attempting in cascade to maintain 50% flow. This will allow the wells to catch up to the valve and place the valve back in a position to act quickly in either direction.

At all times that the wells are available, the pressure transmitter will be used to control the three wells supplying the water vault line. The three wells will regularly alternate a lead, lag, and lag-lag functionality controlling the VFD speed for each well to maintain the pressure setpoint. VFD's have a minimum speed, and then will turn off as needed. Control bands will prevent frequent start/stops.

SCADA will centrally control to the pressure setpoint and determine the desired lead/lag/lag-lag run/stop and speed of each well and communicate commands and setpoints with all three VFD's via SCADA network.

SCADA will monitor run/stop status and speed feedback as well as the health of the communication link in order to make control decisions and alarm mismatches or faults. A well pump in "OFF", miscommunicating, or otherwise shut down will not be considered available for pressure control.

In the event that there is a manual bypass of the site, or other disruption, then each well will return to legacy control via operator input, controlling independently to the system design pressure with their own local pressure transmitter.

4. The additional inputs and SCADA functionality for the Well 12 PLC besides existing I/O and the new Water Vault points include:
    a. AI: Well Pump Outlet Pressure. Shutdown on high pressure.
    b. AI: Pre-Lube Flow. Start permissive, lube flow for long enough time.
    c. AI: Well Speed Status. Alarm on discrepancy between command and status.
    d. DI: Pump in Auto. Alarm when not in Auto.
    e. DI: Well High Discharge Pressure Shutdown. Shutdown on high pressure. Fail safe shutdown.
    f. DI: VFD Fail.
    g. DI: Hypochlorite system alarm.
    h. DI: VFD Motor RTD High Temp Shutdown. Shutdown on high motor temp.
    i. DO: Well Pump Enable. Start Permissives all OK.
    j. DO: Enable Hypo Dosing. When Well running and flow detected, enable Hypo Dosing.
    k. Coordinate with Owner for any additional points.

D. FILTER CONTROLLER
1. The Filter control narrative is included with the Filter system submittal. It operates the filtration, backwash, and cycling of multiple valves per manufacturer control strategies independent of control initiation from operators or other systems except for supervisory control and operator overrides.
2. The Blower is integral with the Filter system and controlled by the Filter controller. It sends a contact to the Blower starter that closes starter contacts across-the-line to both the blower motor, and the cooling fan.
3. WELL RUN COMMAND AND STATUS: Treating the Filter Controller as a black box, it has very few inputs and outputs from the field. Its most common operation for most plants is different then how it will be operated in this plant. In most plants, the system is to request a well run, and when the run status is received, then backwashing operation will be permitted to proceed. However, for this plant, there are many sources of water passing through the filter system. For the purposes of the Filter controller, the well run command will be unconnected and ignored. The well run status will be assumed always on and set as such for the filter system. In the rare case that there may not actually be water available to the filter system, then the filter controller will be manually shut down.
4. WELL SHUTDOWN COMMAND. In most plants, should there be an emergency shutdown or failure of the filter system, then a well shutdown will be issued so that the water is not pushing against a shutdown filter. However, for this plant, with the many sources of water passing through the system, and the requirement for water to continue to be fed through the site, a well shutdown command from the Filter Controller will be interpreted as a requirement to automatically place the filter building valves in a bypass state, and send an alarm.
5. WHEN BUILDING IS IN BYPASS. When the building is placed in bypass mode manually, the filter controller will have its input (likely the Well Run Status input) dropped. The filter system will automatically position its valves for a shutdown case as defined and programmed by the manufacturer.
6. 10-FIT-101-1 RAW WATER FLOW FILTER 1. AI. Historize and report Raw Water flow live into Filter 1. Shared via comms with Filter Building PLC. Note that the Filter Building PLC receives the totalized flow directly.

I/O	TYPE	DESCRIPTION
AI	FT	LIVE FLOW RATE

7. 10-FIT-101-2 RAW WATER FLOW FILTER 2. Totalized PULSE. Historize and report Raw Water flow totalized into Filter 2. Shared via comms with Filter Building PLC. Note that the Filter Building PLC receives the totalized flow directly.

I/O	TYPE	DESCRIPTION
AI	FT	LIVE FLOW RATE

8. 10-FIT-102 BACKWASH WASTE FLOW. Totalized PULSE. Historize and report backwash waste flow totalized. Shared via comms with Filter Building PLC. Note that the Filter Building PLC receives the totalized flow directly.

I/O	TYPE	DESCRIPTION
AI	FT	LIVE FLOW RATE

9. 10-FIT-103 FILTERED TO WASTE FLOW. Totalized PULSE. Historize and report filtered water to waste flow totalized. Shared via comms with Filter Building PLC. Note that the Filter Building PLC receives the totalized flow directly.

I/O	TYPE	DESCRIPTION
AI	FT	LIVE FLOW RATE

E. FILTER BUILDING HYPOCHLORITE CONTROLLER
1. The Filter Building Hypochlorite Control Narrative is to be included with the hypochlorite system submittal and follow the specification “11400 ONSITE HYPOCHLORITE GENERATION SYSTEM”. It operates the generation, storage, and dosing of Sodium Hypochlorite to the inlet and to the outlet of the filter building.
2. There are two (2) dosing pumps, one for the inlet, and one for the outlet of the filter building.
3. The Hypochlorite controller contains all I/O and programming necessary to run the entire chlorination train independent of control initiation from operators or other systems except for supervisory control and operator overrides.
4. HYPOCHLRORITE DOSING ENABLE. Part of the Hypochlorite controller operation is to enable dosing and regulate dosing rates. An OFF condition will both request a zero dosing rate, and also drop the dosing enable signal. The dosing pump shall not run if the dosing enable signal is dropped. The off condition shall be programmed per the manufacturers recommendation.
5. PRE-FILTER FLOW INPUT. Dosing rates will be programmed using standard algorithms as recommended by the Manufacturer. Part of that algorithm requires on the flow rate of the pipeline in which chlorine injection is occurring. Because there is not a physical flow meter on the pre-filter pipeline, the dosing rate for the Pre-filter dosing pump will be calculated as the sum of flows in each of the lines drawing from the pre-filter pipeline. The sum is 10-FIT-101-1 plus 10-FIT-101-2. This calculation will be performed in the Filter Building PLC, and an Analog Output from that PLC will send to the Filter Building Hypochlorite Controller an analog signal representing the equivalent flow rate of the pre-filter pipeline. This will allow the Filter Building Hypochlorite Controller to maintain its standard implementation of its dosing algorithm from a single flow input.

6. POST-FILTER FLOW INPUT. Dosing rates will be programmed using standard algorithms as recommended by the Manufacturer. Part of that algorithm requires on the flow rate of the pipeline in which chlorine injection is occurring. Because there is not a physical flow meter on the pre-filter pipeline, the dosing rate for the Post-filter dosing pump will be calculated as the sum of flows into the filter system less the sum of the flows to waste. The sum is plus 10-FIT-101-1 plus 10-FIT-101-2 less 10-FIT-102 less 10-FIT-103. This calculation will be performed in the Filter Building PLC, and an Analog Output from that PLC will send to the Filter Building Hypochlorite Controller an analog signal representing the equivalent flow rate of the pre-filter pipeline. This will allow the Filter Building Hypochlorite Controller to maintain its standard implementation of its dosing algorithm from a single flow input.

F. WELL 12 BUILDING HYPOCHLORITE CONTROLLER
1. The Filter Building Hypochlorite Control Narrative is to be included with the hypochlorite system submittal and follow the specification "11400 ONSITE HYPOCHLORITE GENERATION SYSTEM". It operates the generation, storage, and dosing of Sodium Hypochlorite to the inlet and to the outlet of the filter building.
2. There are two (2) dosing pumps, one is to operate as the duty pump, and one to operate as the stand-by pump.
3. The duty and stand-by pump shall be automatically cycled each month, or by operator request.
4. The Hypochlorite controller contains all I/O and programming necessary to run the entire chlorination train independent of control initiation from operators or other systems except for supervisory control and operator overrides.
5. HYPOCHLRORITE DOSING ENABLE. Part of the Hypochlorite controller operation is to enable dosing and regulate dosing rates. An OFF condition will both request a zero dosing rate, and also drop the dosing enable signal. The dosing pump shall not run if the dosing enable signal is dropped. The off condition shall be programmed per the manufacturers recommendation.
6. FLOW INPUT. Dosing rates will be programmed using standard algorithms as recommended by the Manufacturer. Part of that algorithm requires on the flow rate of the pipeline in which chlorine injection is occurring. This will be sent from an analog output of the PLC replicating the 4-20mA input signal coming from the Well #12 pipeline flowmeter. Rather than using a signal splitter, this allows the PLC to have other conditions including PLC failure and well not running status to remove the flow signal to the dosing pumps. Even a failed flow meter artificially obtaining a flow status would then have the backstop of the additional PLC Logic to detect a no flow state.

G. FILTER BUILDING PLC
1. 10-SV-301 RAW WATER ISOLATION VALVE. The raw water isolation valve is open under normal operation. It is closed during bypass of the filter building. It can be opened or closed manually by commands from the operator interface panel. It closes automatically if the filter shutdown input is asserted.

I/O	**TYPE**	**DESCRIPTION**
DO	ZCO	VALVE OPEN COMMAND. FAIL CLOSED.
DI	ZSO	VALVE OPEN STATUS
DI	ZSC	VALVE CLOSED STATUS

INTERNAL	ZSA	ALARM WHEN VALVE STATUS DOES NOT MATCH VALVE COMMAND. DELAY.

2. 10-SV-302 FILTERED WATER ISOLATION VALVE. The filtered water isolation valve is open under normal operation. It is closed during bypass of the filter building. It can be opened or closed manually by commands from the operator interface panel. It closes automatically if the filter shutdown input is asserted.

I/O	TYPE	DESCRIPTION
DO	ZCO	VALVE OPEN COMMAND. FAIL CLOSED.
DI	ZSO	VALVE OPEN STATUS
DI	ZSC	VALVE CLOSED STATUS
INTERNAL	ZSA	ALARM WHEN VALVE STATUS DOES NOT MATCH VALVE COMMAND. DELAY.

3. 10-SV-303 BYPASS VALVE. The bypass valve is closed under normal operation. It is closed during bypass of the filter building. It can be opened or closed manually by commands from the operator interface panel. It closes automatically if the filter shutdown input is asserted.

I/O	TYPE	DESCRIPTION
DO	ZCC	VALVE CLOSE COMMAND. FAIL OPEN.
DI	ZSO	VALVE OPEN STATUS
DI	ZSC	VALVE CLOSED STATUS
INTERNAL	ZSA	ALARM WHEN VALVE STATUS DOES NOT MATCH VALVE COMMAND. DELAY.

4. 10-FIT-101-1 RAW WATER FLOW FILTER 1. Totalized PULSE. Historize and report Raw Water flow totalized into Filter 1. Live value is obtained via communications with SCADA from the Filter Controller.

I/O	TYPE	DESCRIPTION
COMM	FT	LIVE FLOW RATE
PULSE	FQI	TOTALIZED FLOW

5. 10-FIT-101-2 RAW WATER FLOW FILTER 2. Totalized PULSE. Historize and report Raw Water flow totalized into Filter 2. Live value is obtained via communications with SCADA from the Filter Controller.

I/O	TYPE	DESCRIPTION
COMM	FT	LIVE FLOW RATE
PULSE	FQI	TOTALIZED FLOW

6. 10-FIT-102 BACKWASH WASTE FLOW. Totalized PULSE. Historize and report backwash

waste flow totalized. Live value is obtained via communications with SCADA from the Filter Controller.

I/O	TYPE	DESCRIPTION
COMM	FT	LIVE FLOW RATE
PULSE	FQI	TOTALIZED FLOW

7. 10-FIT-103 FILTERED TO WASTE FLOW. Totalized PULSE. Historize and report filtered water to waste flow totalized. Live value is obtained via communications with SCADA from the Filter Controller.

I/O	TYPE	DESCRIPTION
COMM	FT	LIVE FLOW RATE
PULSE	FQI	TOTALIZED FLOW

8. 10-FY-201 CALCULATED RAW WATER INLET FLOW. Calculated and then AO. AO to hypochlorite system to regulate dosing. Raw Water Inlet Flow is the sum plus 10-FIT-101-1 plus 10-FIT-101-2. See also FILTER BUILDING HYPOCHLORITE CONTROLLER above.
9. 10-FY-202 CALCULATED FILTERED WATER OUTLET FLOW. Calculated and then AO. AO to hypochlorite system to regulate dosing. Filtered Water Outlet Flow is the sum plus 10-FIT-101-1 plus 10-FIT-101-2 less 10-FIT-102 less 10-FIT-103. Note that there may be instantaneous cases in which the calculated outlet flow may not represent the actual instantaneous, such as when the filters are filling with raw water. But the totalized flows will eventually align with maximum error equal to a single fill of both tanks. See also FILTER BUILDING HYPOCHLORITE CONTROLLER above.
10. 10-AE-111 FILTERED WATER CHLORINE ANALYZER. Four AI's. Report, historize, hi/lo alarm.

I/O	TYPE	DESCRIPTION
AI	AT	FREE CHLORINE
ALARM	HIGH	HI FREE CHLORINE
ALARM	LOW	LO FREE CHLORINE
AI	AT	TOTAL CHLORINE
ALARM	HIGH	HI TOTAL CHLORINE
ALARM	LOW	LO TOTAL CHLORINE
AI	AT	WATER PH
ALARM	HIGH	HI PH
ALARM	LOW	LO PH
AI	AT	WATER TEMPERATURE
ALARM	HIGH	HI TEMPERATURE
ALARM	LOW	LO TEMPERATURE

11. 10-AE-112 FILTERED WATER AMMONIA ANALYZER. Four AI's. Report, historize, hi/lo alarm.

I/O	TYPE	DESCRIPTION
AI	AT	MONOCHLORAMINE
ALARM	HIGH	HI MONOCHLORAMINE

ALARM	LOW	LO MONOCHLORAMINE
AI	AT	TOTAL AMMONIA
ALARM	HIGH	HI TOTAL AMMONIA
ALARM	LOW	LO TOTAL AMMONIA
AI	AT	FREE AMMONIA
ALARM	HIGH	HI FREE AMMONIA
ALARM	LOW	LO FREE AMMONIA
AI	AT	CL2:NH3 RATIO
ALARM	HIGH	HI CL2:NH3 RATIO
ALARM	LOW	LO CL2:NH3 RATIO

12. 10-AE-113 FILTERED WATER TURBIDITY ANALZYER. One AI. Report, historize, hi alarm.

I/O	**TYPE**	**DESCRIPTION**
AI	AT	TURBIDITY
ALARM	HIGH	HI TURBIDITY

13. 10-TT-101 ROOM TEMPERATURE. One AI. Report, historize, hi/lo alarm.

I/O	**TYPE**	**DESCRIPTION**
AI	TT	BUILDING TEMPERATURE
ALARM	HIGH	HI BLDG TEMP
ALARM	LO	LO BLDG TEMP

14. INTRUSTION ALARM (SECURITY SYSTEM)
    a. All door switches, and the tank hatch shall send an alarm via the security system.

H. NOT CONTROLLED BY PLC
1. FILTER ROOM VENT FAN controlled by a vent fan controller. Hand-Off-Auto control. Auto Control by high temperature, and on a timer for regular cycling of room air.
2. HVAC Equipment controlled by thermostat.
3. ELECTRIC HEATERS controlled by integral thermostat.
4. LIGHTING controlled by light switches with daylight sensors.
5. ATS and Generator by integral controls.

END OF SECTION

SECTION 16760

PRESSURE SWITCHES AND SEALS

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish, test, install, and place into satisfactory operation the pressure switches and seals with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.2 MANUFACTURERS

A. Process Control and information Systems

B. Instruments, General

PART 2 - PRODUCTS

2.1 Pressure Instrumentation

A. Seals

1. All pressure switches and/or transmitters shall be provided with seals.

2. Pressure switches, gages, and/or transmitters and seals shall be assembled and oil filled at the factory prior to shipment. Filling fluid shall be compatible with piping contents and temperature.

3. Pressure switches and/or transducers attached to systems involving chemical solutions, corrosive fluids, or other liquids containing one percent or more of solids, shall be equipped with diaphragm or annular seals whether shown or not on the drawings, or equal protective pressure sensing devices, as follows:

a) Clear process water applications:

1. Type 316 stainless steel for pressures over 15 psi.

2. Elastomer for pressures of 15 psi and below.

3. Type 316 stainless steel nuts and bolts, fill connection and valved flush port size of ¼-inch NPT, capable of disassembly without loss of filler fluid.

4. As manufactured by:

a) Ashcroft Type 101

b) Or prior approved equal.

b) For chemical solutions, sludge, etc., where breakage does not create major shutdown:

1. Seals with PVC body for removable mounting rated at 200 psi.

2. Type 316 stainless steel bolts and nuts

3. ½-inch inlet
4. ¼-inch outlet
5. Liquid-filled with Teflon diaphragm for pressure.
6. Elastomer diaphragm for vacuum service.

c) For sludge, liquids containing solids, pulsating flow:

1. Pressure instrument protectors shall be of the isolation ring type seal with integral instrument removal device.
2. Construction
   a. Unit consists of a body, 360 degree flexible elastomeric cylinder with positive O-ring type sealing arrangement, captive fill fluid and two assembly flanges.
   b. Includes integral instrument removal device to remove instrumentation without interrupting process flow. The isolation ring I.D. shall match the pipeline I.D. The isolation ring O.D. shall not exceed the I.D. of the piping flange bolt circle. Units are designed to fit 135#, 150# and 300# ANSI piping flanges.
3. Materials
   a. Body is 316 Stainless Steel unless otherwise required. Two assembly flanges are 316 S.S. Flexible elastomeric cylinder is Silicone. Captive sensing liquid is glycerin, Silicone or Halocarbon as required for the piped fluid.
4. As manufactured by:
   a. Ashcroft Type 80, 81.
   b. Prior Approved Equal.

B. Pressure Switches High

1. General:
   a. Enclosure NEMA 4X
   b. Manual Reset trip on increasing pressure
   c. DPDT
   d. Actuator Seal: Teflon
   e. Each pressure switch shall have visible scale and contact operation.
2. Pressure switches shall have a contact rating of 10 amperes at 125 VAC.
3. Pressure switches shall be snap-action switches and shall be in general-purpose enclosures at indoor installations, or weatherproof enclosures at outdoor installations.

4. Diaphragm seals shall be provided and included at the locations shown.
5. Automatic reset
6. Standard Ranges:
    a. 10” H20, Proof psi 20, Burst psi 35
    b. 30” H20, Proof psi 20, Burst psi 35
    c. 60” H20, Proof psi 20, Burst psi 35
    d. 100” H20, Proof psi 20, Burst psi 35
    e. 150” H20, Proof psi 20, Burst psi 35
    f. 15” H20, Proof psi 500, Burst psi 1000
    g. 30” H20, Proof psi 500, Burst psi 1500
    h. 60” H20, Proof psi 500, Burst psi 1500
    i. 100” H20, Proof psi 1000, Burst psi 3000
    j. 200” H20, Proof psi 1000, Burst psi 3000
    k. 400” H20, Proof psi 2400, Burst psi 3000
    l. 600” H20, Proof psi 2400, Burst psi 3000
7. As manufactured by:
    a. Mercoid.
    b. Or approved equal.

C. Pressure Switches Low
1. Device identifications.
2. General:
    a. Enclosure NEMA 4X
    b. Manual Reset trip on increasing pressure
    c. DPDT
    d. Actuator Seal: Teflon
    e. Each pressure switch shall have visible scale and contact operation.
3. Pressure switches shall have a contact rating of 10 amperes at 125 VAC.
4. Pressure switches shall be snap-action switches and shall be in general-purpose enclosures at indoor installations, or weatherproof enclosures at outdoor installations.
5. Diaphragm seals shall be provided and included at the locations shown.
6. Automatic reset.

7. As manufactured by:
    a. Mercoid.
    b. Or approved equal.

2.2 SPARE PARTS:

A. The CONTRACTOR shall deliver to the OWNER all required spare parts. The spare parts shall not be used as replacement parts during system start-up or the guarantee period.

PART 3 - EXECUTION

3.1 REQUIREMENTS

END OF SECTION

SECTION 16771
LIQUID LEVEL SWITCHES

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish, test, install, and place into satisfactory operation the liquid level switches with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Process Control and Information Systems

Instruments, General

PART 2 - PRODUCTS

2.1 LIQUID LEVEL SWITCHES

A. Level Switch Tipping Float

1. Device identification.
2. Float actuated switch shall be a dry contact type switch in a hermetically sealed polypropylene casing, suspended on a PVC coated cable.
3. The number of floats per level system shall be as shown.
4. The switch rating shall be at least 10 amps at 120 VAC.
5. Switch set points shall be as shown on the drawings.
6. Mercury switch type capsules are not allowed.
7. As manufactured by:
   a) WE Anderson/Dwyer FSW Series
   b) Or approved equal

B. Room flood monitoring switches

1. Device identification.
2. Stem and mounting shall be 304 Stainless Steel.
3. The float shall be Buna N material.
4. The wetted parts shall be manufactured of Beryllium Copper, Copper Nickel, or Polycarbonate.
5. Dry contact with an electrical rating of 20VA.

6. Operating Temperature of -40 F to 140F.
7. Gems Sensors LS-270 or approved equal.

C. The CONTRACTOR shall deliver to the OWNER all required spare parts. The spare parts shall not be used as replacement parts during system start-up or the guarantee period.

PART 3 - EXECUTION

3.1 REQUIREMENTS

END OF SECTION

SECTION 16772

LEVEL DETECTOR

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish, test, install, and place into satisfactory operation the Radar level sensor and transmitter systems, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Process Control and Information Systems

Instruments, General

PART 1 - PRODUCTS

2.1 LEVEL DETECTOR/WITH REMOTE DISPLAY/TRANSMITTERS

A. The level detector shall be of the non-contact microprocessor based type for

the continuous measurement of liquid levels.

B. The unit shall be a two piece transmitter/display meter and transducer with interconnecting cables.

C. The transmitter shall store the level profile in the computer memory and moment by moment, analyze the profile to determine the actual liquid level.

D. All program data shall be safeguarded internally in non-volatile EEPROM memory.

E. The transducer shall be encapsulated and shall be capable of:

1. Accuracy of ± 0.25% of range.
2. Range 0.8 to 26.2 feet or the maximum depth of the measured material whichever is greater.
3. Provide for flange mounting, or provide wall mounted mounting bracket as detailed on the drawings.
4. With integral temperature compensation or without temperature factors playing into the level measurements.
5. The unit shall utilize a narrow beam transducer which is rated Class 1 Division 1, explosion proof. The unit shall be provided with factory fabricated lead cable integral to sensor unit and shall extend to the meter unit within the electrical room.

F. The control transmitter shall be in a NEMA 6P enclosure with an integral from panel mounted meter indicating in scaled engineering units.

1. The unit shall provide a 4-20 mA analog output signal directly proportional to level, driven from the PLC and its associated power supplies.
2. The unit shall be capable of displaying by software selection:
   a) Distance to liquid surface from transmitter.
3. The unit shall contain four relays for use as programmable alarm or hard-wired control points.
4. Power requirements shall be 24VDC (fed from a UPS via a power supply.)
5. 4-20 mA output into 750 Ohms at 24 VDC.
6. Selectable damping 1 to 10 m/min.
7. 4 button HMI, wall mounted controller allowing for programming from the panel face, including blanking distances and obstruction blanking.

G. The programming unit shall be incorporated into the body of the instrument.

H. Operating temperature range -40º to 60° C.

I. Mount transducer with non-metallic mounting only.

J. Three wire extended range.

K. As manufactured by:

1. Siemens Hydroranger 500 with LR100 series radar.

PART 2 - EXECUTION

3.1 REQUIREMENTS

A. Refer to Instruments, General

B. Transducers shall be provided with flange mounting options. Mount to flanged support rigidly attached to wall or concrete square and plumb to building. Sensor shall be mounted to avoid all signal interferences.

END OF SECTION

SECTION 16912

PRESSURE GAUGES

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish, test, install, and place into satisfactory operation the pressure gauges and seals with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.2 RELATED SPECIFICATION SECTIONS

A. Process Control and information Systems

B. Instruments, General

C. Pressure Switches and Seals

1.3 SUBMITTALS

A. Furnish complete submittals.

B. Product Data

1. Complete manufacturer's brochures; identify instrument construction, accuracy, ranges, materials and options.

2. Complete instrument data sheets, including catalog number and source for determining catalog number for all gauges and seals.

PART 2 - PRODUCTS

2.1 PRESSURE INSTRUMENTATION

A. Seals

1. All pressure gauges shall be provided with seals.

2. Pressure gauges and seals shall be assembled and oil filled at the factory prior to shipment. Filling fluid shall be compatible with piping contents and temperature.

2.2 PRESSURE GAUGES MANUFACTURED UNITS

A. Pressure, Vacuum, Compound Gauges.

1. General

a. Furnish and install pressure and vacuum gauges as specified; complete, including all fittings, snubbers, connections, gaskets, supports and accessories in the locations shown or specified, in accordance with the Contract Documents.

b. Pressure gauges shall be provided whether or not shown on the plans:

1) On suction and discharge connection to all pumps.

2) On discharge connection from blowers and compressors.

3) On each side of pressure reducing valves.

4) In other locations as shown on the P&IDs and/or mechanical plans.

c. Vacuum gauges shall be provided whether or not shown on the plans:

1) On all supply side educator type chemical feeders.

2) In other locations as shown on the P&IDs and/or mechanical plans.

d. Sleeve pressure gauges

1) Shall be provided where shown on the plans.

2) Pressure shall be sensed by a flexible sleeve contained in a flanged cast iron or steel spool or wafer body, and transmitted to the gauge through a captive fluid.

3) Sleeve shall be of BUNA A and fabricated so as to isolate the body from the process liquid.

4) Gauges shall be calibrated to read in applicable units.

5) Accuracy of ±1% to 150% of the working pressure of the system to which they are connected.

2. Construction

a. Gauges shall be industrial quality type with all Type 316 stainless steel construction.

b. Glycerin filled.

c. All wetted parts shall be stainless steel with a Teflon lined diaphragm..

d. Unless otherwise shown or specified, gauges shall have:

1) A 4 inch minimum dial.

2) ½ inch threaded connection.

3) Type pulsation dampener adapter.

4) A block and bleed valve – ½ inch national pipe thread process connection and bleed/calibrate valve between block valve and outlet port.

e. Gauges shall be calibrated to read in applicable engineering units with the normal operating pressure at 70% of full scale.

f. Accuracy of ±0.5% to 150% of the working pressure or vacuum of the pipe or vessel to which they are connected.

g. All gauges shall be vibration and shock resistant.

3. Seals

a. Gauges attached to systems without particulates shall be equipped with seals.

4. Gauges general as manufactured by:

a. WIKA Industrial Sealgauge®, Type 432.50

b. Or approved equivalent.

5. Gauges sleeve pressure as manufactured by:

a. Red Valve Co., Inc.

b. Ronningen-Petter.

c. Onyx.

d. No Equal.

6. Snubbers as manufactured byL

a. Cajon Co.

b. Weksler Instruments, Corp.

c. Ashcroft.

d. No Equal.

7. Pulsation dampeners as manufactured by:

a. Cajon Co.

b. Weksler Instruments, Corp.

c. Ashcroft.

d. No Equal.

2.3 ACCESSORIES

A. Annular pressure isolator in-line diaphragm type (for pressure gauges).

1. Provide in-line diaphragm pressure sensor for all sewage and sludge piping where shown on the drawings. Contractor shall furnish and install all material required to accommodate the installation of the in-line pressure sensor.

2. The in-line diaphragm pressure sensor shall be provided with flanged ends. The sensor body shall be carbon steel (non-wetted) with Buna N sleeves. All wetted materials shall be suitable for wastewater service.

3. The in-line diaphragm pressure sensor shall be the same diameter as the piping to which it is to be installed.

4. Pressure gauges, switches, and transmitter shall be factory mounted and calibrated and shall conform with Divisions 11, 13, 15 and 16.

B. Product and Manufacturer.

a. Ashcroft Type 80 (wafer).

b. Ashcroft Type 81 (bolt-through, flanged)

c. Or approved equal.

2.4 SOURCE QUALITY CONTROL

A. All instruments and/or representative instruments shall be calibrated to, and in facilities with instruments traceable to the National Bureau of Standards.

1. Provide complete documentation covering the traceability of all calibration instruments.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the complete set of plans, the process fluids, pressures and temperatures and furnish instruments that are compatible with installed process condition.

3.2 PREPARATION

A. Coordinate the installation with all trades to ensure the mechanical system has all necessary appurtenances, weldolets, valves, orientation, etc. for proper installation of the instruments.

3.3 INSTALLATION

A. All instruments shall be installed in strict conformance with the manufacturer's recommendations.

1. It is the CONTRACTOR's responsibility to install all instruments in conformance with manufacturer's recommendations.

2. It is the CONTRACTOR's responsibility to notify the ENGINEER of any installation conditions that may be shown at variance with the manufacturer's recommendations.

B. Install two 2 –valve instrument manifolds for each gauge pressure transmitter.

C. Bolt 3 valve manifolds at non-flange diaphragm type differential pressure transmitters in place of standard flange adapters.

D. Install root valves at process taps except insertion elements.

E. Install gauge valves on process connections to instruments where multiple instruments are connected to one tap or where root valves are not readily accessible.

F. All gauges shall be installed with the face in the vertical position.

G. In strict accordance with the manufacturer's printed instructions.

H. At the locations shown on the drawings, when so shown.

I. Care shall be taken to minimize the effect of water hammer or vibrations on the gauges.

J. In extreme cases, and with the approval of the ENGINEER, gauges may be mounted independently, with flexible connectors.

3.4 FIELD QUALITY CONTROL

A. The Instrumentation and Control Systems Contractor shall calibrate all instruments in the field during the Calibration and Loop Validation Tests as identified.

3.5 ADJUSTING

A. All instruments shall be field verified.

3.6 DEMONSTRATION

A. Performance of all instruments shall be demonstrated to the ENGINEER prior to commissioning.

3.7 PROTECTION

A. All instruments shall be fully protected after installation and before commissioning.

The CONTRACTOR shall replace any instruments damaged prior to commissioning.

1. The ENGINEER shall be the sole party responsible for determining the corrective measures.

END OF SECTION

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SECTION 16913
CONTROL DEVICES

PART 1 - GENERAL

1.1 SCOPE

A. This section sets forth the general specification and requirements for the control devices that shall be provided with control panels, motor starters, and other enclosures in order to assemble a complete and operable control, alarm, or indicating system.

B. The SUPPLIER shall coordinate the installation of items specified herein as required to ensure the complete and proper interfacing of all the components and systems.

1.2 APPLICABLE SECTIONS

A. The General Conditions, Supplementary General Conditions, Special Conditions, alternates and Addenda, applicable drawings and the technical specification herein shall apply to work under this Section.

1.3 APPLICABLE REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1985; Incl. Rev. I and 2; ICS-6) Enclosures for Electrical Equipment
NEMA ICS 1	(1988) General Standards for Industrial Controls and Systems

UNDERWRITERS LABORATORIES, Inc. (UL)

UL 50	Enclosures for Electrical Equipment
UL 508	Industrial Control Equipment

1.4 SUBMITTALS

A. Provide complete submittal information for the “control devices”.

B. Comply with the following requirements:

1. Submit certified dimensional drawings and manufacturer’s data sheets for each size and type of device specified herein to be utilized. Data sheets are to be highlighted to define the specific materials of construction and features specified herein along with detailed manufacturer’s model number.

2. Submit instruction bulletins for each type of control device. The instruction bulletins shall include installation instructions, wiring diagrams, power requirements, maintenance instructions, calibration instructions, and any other details of a specialized nature to the devices furnished.

C. Additional submittal requirements:

1. Circuit Breakers and/or fuses:

a. Provide a complete schedule showing load and rating of circuit breakers and/or fuses.

2. Control power transformers and/or power supplies:

    a. Provide complete sizing calculations in accordance with the requirements identified herein.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturers have been indicated for various specified devices to establish the standard of quality and performance of the equipment to be supplied.

B. Devices of a given type shall be of the same model, class, or rating, have the same general appearance, and be from the same manufacturer.

2.2 GENERAL REQUIREMENTS

A. Analog measurements and control signals shall:

1. Be electrical as indicated herein, and shall vary in direct linear proportion to the measured variable, except as noted.

2. Electrical signals outside control panels shall be 4 to 20 mA DC, except as noted.

3. Signals within enclosures may be 1 to 5 VDC, or 0-10 VDC.

4. Dropping resistors shall be installed at all field side terminations in the control panels to ensure loop integrity.

B. Control panels provided with integral power supplies and control power transformers shall be configured to match the voltage and current requirements of the loads.

C. Each control loop or instrument shall have an individual circuit breaker or fuse within its respective control panel and clearly identified for function.

D. Each PLC output shall have its own individual fuse external of the I/O card, with blown fused indication.

1. Size external fuse to open before any I/O card mounted fuses.

F. Signal isolators, Signal Converters, and Power Supplies:

1. Signal isolators shall be furnished and installed in each measurement and control loop, wherever required:

    a. To ensure adjacent component impedance match.

    b. Where feedback paths may be generated.

    c. To maintain loop integrity when the removal of a component of a loop is required.

2. Signal converters shall be included where required to resolve any signal level or signal type incompatibilities.

3. Power supplies shall be included, as required by the device manufacturers' load characteristics, to ensure sufficient power to each loop component.

2.3 CONTROL DEVICES

A. Signal Isolators and Converters.

1. Signal isolators shall have complete isolation of input, output and power input.
    a. Signal input shall be 4-20 mA into 50 ohms, maximum.
    b. Signal output shall be 4-20 mA into 1000 ohms, minimum.
    c. Power input shall be 120 VAC, 60 Hz or 24 VDC.
    d. Span and zero shall be adjustable.
    e. Accuracy shall be ±1 percent of span.
    f. Units shall be surface or DIN rail mounted.
2. Signal Converters
    a. Signal inputs of 1-5 V, 0-10 V, ect.
    b. Signal output shall be 4-20 mA into 1000 ohms, minimum.
    c. Power input shall be 120 VAC, 60 Hz or 24 VDC.
    d. Span and zero shall be adjustable.
    e. Accuracy shall be ±1 percent of span.
    f. Units shall be surface or DIN rail mounted.
3. Acceptable manufacturers:
    a. Accromag.
    b. AGM Electronics Model TA-4000.
    c. Or approved equal.

B. Relays
1. General Purpose Relays:
    a. General purpose relays shall be plug-in type.
    b. Contacts rated 10 amperes at 120 volts AC.
    c. With LED indication when engergized.
    d. Quantity and type of contacts shall be as shown on the Plans or as needed for system compatibility.
    e. Each relay shall be enclosed in a clear plastic heat and shock resistance dust cover.
    f. Sockets for relays shall have screw type terminals.
    g. Provide transient surge protection across the coil of each relay.
    h. Relays shall be:
        1) Potter and Brumfield Type KRP or KUP.
        2) IDEC.
        3) Square D Type K.
        4) Allen Bradley.

5) Or approved equal.

2. Slave and Interposing Relays:
    a. Additional slave relays shall be provided when the number or type of contacts shown exceeds the contact capacity of the specified relays and timers.
    b. Additional relays shall be provided when higher contact rating is required in order to interface with starter circuits or other equipment.
    c. Shall be provided to compensate for voltage drop due to long wire runs.
    d. The slave and interposing relays shall be as the general purpose relays.
    e. Provide transient surge protection across the coil of each relay.
3. Time Delay Relays
    a. Time delay relays shall be pneumatic on-delay or off-delay type.
    b. Contacts shall be rated 10-amperes at 120 VAC.
    c. Units shall be including adjustable dial with graduated scale covering the time range in each case.
    d. Provide transient surge protection across the coil of each relay.
    e. As manufactured by Agastat, Series 7000.

C. Manual Operators and Interface Devices - Unclassified Areas
1. General Requirements
    a. NEMA Type 13 Oil tight.
    b. With synthetic rubber gasket.
    c. Heavy duty.
    d. Industrial grade full size 1 – 13/64” diameter.
2. Pushbutton Units:
    a. Contacts rated:
        1) NEMA A600.
        2) 600 VAC maximum.
    b. Color Code:
        1) Red - Stop
        2) Green - Start
        3) Orange - Open
        4) Blue - Closed
    c. As manufactured by:
        1) Allen Bradley 800T.
        2) Square D Type K.

3) Cutler-Hammer 10250T Series.

d. Furnish one spare normally open and normally closed contact with each switch.

3. Selector Switches:

a. Contacts rated:

1) NEMA A600.

2) 600 VAC maximum.

b. As manufactured by:

1) Allen Bradley 800T.

2) Square D Type K.

3) Cutler-Hammer 10250T Series.

c. Furnish one spare normally open and normally closed contact with each switch.

4. Pilot Lights:

a. Transformer type LED pilot lights.

b. 120 VAC.

c. Push to Test type.

d. As manufactured by:

1) Allen Bradley.

2) Square D Type K.

3) Cutler-Hammer 10250T Series.

D. Manual Operators and Interface Devices - Corrosive Areas

1. General Requirements:

a. NEMA 4X corrosion resistant.

b. Exterior parts to be made of high impact strength fiberglass reinforced polyester or other corrosion resistant materials.

c. Incorporating an internal neoprene boot which completely encloses all internal parts.

e. Industrial grade full-size 1 – 13/64” diameter.

2. Pushbutton

a. Having an integral wiping gasket around the pushbutton that cleans the wall of the pushbutton guard of any foreign material accumulation as the button is operated.

b. Contacts rated:

1)NEMA A600.

2)600 VAC maximum.

c. Color code:

1) Red - Stop
2) Green - Start
3) Orange - Open
4) Blue - Closed

d. As manufactured by:
1) Allen Bradley NEMA 4, 4X – 800H.
2) Crouse Hinds NPB1211.
3) Cutler-Hammer E34 Series.
4) Square D Type SK.

3. Selector Switches:
a. Contacts rated:
1) NEMA A600.
2) 600 VAC maximum.

b. As manufactured by:
1) Allen Bradley NEMA 4, 4X-800H.
2) Crouse Hinds NW 12221.
3) Crouse Hinds NSW 12321.
4) Cutler-Hammer E34 Series.
5) Square D Type SK.

c. Furnish one spare normally open and normally closed contact with each switch.

4. Pilot lights:
a. Transformer type LED pilot lights.
b. 120 VAC.
c. Push to test.
d. Light colors shall be as identified on the Plans.
e. As manufactured by:
1) Allen Bradley NEMA 4, 4X-800H.
2) Crouse Hinds NW 12221.
3) Crouse Hinds NSW 12321.
4) Cutler-Hammer E34 Series.
5) Square D Type SK.

E. Terminal Blocks
1. Din rail mounted.

2. Terminal to be of the tubular screw type with pressure plate to minimize the possibility of breaking wire strands during tightening.
3. Recessed terminal hardware to minimize the possibility of contact with current carrying parts.
4. Molded of high dielectric material.
5. Minimum rating 600 VAC, 30 amp.
6. External connections to and from all control panel must be via terminal blocks, including power, control, alarm, instrumentation, monitoring, and solenoid circuits.
7. Individual terminals and terminal blocks shall be marked in a permanent manner with printed identification.
8. As manufactured by:
    a. Entrelec M 4/6
    b. Phoenix Contact UK 5 N
    c. Or approved equal

F. Conductors within Control Panels
1. Single conductors shall be as follows:
    a. Material: Soft annealed coated copper per ASTMB33 or B189.
    b. Standard: ICEA S-19-81.
    c. Stranded Wire - Class B.
    d. Insulation and Coverings:
        1) Thickness: Per ICEA.
        2) Material:
            a) No. 8 and Smaller: Type XHHW single conductor, copper power cable, moisture resistant, flame retardant thermoplastic insulation, 600 volt, 75 °C.
            b) No. 6 and larger: Type XHHW-2 single conductor, copper power cable, heat and moisture resistant, flame retardant, thermoplastic insulation, 600 volt, 75°C.
    e. No. 14 AWG minimum, shall be used for field control circuits, unless otherwise noted.
    f. No. 16 AWG minimum, Type MTW shall be used for all PLC I/O connections within the panel; between I/O device and field wiring terminal blocks.
2. Instrumentation Cable (Shielded Twisted Pair STP):
    a. Minimum conductor size 18 AWG.
    b. Stranded and tinned copper conductors.
    c. Polyethylene conductor insulated.
    d. Foil aluminum-polyester shield – 100% shielding.

e. Minimum 18 AWG, stranded, tinned, copper drain wire.

f. PVC outer jacket.

g. UL Listed, TC rated.

h. 600 volt insulation level.

G. Wire markers:

1. Conductors within the control panel are to be permanently marked with wire numbers at each end.

2. Wire numbers are to correspond to the wire numbers indicated on the submittal drawings and are to correspond to the terminal block number to which they are attached in the control panel.

3. Markers shall be heat shrinkable tubing, imprinted type wire markers.

4. Manufacturers:

a. 3M.

b. Thomas & Betts.

c. Panduit.

H. Nameplates:

1. Nameplates: Engraved three-layer laminated plastic, white letters on black background.

2. Control components within the control panel shall have nameplates secured with stainless steel screws. Nameplates cannot be attached to the covers of the panel wireways.

3. The enclosure and components on the front cover or interior swing out panels shall be identified by nameplates.

a. Use standard manufacturer engraved nameplates for all pushbuttons, and selector switches only if color matches that specified for engraved nameplates. If not, then furnish nameplates to match colors as specified herein.

b. Use engraved plastic laminated nameplates for all other devices, displays, keypads, and annunciator LED's.

c. For NEMA 12, 4, and 4X enclosures, use an epoxy based adhesive to affix nameplates to enclosure cover.

4. A nameplate shall be provided for each signal transducer, signal converter, signal isolator, power supply, relay, terminal strips, and the like mounted inside the panel. The nameplate nomenclature shall match the component names identified in the submittal drawings.

5. Lettering, styles, abbreviations and sizes shall be in conformance with ISA-RP-60.6 (1984) with an intended viewing distance of 3 to 6 feet for external nameplates and 1 to 2 feet for internal nameplates.

I. Control Circuit Breakers:

1. Each 120 VAC control circuit, instrument, or loop shall be powered from an individual control circuit breaker.
2. Din rail mounted using the same DIN rail as used for the terminal blocks.
3. Manual ON-OFF Switch.
4. Rated 240 VAC.
5. Rated 2000 AIC.
6. Current ratings as needed load served.
7. Provide complete nameplate identifying each circuit.
8. As manufactured by:
    a. ABB
    b. Phoenix Contact
    c. Entrelec
    d. Square D

J. Fused Terminals:

1. Isolate all PLC Digital Outputs with fuses.
2. Isolate all PLC Digital Inputs with fuses.
3. Isolate all PLC Analog Inputs and Outputs with fuses.
4. Coordinate fuse size to be as recommended by the manufacturers. For PLCs, the fuse size to be below internal output protection of the PLC output module.
5. Fuses to be terminal block mounted.
6. Furnish nameplate identifying each fused terminal.
7. As manufactured by:
    a. Entrelec
    b. Phoenix Contact
    c. Or approved equal

K. Field / Remote Connections:

1. Field/remote connections shall be made at terminal blocks within the panel.
2. Furnish an individual terminal block space for each wire.
    a. Two wires on one terminal block will not be allowed.
3. Furnish an empty wire channel on the backpanel adjacent to the field/remote terminal block strip to be used to route the field/remote wires to the connection terminal blocks.
4. Provide spare terminal blocks as specified herein.

L. Control Voltages:

1. Control voltage shall be supplied via control circuit breakers in the panel.

2. Control power shall be sourced from the 120V power supplied to the panel, unless otherwise noted in the Plans.

3. AC control voltages other than that supplied shall be transformed via a control power transformer within the panel. DC control voltages shall be supplied by AC to DC power supplies, specified herein.

M. Control Power Transformers:

1. Low impedance type.

2. The control power transformers shall have fused over current protection on both the primary and secondary sides of the transformer.

3. Use actual coil power factors in calculating the VA rating of the transformer. Use a power factor of 35% if power factor of coils is unavailable.

4. Determine the continuous VA rating of the transformer based on maximum sealed VA load current from the coils of the starters, relays, and pilot lights. Maximum inrush current shall be calculated based on the maximum inrush of devices that can be energized at one time plus the load presented by the devices already energized, and the actual power factor of the loads. This maximum inrush current must not cause the secondary voltage of the transformer to fall below 85% of rated voltage when the primary voltage has been reduced to 90% of rated voltage. Based on these calculations then actual transformer size shall be the calculated value times 1.5.

N. Transient / Surge Protection

1. Data and Signal Line Protectors to be used on each and every analog input or output, and on each and every data and signal line external connection point:

a. Provide electronic circuits and components from damaging surge voltage and currents.

b. Provide protection of signal and data lines associated with computer, data, communications, instrumentation, broadcasting, and industrial control interfaces.

c. Shall be used directly with EIA standard interfaces:

1) RS-232

2) RS-422

3) RS-423

4) RS-485

5) 4-20 mA instrumentation loops.

d. Repeatedly provide protection against surge currents in excess of 10,000 Amps.

e. DIN rail mounted.

f. Cable shields shall be passed through and may be either grounded or not grounded at the protector.

g. System:

1) Heavy duty multi-staged protectors.

2) Solid state stage intercepts the leading edge of the surge with sub-nanosecond response time.

3) Within micro-seconds, a 3-pole common chambered gas tube capable of handling 20,000 ampere lightning current operates and crowbars the surge to ground.

4) The protector remains in the crowbar state until the surge has passed and line voltages return to safe levels.

h. Location:

1) Place at each end of a signal line, data line, or current loop.

2) In the case of daisy chain configuration, such as RS-485, protectors shall be placed at each node.

i. Electrical Characteristics:

1) Surge Life:

a) Greater than 1000 operations with 200 Amps, 10 x 100 µsec.

b) Greater than 10 operations with 10,000 Amps, 8 x 20 µsec.

2) Leakage current at rate line to ground voltage < 10 µAmps.

3) Signal/Data attenuation at maximum data rate 3 db with 600 terminations.

4) Operating temperature -40°C to +60°C.

j. As manufactured by:

1) Joslyn:

a) For differential signals, such as RS-422 or RS-485, and current loops – Model 1820.

b) For high frequency differential signals and current loops – Model 1821.

c) For line to ground protection, two separate circuits, and ground referenced signals (RS-232) and 4-20 mA loops where the return wire is grounded at the protector – Model 1810.

d) For high frequency line to ground protection, two separate circuits, and ground referenced signals (RS-232) and 4-20 mA loops where the return wire is grounded at the protector – Model 1811.

2. Protection from inductive spikes within the control panel.

a. Provide surge protection across all inductive coils for control relays, starters, solenoids, etc.

O. Power Supplies: Power supplies shall convert 120 VAC ±10% to 24 volt DC or other DC voltages as necessary.

1. Power supplies shall have an excess rated capacity of 40 percent or be rated 100 watt minimum.

2. The failure of a power supply shall be annunciated at the control panel and repeated to the SCADA system through a connection to PLC.
3. Output regulation shall be accurate within ±0.05% for a 10% line change or a 50% load change and shall include remote voltage sensing.
4. The power supply shall be rated for temperatures of 32 to 122 degrees F and shall be UL recognized.
5. Power supplies shall have fully isolated primary and secondary coils which shall be surrounded by an insulating enclosure which shall also provide mechanical isolation.
6. All power supplies shall be designed and configured as fully redundant systems so that the failure of one power supply will automatically transfer to the other power supply with no interruption in power.
    a. The power supply failure shall supply a dry contact for connection to a PLC input for an alarm indication.
7. As manufactured by:
    a. Power One W Series.
    b. Phoenix Contact Quint Series.
    c. IDEC Slim Line.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Conform to all application provisions of the NEMA and UL standards, NEC and local, state, and federal codes when fabricating the equipment.

B. Install each item in accordance with manufacturer's recommendations and in accordance with the Contract Documents. Locate devices, including accessories, where they shall be accessible from grade, except as shown otherwise.

C. Mount components in accordance with the installation details as prepared by the manufacturers.

D. Mount equipment so that each device is rigidly supported, level and plumb, and in such a manner as to provide accessibility; protection from damage; isolation from heat, shock, and vibration; and freedom from interference with other equipment within the panel.

E. Items, components, devices, and accessories shall be mounted and anchored using stainless-steel hardware, unless otherwise noted.

3.2 SPARES

A. Unused inputs and outputs from the PLC shall be wired to field terminal blocks and identified.

B. Furnish one spare normally open and one spare normally closed dry contact for each push-button, selector switch, relay, etc.

C. Furnish ten spare fuses for each type of fuse in the panel.

D. Furnish 15 spare terminal blocks or 20% whichever is greater.

E. Furnish five spare relays for each type used in the panel.

F. Spare contacts of relays, switches, etc., shall be internally wired to terminal blocks.

END OF SECTION

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SECTION 16913.16
CHLORINE ANALYZER

PART 1 GENERAL

1.1 Section includes

A. Potentiostatic chlorine analyzer for continuous measurement free chlorine in aqueous solutions.

1.2 Measurement Procedures

A. The method of measuring free chlorine will be with a three-electrode potentiostatic sensor immersed into an electrolytic medium with a gold electrodes, selective to free chlorine, separating it from the sample.
B. pH and Temperature correction
   1. pH compensation by included 0-14 pH measurement
   2. Temperature compensation by Pt-100 temperature measurment

1.3 Alternates

A. Other methods of chlorine measurement, such as a two-electrode amperometric and amperometric requiring a flexible replaceable membrane plus electrolyte are not acceptable.

1.4 System Description

A. Performance Requirements
   1. Measurement range selectable: 0-1000 ppb, 0-5 ppm, 0-10 ppm, and 0-20 ppm chlorine for free chlorine.
   2. Free Chlorine
      a. Low Limit of Detection (LOD): 40 ppb (0.04 ppm) or better
      b. Response time: ~21s for 90% change (T_{90}) (At a stable T and pH)
      c. Interference: Chlorine Dioxide, and Ozone
   3. Drift: <10% with regular calibration (calibration will be weekly to quarterly depending on the application, given stable sample temperature and pH of water sample)
   4. Specificity/Selectivity: free chlorine
   5. Calibration method: A one point
   6. Verification procedure: One-point process calibration (slope) against a standard reference method.
   7. Measurement Ranges:
      a. Free chlorine: 0-10mg/L
      b. Temp: 0-50degC (32-122F)
      c. pH: 0-14
      d. Total chlorine: 0-10mg/L

1.5 Certifications (when connected to a Kuntze Krypton Multi system):

A. CE-Symbol: The product meets the requirements of the Harmonized European standards and complies with the legal requirements of the EC directives

B. EMC: EN 61000 6-1 (3) EN 61000 6-2 (4) EN 61326-1

C. Rating: Front IP54; IP65

1.6 Environmental Requirements

A. Operational Criteria
   1. Operating temperature: -5 to 50 °C (23 to 122 °F)
   2. Relative humidity: 0-95%, non condensing

B. Sample Requirements
   1. Maximum back pressure the chlorine sensor can manage without failure:
      a. 6.0 bar (87 psi)
   2. Temperature: 0 to 50 °C (32 to 122 °F)
   3. Temperature compensation range: 0 to 50 °C (32 to 122 °F)
   4. Flow: 35 – 400 L/hr (Instrument Controlled at 30 L/hr)
   5. Pressure: 6.0 bar (87 psi)

C. Storage Requirements
   1. Chlorine sensors: 0 to 30°C (32 to 86°F)

1.7 Warranty

A. The product includes a one-year warranty from the date of shipment.

1.8 Maintenance Service

A. Scheduled maintenance:
   1. Calibration by comparison with lab method: every 1 month or as necessary
   2. Automated cleaning can be programmed via ASR

B. Unscheduled maintenance
   1. Cleaning as needed based on environmental conditions.
   2. Working electrode tip scrubbing with wet paper towel and granular cleaning detergent.

PART 2 PRODUCTS

2.1 Manufacturer

A. Kuntze Instruments, Meerbusch, Germany
   1. Model Krypton Multi Reagentless Free Chlorine Analyzer

2.2 Manufactured Unit

A. The Kuntze Krypton Multi analyzer consists of:

1. Three Electrode Potentiostatic sensor that employs a two gold measuring electrodes.
2. Argon® StabiFlow Assembly that incorporates an inlet and outlet with stop cocks, sampling point, holder for FCL sensor, flow control, filter, check valve multisensor for flow monitoring and temperature
3. Neon Multi controller with five 4-20mA outputs, four control relays, four alarm relays.
4. Pre-assembled PVC panel mount

2.3 Equipment

A. The Zirkon® DIS FCL sensor work with Kuntze Neon controllers. (Specific controller specifications can be found in the associated sensor CSI specifications)
B. The potentiostatic cell of the sensor consists of:
   1. Two gold electrodes
   2. Silver/silver chloride/Tepox-Gel reference electrode
C. Wetted materials as follows:
   1. Chlorine Measuring Cell: Acrylic
   2. Chlorine Sensor Body: Glass
   3. Chlorine Sensor Flow Cell: Acrylic
   4. Optional pH Sensor Flow Cell: Acrylic
D. The chlorine sensor automatically compensates for temperature utilizing an external temperature sensor.
E. The panel assembly includes a flow control and monitoring.

2.4 Components

A. Standard equipment:
   1. PVC Mounting Panel
   2. Chlorine Sensor with gold electrodes
   3. Stabiflow Assembly with temperature sensor/flow monitor
   4. User Manual
B. Dimensions
   1. Sensor
      a. Length: 5.94 in. (151mm)
      b. Diameter: 0.47 in. (12 mm)
   2. Panel
      a. Length: 19.7 in. (500 mm)
      b. Width: 15.8 in. (400 mm)
      c. Depth: 6.3 in. (160 mm)

C. Weight
   1. Complete panel: approximately 14 lbs. (6.4 kg)

PART 3 EXECUTION

3.1 Preparation

A. Clearances
   1. The pre-assembled analyzer panel must be mounted to allow clearance for sensor removal and routine maintenance.
B. Mounting
   1. Wall or panel mounted
C. Sample Inlet (Metric Fittings)
   1. Metric Fittings
      a. Tube Connector DN 6/8 ¼”
D. Sample Outlet Metric (Fittings)
   1. Metric Fittings
      a. Tube Connector DR 6/8 ¼”

3.2 Installation

A. Contractor will install the analyzer in strict accordance with the manufacturer’s instructions and recommendation.
B. Manufacturer’s representative will include a half-day of start-up service by a factory-trained technician, if requested.
   1. Contractor will schedule a date and time for start-up.
   2. Contractor will require the following people to be present during the start-up procedure.
      a. General contractor
      b. Electrical contractor
      c. Kuntze factory trained representative
      d. Owner’s personnel
      e. Engineer

3.3 Manufacturer’s Service and Start-Up

A. Contractor will include the manufacturer’s services to perform start-up on instrument to include basic operational training and certification of performance of the instrument.
B. Contractor will include a manufacturer’s Service Agreement that covers all the manufacturer’s recommended preventative maintenance, regularly scheduled calibration and any necessary repairs beginning from the time of equipment startup through to end user acceptance / plant turnover and the first 12 months of end-user operation post turnover.

END OF SECTION

SECTION 16913.19

Turbidity Analyzer

PART 1 GENERAL

1.1 Section includes:

A. Instrument for monitoring turbidity in water accordance/compliance with DIN EN ISO 7027.

1.2 Measurement Procedures

A. The method of measuring turbidity will be nephelometric using pulse scattered infrared light at 860nm at a 90° angle in accordance with/compliance with DIN EN ISO 7027.

1.3 Alternates

A. Other methods of turbidity measurement including those that require a sample cell, those with incandescent light sources, or turbidimeters used for EPA reporting are not acceptable.

1.4 System Description

A. Performance Requirements
   1. Range
      a. 0.0001 to 1000 FNU (1 FNU = 1 NTU)
   2. Resolution
      a. 0.0001 to 0.9999 / 1.000 to 9.999 / 10.00 to 99.99 / 100 to 1000 FNU (NTU)
   3. Precision
      a. +0.008 FNU or +1% of reading (0 to 10 FNU)
   4. Repeatability
      a. +0.003 FNU or +5% of reading (0 to 2 FNU)
   5. Response time
      a. 1 to 60 seconds (user adjustable)

1.5 Certifications

A. EMC: CE compliant for conducted and radiated emissions CISPR 11 (Class A limits), EMC Immunity EN 61326-1 (Industrial limits) when connected to an sc controller.
B. Safety: General Purpose UL/CSA 61010-1 with cETLus safety mark when connected to an sc controller
C. Australian C-TICK and Korean KC Markings when connected to an sc controller.
D. IP 65 Enclosure Rating

1.6 Environmental Requirements

A. Operational Criteria
   1. Operating Temperature
      a. 36 to 104 °F (2 to 40°C)
   2. Sample Temperature
      a. 122 °F (50 °C) maximum
   3. Sample Pressure
      a. 87 psi at 68°F (6 bar at 20°C)
   4. Sample flow rate
      a. Minimum: 0.2 L/min
      b. Maximum: 1L/min

5. Sample Salt Content (for *seawater* version ONLY)
    a. Tested up to 65 g/L

1.7 Warranty

A. The sensor includes a one-year warranty from the date of shipment.

1.8 Maintenance Service

A. Scheduled Maintenance
    1. Every 1200 Cycles
        a. Replace wiper profile (only on *plus* and *seawater* versions)
    2. Every Two Years
        a. Replace desiccant
        b. Monitor test equipment with CVM Dry Calibration
B. Unscheduled Maintenance
    1. Clean measuring chamber
        a. Dependent on substances contained in the water
    2. Check Zero Point
        a. Dependent on substances contained in the water
    3. Check Gradient
        a. At least once per year

PART 2 PRODUCTS

2.1 Manufacturer

A. Hach-Lange GmbH, Berlin, Germany
    1. Ultraturb sc Basic/Plus/Seawater Turbidimeter
        a. LPV415.52.10002

2.2 Manufactured Unit

A. The Ultraturb sc Turbidimeter consists of an 860nm LED light source, detection system, and internal light trap. Sample chamber wiper available for *plus* and *seawater* versions.

2.3 Equipment

A. The Ultraturb sc functions when attached to Hach model sc200 controller only. (Additional specifications can be found in the CSI documents for these particular controllers)
B. The Ultraturb sc turbidimeter operates continuously.
C. The Ultraturb sc turbidimeter provides user selectable bubble rejection, alarm and controller output hold, and self-test diagnostics.
D. The sc200 controller is capable of functioning with one or two Ultraturb sc turbidimeters
E. Wetted materials as follows:
    1. Measuring window:
        a. Quartz
    2. Measuring Chamber:
        a. Noryl GFN2
    3. Wiper axle:
        a. Stainless Steel 1.4571
    4. Wiper arm *(seawater* version only):
        a. Titanium Alloy
    5. Wiper profile

a. Silicone

2.4 Components

A. Standard Equipment
   1. Ultraturb sc sensor with appropriate cable length
   2. User Manual
   3. Factory Test Certificate
   4. Accessory Set
   5. Wiper Set (only for *pfus* and *seawater* versions)

B. Dimensions: 9.9 x 9.4 x 4.3 in. (250 x 240 x 110mm)

C. Weight: 3.3 lbs (1.5 kg)

2.5 Optional Accessories

A. Certified Verification Module Dry Standard, 0.6 NTU (HACH model # LZV414.00.00000)
B. Extension Cable
C. Formazin Turbidity Standard, 4000 NTU, 500 mL (HACH Model #246149). Contractor shall dilute to 10 NTU for calibration during startup.
D. SC200 Universal Controller, Part Number LXV404.99.00502
   1. Power Option: 120VAC
   2. Communication Capabilities: Serial communication not required.
   3. Mounting Option: Surface mount

PART 3 EXECUTION

3.1 Preparation

1. Mounting
   a. Wall mount only
2. Sample inlet
   a. 13 mm ID tubing
3. Drain
   a. 13 mm ID tubing

3.2 Installation

A. Contractor will install the analyzer in strict accordance with the manufacturer's instructions and recommendation.
B. Manufacturer's representative will include a half-day of start-up service by a factory-trained technician, if requested.
   1. Contractor will schedule a date and time for start-up.
   2. Contractor will require the following people to be present during the start-up procedure.
      a. General contractor
      b. Electrical contractor
      c. Hach Company factory trained representative
      d. Owner's personnel
      e. Engineer

3.3 Manufacturer's Service and Start-Up

A. Contractor will include the manufacturer's services to perform start-up on instrument to include basic operational training and certification of performance of the instrument.

B. Contractor will include a manufacturer's Service Agreement that covers all the manufacturer's recommended preventative maintenance, regularly scheduled calibration and any necessary repairs beginning from the time of equipment startup through to end user acceptance / plant turnover and the first 12 months of end-user operation post turnover.

C. Items A and B are to be performed by manufacturer's factory-trained service personnel. Field service and factory repair by personnel not employed by the manufacturer is not allowed.

D. Use of manufacturer's service parts and reagents is required. Third-party parts and reagents are not approved for use.

END OF SECTION

SECTION 16921

TEMPERATURE TRANSMITTER

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish, test, install, and place into satisfactory operation the pressure transmitters, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Process Control and Information Systems

B. Instruments, General

PART 2 - PRODUCTS

2.1 TEMPERATURE TRANSMITTERS

A. Room Temperature Transmitters

1. Pressure transmitter shall be 28 VDC powered from PLC panel power supply, Foxboro I/A Series, or equal. Power supply shall be VDC powered from PLC panel power supply. Transmitter shall be wall mounted with bare transducer element below sensing room temperature. Signal output shall be 4 to 20 mA.

2. Temperature transducer shall be RTD type. Element shall be bare connected directly to transmitter. Adjustable dampening shall be provided. External zero adjustment shall be provided. Accuracy shall be +/- 0.0 degrees Fahrenheit.

PART 3 - EXECUTION

3.1 REQUIREMENTS

END OF SECTION

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SECTION 16923
SCADA NETWORK SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

A. Sections Includes
   1. Description of required Data and Programming.

B. Furnish a complete operating data network as indicated on the Drawings, as shown on the cable or system block diagrams; and as specified herein.

C. SCADA will link with the existing SCADA network Via existing communications.

D. All connected equipment having Modbus / Ethernet connectivity will have all data points available to SCADA.

E. SCADA system existing at the central location will be modified to include all new and updated data points.

F. Related Sections: The Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Sub-Contractors to review all sections to ensure a complete and coordinated project.

1.2 REFERENCES

A. TIA/EIA Standards:
   1. TIA/EIA-568-B (Series), Commercial Building Telecommunications Standards.
   2. TIA/EIA-569 (Series), “Commercial Building Standard for Telecommunications Pathways and Spaces”
   3. IEEE Series 802 standards.

1.3 DEFINITIONS

1.4 SUBMITTALS

A. Furnish complete submittals in accordance.

B. Furnish complete Product Data, Shop Drawings, Test Reports, Operating Manuals, Record Drawings, Manufacturer’s certifications, Manufacturer’s Field Reports, and other submittals as specified in Section 17200 and below.

C. Additional Requirements
   1. Test Reports
      a. As noted herein.
      b. Signed test results as described in Part 3 of this Section.
      c. Test results shall include:
         1) Narrative describing the test procedures followed.
         2) Block diagram of test set up.
         3) Manufacturer’s information on test equipment used.
         4) Detailed test results.
         5) A narrative summarizing the results of the testing and identifying any further action required.

1.5 DELIVERY, STORAGE AND HANDLING

A. Store all equipment in a dedicated structure with space conditioning to meet the recommended storage requirements provided by the manufacturer:

1. Replace any components that are not stored in strict conformance with the manufacturer's recommendation.

1.6 PROJECT OR SITE CONDITIONS

A. Equipment shall be suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, ambient temperature, and humidity conditions.

1.7 WARRANTY

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 PREPERATION

A. Work with current system managers and staff to design SCADA screens.

B. Outline with system managers how data will be presented and used.

C. Do not proceed with programming until agreement is reached.

3.2 PROGRAMMING

A. All data points (tags) available to the PLCs and connected controllers and devices must be available to the SCADA system.

B. All process data must be recorded, stored and displayed in a usable manner.

C. New SCADA programming must not interfere with existing SCADA functions.

3.3 INSTALLATION

A. Installation of program code and updates must be scheduled with system managers to avoid interrupting current operations.

3.4 FIELD QUALITY CONTROL

A. Each data point must be tested and verified for accuracy.

B. Each trend and data log must be fully tested for proper operation.

C. All screens must be approved by system manager.

3.5 ADJUSTING

A. Perform all configuration and other set up, as required, to place the SCADA system into proper operation.

3.6 TRAINING

1. All operations staff and managers must be fully trained in:
   a. SCADA operation.
   b. Alarm notification response.
   c. Error conditions.
   d. Error recovery.
   e. Data usage.
   f. Data recovery.

g. Report printing.
h. Any other functions.

END OF SECTION

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SECTION 16930
HVAC SYSTEMS CONTROL

PART 1 - GENERAL

1.1 SCOPE

Furnish all labor, materials, equipment, appliances and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work:

A. Electrical work associated with the systems including, but not necessarily limited to:

1. All electrical installation including power distribution and special systems, is included in the scope of the general contract. Of specific concern are the control systems related to mechanical equipment. Responsibility for the control work is divided between the project electrician (Division 16) and his controls sub-contractor. The plant PLC system shall control HVAC systems.
2. All electrical work shall be in accordance with Division 16.
3. Division 16 shall provide all power to and throughout the building, to include motor control centers, breaker panels, and all other systems designated to Division 16, and specified herein. Division 16 shall install all conduit systems.
4. Division 16 shall run and connect all wiring and devices which power or control motors and other mechanical or control devices. Where control devices are located in power circuit, the controls contractor shall interrupt the circuit in the mechanical equipment junction box, wire through the control device and back to the junction box.
5. Breakers and disconnects, auxiliary contacts, standard pilot lights and magnetic starters are the responsibility of Division 16 and shall be as specified herein.
6. Auxiliary relays, low voltage transformers, control panel switches and devices, thermostats, pressure switches, electric operated valves, etc., are the responsibility of Division 16.
7. All wiring shall terminate at labeled terminal strips.

1.2 APPLICABLE SECTIONS

The General Conditions, Supplementary General Conditions, alternates and Addenda, applicable drawings and the technical specification including but not limited to the following;

A. Section “Electrical General Requirements”.

B. Section “Conductors and Cables”.

1.3 SUBMITTALS

A. The controls contractor shall provide shop drawings for control system circuits.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Terminal Blocks: DIN rail mounted, modular type, single layer, non-fused. Entreloc or approved equal.

B. Twisted, Shielded Pair Conductors for Control Wiring: Conductors shall be copper with 100 % shielding, plenum rated. Beldon type 89418 or approved equal. Cables shall be run in conduit.

C. Conductors: All control conductors shall be #14 AWG THWN minimum.

D. Labeling: All control conductors shall be labeled with a number corresponding to the mechanical control system drawings. All labeling shall be heat-shrink ink printed type by Panduit Pan-Quick LS3 system or equal.

PART 3 - EXECUTION

3.1 GROUNDING

A. Labeling: All control conductors shall be numerically labeled corresponding to the mechanical control systems record drawings.

B. Grounding Lugs: Ground all shielded pair shields at one end only to avoid ground loops. At terminal block connections, the shield shall be continuous from one conductor to another and shall be isolated from the local ground plane.

C. Conductors: All conductors shall be run in conduit unless specifically noted otherwise. The minimum size of conduit shall be 3/4" unless specifically noted otherwise.

END OF SECTION

SECTION 16933
CONTROL SYSTEMS - HUMAN MACHINE INTERFACE SOFTWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. General requirements for application software to be used in conjunction with the specified human machine interface hardware.

B. Related Sections

1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the CONTRACTOR and its Sub-Contractors to review all Sections to ensure a complete and coordinated project.

1.2 SUBMITTALS

C. Furnish complete submittals in accordance.

D. Furnish complete Product Data, Graphic Screens, Operating Manuals, Manufacturer's certifications, and other submittals as specified.

E. Additional Requirements:

1. Product Data:

a. Operating system requirements.

2. Graphic Screens:

a. Color printouts of each graphic screen and control pop-up.

1.3 QUALITY ASSURANCE

F. System Compatibility.

1. The software must be the standard operating software system designed specifically for use with the human machine interface hardware.

a. The software must be furnished and developed by the manufacturer of the human machine interface hardware.

1.4 WARRANTY

G. Provide extended 2 year manufacturer's warranty support as follows:

1. Dedicated technical support department or handled by programming staff or distributor.

2. Telephone hours for support shall be 24 hours, 7 days per week.

3. Email & Web support addresses.

4. Document download via website.

1.5 MAINTENANCE

H. Provide system upgrades and maintenance fixes for a period of two years from substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The human machine interface graphic software system shall be manufactured by or if necessary or approved, compatible with the human machine interface hardware manufacturer.

B. Compatible with Modicon M340 PLC, approved by OWNER.

2.2 MANUFACTURED UNITS

C. Human machine interface software.

1. Provide a complete software package to be used for programming the necessary screens and operator interaction with the human machine interfaces.

2. Operating System:

a. Microsoft Windows.

3. Software shall use preconfigured symbols, objects, graphics, and imported bitmaps for the generation of the displays.

4. Software shall allow bitmaps to be imported or exported to or from other applications.

5. Capable of generating custom reports, complete with screen prints.

6. Capable of working with multiple screens concurrently.

7. Shall provide dialog boxes for defining object attributes.

8. Objects shall be configured using fill in dialog boxes.

9. Graphic and text editor to allow custom formatting to customize and change the appearance of objects and text.

a. Allow selection of different fill patterns to define object status.

10. As a minimum, provide the following object capabilities.

a. Operator Inputs

1) Momentary Push Button.

2) Maintained Push Button.

3) Latched Push Button.

4) Multistate Push Button.

5) Keypad Enable Button.

6) Cursor Point.

b. Control List Selectors.

1) Standard Control List.

2) Piloted Control List.

c. Global Objects.

d. Display Objects.

1) Bar Graph.

2) Scale.

3) Message Display.

4) Multistate Indicator.

5) List Indicator.

6) Numeric Data Display.

e. Screen Selector Objects.

1) Go To.

2) Return.

3) Screen List Selector.

f. Embedded Variables.

1) Time.

2) Date.

3) Numeric Variable.

g. Graphics.

1) Lines.

2) Shapes.

3) Freeform Drawings.

4) Imported Graphics.

5) Background Text.

6) Selection Table for standard ISA symbols.

7) PID Controller Faceplate.

h. Alarm screens.

11. Documentation

a. The system shall provide complete user documentation, including examples of how to operate the various modules within the system.

b. The documentation must be in electronic format, HTML based with the ability to search for topics by keyword or search or specific text.

12. On-line Help

a. An on-line "help" facility, based upon Windows standard Hypertext, shall provide useful, context-sensitive information on the operation of the package.

1) This help facility shall be capable of being invoked on-line through a point-and-click operation.

2) The "help" facility must also support the ability to perform full text word search, add custom comments, bookmark topics, copy and pasting into another application, printing, and use of system fonts and colors.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All tags used and/or assigned as part of the application programming work shall use the Tag and Loop identifications found on the P&IDs.

B. Station Graphics:

1. For each device both in the treatment plant, and/or process area, a station graphic display shall be configured, this graphic shall include:

a) Symbols for

1) Pumps.

2) Valves

3) Major instruments.

4) Flowmeters.

5) Pressure transmitter.

6) Level Transmitter

7) Etc.

b) Alarm symbols including intrusion alarm.

c) Relevant test and operational data.

d) Each pump and valve shall include indication of status:

1) Hand.

2) Off.

3) Automatic

4) Local.

5) Remote.

6) Run.

7) Call.

8) Fail.

9) Open.

10) Close.

11) Hold.

12) Modulate.

2. Change of state of pumps and valves shall be depicted by change in color.

3. Production and Usage Bar Graph:

a) A display shall depict the production for each site and/or piece of equipment, as determined during the requisite graphics meeting, within the treatment plant, summarized to type, and total usage, with a bar graph and numeric value for each analog value.

3.2 TRAINING

C. The training shall be performed by pre-approved and qualified representatives of the manufacturer of the human machine interface hardware or a representative of the vendor supplying the control panel. A representative of the vendor supplying the control panel may perform the training only if the representative has completed the manufacturer's training course for the human machine interface software.

END OF SECTION

SECTION 16944

SOLAR ENERGY ELECTRICAL POWER GENERATION SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, connection, testing, and commissioning of solar energy electrical power generation systems.

B. The requirements of this Section apply to all sections of Division 16 related to solar energy electrical power generation systems.

1.3 DEFINITIONS

A. Unless otherwise specified or indicated, solar energy conversion and solar photovoltaic energy system terminology used in these specifications, and on the drawings, shall be as defined in ASTM E772.

1.4 QUALITY ASSURANCE

A. Solar Energy Electrical Power Generation System installer(s) shall demonstrate that they have successfully installed at least four projects within the past five years that, in aggregate, equal or exceed the size of the proposed project. The installer(s) shall provide written references for each of the referenced qualified projects to Resident Engineer.

B. Supports and racking for solar photovoltaic system installations shall be prepared by a licensed Structural Engineer whose structural engineering license is current and valid. For roof top installations on existing structure, the engineer shall provide review and structural analysis of the existing structure to ensure that the existing structure shall safely support the proposed installations. The engineer shall submit to Resident Engineer design documents such as engineering calculations, drawings (if applicable), the environmental loading analyses (including wind, snow, hail, and where applicable, seismic), and the rack and substrate's ability to withstand these environmental forces.

C. If paralleling arrangement is desired, the system shall have anti-islanding capability such that it is incapable of exporting power to the utility distribution system in the absence of utility power. Paralleling must be approved by serving electric utility. Provide written correspondence from the utility confirming its requirements.

D. Investigate whether the Resident Engineer or local VAMC's environmental entities require environmental impact studies which may include, but are not limited to, effects upon wildlife. The Contractor shall determine which entity has jurisdiction over environmental matters and shall make appropriate inquiry and comply with all applicable regulations.

E. Investigate any other local ordinances that may apply to installation of a solar energy electrical generating system in the proposed location. Bring any conflicts with the drawings and specifications to the attention of the Resident Engineer.

G. Warranties: The solar energy electrical generating system shall be subject to the terms of FAR Clause 52.246-21, except that the warranty period shall be as noted for the items below:

1. Solar photovoltaic modules and inverter: 10 year manufacturer's warranty against defects in materials and workmanship.

2. Power output: 25 year manufacturer's power output warranty, with the first 10 years at 90% minimum rated power output and the balance of the 25 years at 80% minimum rated power output.

1.5 SUBMITTALS

A. Where proposed system shall be a Net Meter project, prepare appropriate applications and submittals to the Resident Engineer. Where proposed system shall be connected before the serving electric utility's meter and tied directly to the grid, prepare appropriate applications and submittals to the Resident Engineer. In all cases, the serving electric utility may have a requirement for further electrical studies, which may include or not be limited to power factor analysis, short circuit protection studies, grid wiring adequacy, or capacities of upstream equipment. If such requirements exist and are required by the serving electric utility, these requirements shall be fulfilled by the Contractor. Provide written documentation confirming the utility's approval of the interconnection of the solar energy electrical power generation system with the utility system to the Resident Engineer.

B. Submittals shall comply with the following requirements:

1. Shop Drawings:

   a. Submit sufficient information to demonstrate compliance with drawings and specifications.
   b. Include electrical ratings, dimensions, mounting details, materials, required clearances, terminations, weight, wiring and connection diagrams, accessories, and nameplate data.
   c. Include shop drawings for foundations and other support structures.

2. Product Data:

   a. Include detailed information for components of the solar energy electrical generation system.

      1. Wiring.

      2. Inverter.

      3. Photovoltaic modules.

      4. Rack and support assemblies.

      5. Instrumentation.

6. Switchgear.

7. DC and AC disconnects.

8. Combiner boxes.

9. Monitoring systems.

b. Certification from the manufacturer that the system has been seismically tested to International Building Code requirements. Certification shall be based upon simulated seismic forces on a shake table or by analytical methods, but not by experience data or other methods.

3. Manuals:

a. Submit, simultaneously with the shop drawings, complete maintenance and operating manuals including technical data sheets, wiring diagrams, and information for ordering replacement parts.

1. Safety precautions.

2. Operator restart.

3. Startup, shutdown, and post-shutdown procedures.

4. Normal operations.

5. Emergency operations.

6. Environmental conditions.

7. Preventive maintenance plan and schedule.

8. Troubleshooting guides and diagnostic techniques.

9. Wiring and control diagrams.

10. Maintenance and repair procedures.

11. Removal and replacement instructions.

12. Tracking systems (where applicable).

13. Spare parts and supply list.

14. Parts identification.

15. Testing equipment and special tool information.

16. Warranty information.

17. Testing and performance data.

18. Contractor information.

b. If changes have been made to the maintenance and operating manuals originally submitted, then submit updated maintenance and operating manuals two weeks prior to the final inspection.

4. Certifications: Two weeks prior to final inspection, submit the following.

   a. Certification by the manufacturers of all major items of the solar energy electric generation system that the system conforms to the requirements of the drawings and specifications, and that they have jointly coordinated and properly integrated their equipment and controls to provide a complete and functional installation.
   b. Certification by the Contractor that the solar energy electric generation system has been properly installed, adjusted, tested, commissioned, and warrantied. Contractor shall make all necessary field measurements and investigations to ensure that the equipment and assemblies meet contract requirements.

5. Estimated Annual Power Output: Submit calculated annual power output for each of the proposed solar photovoltaic systems. Provide independent calculations for each fixed system.

C. If equipment submitted differs in arrangement from that shown on the drawings, provide drawings that show the rearrangement of all associated systems. Approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract and acceptable to the Resident Engineer.

D. Submittals and shop drawings for independent but related items shall be furnished together and complete in a group. Coordinate and properly integrate materials and equipment in each group. Final review and approval will be made only by groups.

1.6 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

B. American Society for Testing and Materials (ASTM):
E772-15 (R2021).....Standard Terminology of Solar Energy Conversion

E1038-10 (R2019).....Standard Test Method for Determining Resistance of Photovoltaic Modules to Hail by Impact with Propelled Ice Balls

C. Institute of Electrical and Electronics Engineers (IEEE):
519-22 .....Recommended Practices and Requirements for Harmonic Control in Electric Power Systems

937-19 .....Recommended Practice for Installation and Maintenance of Lead-Acid Batteries for Photovoltaic (PV) Systems

1013-19 .....Recommended Practice for Sizing Lead-Acid Batteries for Stand-Alone Photovoltaic (PV) Systems

1361-14 .....Guide for Selection, Charging, Test and Evaluation of Lead-Acid Batteries Used in Stand-Alone Photovoltaic (PV) Systems

1526-20 .....Recommended Practice for Testing the Performance of Stand-Alone Photovoltaic Systems

1547-18 .....Standard for Interconnecting Distributed Resources with Electric Power Systems

1561-19 .....Guide for Optimizing the Performance and Life of Lead-Acid Batteries in Remote Hybrid Systems

1562-21 .....Guide for Array and Battery Sizing in Stand-Alone Photovoltaic (PV) Systems

1661-19 .....Guide for Test and Evaluation of Lead-Acid Batteries Used in Photovoltaic (PV) Hybrid Power Systems

D. International Code Council (ICC):

IBC-21 .....International Building Code

E. National Electrical Manufacturer's Association (NEMA):

250-20 .....Enclosures for Electrical Equipment (1,000 Volts Maximum)

F. National Fire Protection Association (NFPA):

70-23 .....National Electrical Code (NEC)

70E-21 .....Electrical Safety in the Workplace

G. Underwriters Laboratories (UL):

6-22 .....Electrical Rigid Metal Conduit – Steel

94-23 .....Tests for Flammability of Plastic Materials for Parts in Devices and Appliances; Ed 6

797-07 .....Electrical Metallic Tubing – Steel

969-17 .....Standard for Marking and Labeling Systems

1242-06 .....Standard for Electrical Intermediate Metal Conduit – Steel

1703-02 .....Standard for Flat-Plate Photovoltaic Modules and Panels

1741-21 .....Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide materials to fabricate functioning photovoltaic system in accordance with ASTM, IEEE, NEMA, NFPA, and UL, as specified in this section, and as shown on the drawings.

B. Factory-prefabricated solar equipment packages which include photovoltaic modules, batteries or other energy storage, inverters, and controls and which meet the requirements of this section are acceptable.

2.2 GROUNDING

A. All applicable components of the solar energy electrical power generating system must be grounded per latest NEC requirements.

B. DC Ground-Fault Protector:
   1. Shall be listed per UL 1703.
   2. Shall comply with requirements of the NEC.

2.3 PHOTOVOLTAIC ARRAY CIRCUIT COMBINER BOX

A. Shall be listed to UL 1741.

B. Shall include internal overcurrent protection devices with dead front.

C. Shall be contained in non-conductive NEMA Type 4X enclosure.

D. Up to 48 volts DC: Shall use UL-listed DC breakers that meet NEC requirements for overcurrent protection.

E. Up to 600 volts DC, paralleling system: Shall use fuses instead of breakers.

F. Ground and pole-mounted arrays shall have a separate combiner box mounted to the pole itself.

G. Where applicable, combiner box shall be a disconnecting combiner box.

2.4 SWITCH/DISCONNECTING MEANS

A. Shall be UL-listed, in accordance with the NEC, as shown on the drawings, and as specified.

B. Utility External Disconnect Switch (UEDS): Refer to Resident Engineer, as several states do not require UEDS for small solar photovoltaic systems if the inverter provides the same function per NEC. Coordinate requirements with serving electric utility.

2.5 WIRING SPECIALTIES

A. Direct Current Conductors:
   1. If Exposed: Shall be USE-2, UF (inadequate at 60°C [140°F]), or SE, 90°C [194°F] wet-location rated and sunlight-resistant (usually for tracking modules).
   2. If in Conduit: Shall be RHW-2, THWN-2, or XHHW-2 90°C [194°F], wet-location rated.

B. Conduits and Raceways:
   1. Shall use steel conduit listed per UL 6, UL 1242, UL 797 (as appropriate), except for tracking modules. Weathertight EMT installations shall be allowed for DC wiring in weather-protected areas.
   2. Shall use expansion joints on long conduit runs.
   3. Shall not be installed on photovoltaic modules.

C. Enclosures subject to weather shall be rated NEMA 3R or better.

D. Cable Assemblies and Junction Boxes:
   1. Shall be UL-listed.
   2. Shall be rated to 5VA flammability per UL 94.

E. Prohibited Wiring Materials: Those which are not UL-listed, or listed materials used in environments outside those covered in their listing.

2.6 DC-AC INVERTER

A. Shall be listed to UL 1741.

B. Shall comply with IEEE 519 and IEEE 1547.

C. Shall be listed per FCC Part 15 Class A.1.

D. Shall have stand-alone, utility-interactive, or combined capabilities.

E. Shall include maximum power point tracking (MPPT) features.

F. Shall include anti-islanding protection if paralleling arrangement is required.

2.7 SOLAR PHOTOVOLTAIC (PV) MODULES

A. Minimum Performance Parameters as per UL 1703.

B. Photovoltaic Panel Types:
   1. Monocrystalline: Listed to UL 1703.
   2. Polycrystalline: Listed to UL 1703.
   3. Thin-Film/Flexible: Listed to UL 1703.
   4. Building-Integrated & Solar Shingles: Listed to UL 1703.

C. Module and System Identification

1. Module or Panel:
    a. Listed to UL 969 for weather resistance.
    b. Listed to UL 1703 for marking contents and format.
2. Main Service Disconnect: per NEC.
3. Identification Content and Format: per NEC.
4. Identification for Inverter: per NEC.

D. Bypass diodes shall be built into each PV module either between each cell or each string of cells.

E. Other Components: per UL 1703.

F. Hail Protection: Compliant with testing procedure per ASTM E-1038.

G. Lightning Protection: Shall ground according to manufacturer instructions per UL 1703.

H. Access, Pathways, and Smoke Ventilation: Per IFC 605.3, access and spacing requirements must be observed in order to: ensure access to the roof, provide pathways to specific areas of the roof, provide for smoke ventilation opportunities area, and, where applicable, provide emergency access egress from the roof.

I. Fire Classification:
1. IBC 1505.8 for building-integrated photovoltaic and solar shingles.
2. IBC 1509.7.2: Although not technically enforceable, every effort shall be made to ensure the solar photovoltaic module is not combustible.

2.10 COLLECTOR SUPPORTS

A. Wind Resistance Requirement:
1. For rack-mounted: per IBC 1509.7.1.
2. For building-integrated photovoltaic and solar shingles: IBC 1507.17.3.

B. Mechanical Load Requirement: per UL 1703.

2.11 INSTRUMENTATION

A. Meters: If applicable and system is grid-connected, use net smart meter provided by the serving electric utility.

B. Sensors:
1. Temperature sensor shall be a component in the MPPT control system.
2. May install additional data acquisition sensors to measure irradiance, wind speed, and ambient and PV module temperatures. Any additional sensors shall require a conduit separate from the current conductor conduit.

C. Data logger/Monitoring System: Shall be a packaged system capable of string-level monitoring or in the case of micro-inverters, capable of monitoring and logging an individual module's information.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install the solar photovoltaic system in accordance with the NEC, this section, and the instructions of the manufacturer.

B. Prior to system start-up, ensure no copper wire remains exposed with the exception of ground wire as allowed in certain circumstances per manufacturer's instructions.

C. Systems shall be adequately anchored and braced per details on structural contract documents to withstand seismic forces at the locations where installed.

D. Wiring Installation: Workers shall be made aware that photovoltaic modules are energized electrically when there is any ambient light source; therefore, workers shall take appropriate safety precautions to prevent accidents. Utilize on-site measurements in conjunction with the design drawings to accurately cut wires and layout before making permanent connections. Locate wires out of the way of windows, doors, openings, and other hazards. Ensure wires are free of snags and sharp edges that have the potential to compromise the wire insulation. All cabling shall be mechanically fastened. If the system is roof-mounted, it shall have direct current ground fault protection according to NEC. Ensure breakers in combiner box are in the off position (or fuses removed) during combiner box wiring.

E. Instrumentation: Install instruments as recommended by the manufacturer. Locate control panels inside a room accessible only to qualified persons.

F. Building-Integrated Photovoltaic Installations: Building-integrated photovoltaic modules/shingles shall be installed in accordance with the manufacturer's installation instructions.

G. Rack-Mounted Photovoltaic Installations: Rack-mounted photovoltaic modules shall be installed in accordance with the manufacturer's installation instructions.

H. Ground and Pole-Mounted Photovoltaic Installations: If structure is used as equipment grounding conductor, ensure compliance with NEC. Wiring shall not be readily accessible.

I. Tracking System Installations: Disconnect shall be within sight of the tracking motor.

J. Provide safety signage.

K. Coordinate installation with roofing contractor. Remove, replace, patch, and repair existing roofing materials and surfaces cut or damaged during installation of the solar energy electrical power generation system, by methods and with materials so as not to void existing roofing system warranty. Notify roof warrantor before proceeding with the work.

3.2 FIELD QUALITY CONTROL

A. Field Inspection: Perform in accordance with manufacturer's recommendations. Prior to initial operation, inspect the solar energy electrical power generation system for conformance to drawings, specifications, and NEC. In addition, include the following:
   1. Visual Inspection and Tests:
      a. Compare equipment nameplate data with specifications and approved shop drawings.
      b. Inspect physical, electrical, and mechanical condition.
      c. Verify required area clearances.
      d. Verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey after energization.
      e. Verify the correct operation of all sensing devices, alarms, and indicating devices.
      f. Verify that all cable entries from top of junction boxes are sealed per junction box rating.
      g. Verify all connections and integrity of printed circuit boards in all applicable junction boxes.

B. Tests: Provide equipment and apparatus required for performing tests. Correct defects disclosed by the tests and repeat tests. Conduct tests in the presence of the Resident Engineer.
   1. Module String Voltage Test: Prior to connecting wiring to the combiner box, use a digital multi-meter to ensure each series string's polarity is correct.
   2. Operational Tests: Perform tests in accordance with the manufacturer's written recommendations. Tests for stand-alone systems shall be performed per IEEE 1526.

3.3 FOLLOW-UP VERIFICATION

A. Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that the solar photovoltaic electrical power generation system is in good operating condition and properly performing the intended function.

3.4 COMMISSIONING

A. Comply with the requirements of Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.

B. Only qualified personnel shall connect the solar photovoltaic electrical power generation system to the serving electric utility grid.

C. If the system is grid-tied, the Contractor shall coordinate with the serving electric utility to establish an interconnection agreement.

D. Connect the solar photovoltaic electrical power generation system to the serving electric utility grid only after receiving prior approval from the utility company.

3.5 INSTRUCTION

A. A complete set of operating instructions for the solar photovoltaic electrical power generation system shall be laminated or mounted under acrylic glass and installed in a frame near the equipment.

B. Furnish the services of a factory-trained technician for one, 4-hour training period for instructing personnel in the maintenance and operation of the solar photovoltaic electrical power generation system, on the date requested by the Resident Engineer.

END OF SECTION

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SECTION 220000 - GENERAL PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

Sections of other Divisions which relate to mechanical work apply to the work of this section. See various Sections on sitework, underfloor work, structural work, finish materials, etc.

B. RELATED SECTIONS: Refer to "Electrical Requirements for Plumbing Equipment Section in Division 22 for basic electrical requirements for all plumbing equipment. Special and specific electrical requirements are specified within each respective equipment specification section.

1.2 SUMMARY: This Section specifies the basic requirements for mechanical installations and includes requirements common to more than one section of Division 22 00 00. It expands and supplements the requirements of Division 01000.

This Division does not define, nor is it limited by, trade jurisdictions. All work described herein is a part of the General Contract and is required of the Contractor regardless.

1.3 DESCRIPTION OF PROJECT: The plumbing work described in these Division 22 specifications is for the Anderson Water Treatment Plant project located in West Valley City, Utah. Design weather conditions are: 95°F db, 63°F wb and winter 0°F. Altitude readings, unless otherwise noted, are for an elevation of approximately 4,500 feet above sea level. Make adjustment to manufacturer's performance data as needed.

1.4 CODES AND PERMITS, AUTHORITIES HAVING JURISDICTION:

A. The plumbing work shall be performed in strict accordance with the applicable provisions of the various codes, ordinances and adoptions pertaining to the project location in effect on the date of invitation for bids. All materials and labor necessary to comply with rules, regulations and ordinances shall be provided. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern.

B. The Contractor shall hold and save the Owner and Architect/Engineer free and harmless from liability of any nature or kind arising from his failure to comply with codes and ordinances.

C. Permits necessary for the prosecution of the work under this contract shall be secured and paid for by the contractor(s) include connection fees related to utility hookups. Contractor shall include all sewer, storm drainage and water connection fees and shall verify current rate with West Valley City prior to bid.

D. REFERENCE STANDARDS:

American Welding Society
International Mechanical Code with Utah State Amendments
International Building Code with Utah State Amendments
International Plumbing Code with Utah State Amendments
NFPA Codes
Local Fuel Utility Regulations
Local Power Utility Regulations
American Gas Association
ASME Codes for Pressure Vessels and Piping

ANSI B31.1 Piping
ANSI A117.1 Buildings and Facilities Accessible To and Usable by Physically Handicapped People.
ADA: Americans with Disability Act

E. Final inspection by the Architect/Engineer will not be made nor Certificate of Substantial Completion issued until certificates of acceptability from the Authorities having jurisdiction are delivered.

1.5 DEFINITION OF PLANS AND SPECIFICATIONS: The plumbing drawings show the general arrangement of piping, equipment, etc., and shall be followed as closely as the actual building construction and the work of other trades will permit. The architectural and structural drawings shall be considered as part of the work insofar as these drawings furnish the Contractor with information relating to design and construction of the building. Architectural drawings shall take precedence over plumbing drawings for actual locations, quantities, etc. of plumbing components. Request clarification and participate in resolution in the event of conflict.

Because of the small scale of the plumbing drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. Investigate the structural and finish conditions affecting the work and arrange the work accordingly, providing such extensions, fittings, valves and accessories to meet the conditions as may be required. Some small scale work is not shown such as control conduit and piping, incidental piping, specialties. Provide as directed by note or specification.

Examine the actual construction site prior to bidding and obtain an understanding of the conditions under which the work will be performed. No allowances will be made for failure to make such examination.

During construction, verify the dimensions governing the plumbing work at the building. No extra compensation shall be claimed nor allowed because of differences between actual dimensions and those indicated on the drawings. Examine adjoining work on which plumbing work is dependent for perfect efficiency, and report any work of other trades which must be corrected. No waiver of responsibility for defective work shall be claimed nor allowed due to failure to report unfavorable conditions affecting the plumbing work.

1.6 ROUGH-IN:

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment specifications in Divisions 2 through 50 for rough-in requirements.

1.7 PLUMBING INSTALLATIONS:

A. Coordinate plumbing equipment and materials installation with other building components.

B. Verify all dimensions by field measurements.

C. Arrange for chases, slots, and openings in other building components to allow for plumbing installations.

D. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.

E. Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing-in the building.

F. Coordinate the cutting and patching of building components to accommodate installation of plumbing equipment and materials.

G. Where mounting heights are not detailed or dimensioned, install plumbing services and overhead equipment to provide the maximum headroom possible.

H. Install plumbing equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

I. Coordinate the installation of plumbing materials and equipment above ceilings with suspension system, ductwork, mechanical equipment, light fixtures, and other installations.

J. Coordinate connection of plumbing systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

K. Where plumbing work penetrates other trade work such as gypsum board walls, etc., penetration shall be neatly cut and walls shall be filled and patched.

1.8 ACCESSIBILITY:

A. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing.

B. Extend all grease fittings to an accessible location.

C. Establish required clearance to all installation features involving operation and maintenance. Respect manufacturer’s recommendations for access and clearance.

D. Access Doors - General: All items of plumbing equipment which may require adjustment, maintenance, replacement or which control a system function shall be made readily accessible to personnel operating the building.

1. Provide access doors in floors, walls, ceiling and partitions to valves, cleanouts, chases, etc. Access doors shall be all-steel construction equivalent to "Milcor" by Inland Ryerson in a style approved by the Owner's Representative. Doors shall be 24" x 24", or as needed, with screwdriver latches.

1.9 CHANGE ORDERS: See General Conditions.

1.10 ALTERNATIVE CONSTRUCTION/SUBSTITUTION: These documents outline a way in which the Owner may be delivered a functional and reliable facility. Drawings and specifications describe reasonable engineering practice for the Contractor to follow.

Coordination between trades may result in periodic needs to adjust the installation from that indicated, but in no case shall the intended function be compromised.

The Contractor may perceive some work methods which differ from those specified which could save time and effort. These may be presented to the Architect with a breakdown of possible cost savings for review. Implement only with authorization.

Materials substitutions will generally be covered in a review process prior to bidding. After bidding, substitutions shall be proposed only on the basis of definitive cost accounting and implemented only with authorization.

1.11 CUTTING AND PATCHING:

A. Layout the project ahead of time, providing sleeves and blockouts and have work specifically formed, poured and framed to accommodate mechanical installations. Cut and patch only as needed.

B. Refer to the Division 1 Section: CUTTING AND PATCHING for general requirements for cutting and patching.

C. RECORD DRAWINGS: During the course of construction, maintain a set of drawings, specifications, change orders, shop drawings, addenda, etc., for reference and upon which all deviations from the original layout are recorded. These marked-up documents shall be turned over to the Architect/Engineer at the conclusion of the work so that the original tracings can be revised. If the Contractor fails to mark up the prints, he shall reimburse the Architect/Engineer for time required to do so.

D. Refer Specification Section: BASIC ELECTRICAL REQUIREMENTS for cutting and patching electrical equipment, components, and materials.

E. Do not endanger or damage installed Work through procedures and processes of cutting and patching.

F. Arrange for repairs required to restore other and any work damaged as a result of mechanical installations.

G. No additional compensation will be authorized for cutting and patching Work that is necessitated by ill-timed, defective, or non-conforming installations.

H. Perform cutting, fitting, and patching of mechanical equipment and materials required to:

1. Uncover Work to provide for installation of ill-timed Work;

2. Remove and replace defective Work;

3. Remove and replace Work not conforming to requirements of the Contract Documents;

4. Remove samples of installed Work as specified for testing:

5. Install equipment and materials in existing structures.

I. Upon written instructions from the Architect/Engineer, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.

J. Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including, but not limited to removal of mechanical piping and other mechanical items made obsolete by the new Work.

K. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

L. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

1.12 SUBMITTALS: Submittal of shop drawings, product data, and samples will be accepted only from the Contractor to the Architect. Data submitted from subcontractors and material suppliers directly to the Architect/Engineer will not be processed. The Contractor shall document each transmittal and shall sign and stamp the submittal indicating that it has been reviewed and is in compliance with the criteria of the project, any exceptions being clearly noted.

A. SHOP DRAWINGS: As soon as possible after the contract is awarded, submit to the Architect, an electronic copy of the descriptive literature covering all equipment and materials to be used in the installation of plumbing systems for this project. Written confirmation of acceptable review by the Owner's Representative shall be obtained before ordering, purchasing, acquiring or installing any such equipment or materials for the project.

The submittals shall be prepared in an orderly manner after the order of this specification, contained in a single pdf file with identification tabs for each item or group of related items. Submitted literature shall clearly indicate equipment selection, performance, quality, utility requirements, dimensions of size, connection points and other information pertinent to effective review.

Equipment must fit into the available space with allowance for operation, maintenance, etc. The Contractor shall take full responsibility for space and utility requirements for equipment installed.

Factory-wired equipment shall include shop drawings of all internal wiring to be furnished with unit.

Review of the Architect/Engineer is for general conformance of the submitted equipment of the project specification; in no way does such approval relieve Contractor of his obligation to furnish equipment and materials that comply in detail to the specification, nor does it relieve the Contractor of his obligation to determine actual field dimensions and conditions which may affect his work.

1.13 OPERATION AND MAINTENANCE TRAINING:

A. Instruction Of Owner's Personnel: At a time prior to Owner making use of a device or system, and in general after testing and balance work for a building or major system is complete, prepare, schedule and conduct a series of training sessions for Owner's operating and supervisory personnel. Instructions shall cover each device and system with emphasis on understanding the purpose and function, the maintenance requirements and the proper adjustment and operating technique.

B. Instruct building operating staff in operation and maintenance of mechanical systems utilizing Operation and Maintenance Manual when so doing.

C. Minimum instruction periods shall be as follows:

1. Plumbing - 1 hours, each of 1 days, (1 hours total).

D. Conduct initial instruction periods after pre-final inspection when systems are properly working and before final payment is made. Schedule subsequent visits throughout the first year.

E. None of these instructional periods shall overlap another.

F. Vendors for each piece of equipment controls, etc., shall participate along with the Contractor(s).

1.14 GUARANTEE/WARRANTY: The following guarantee is a part of this specification and shall be binding on the part of the Contractor and his assigns:

> "Contractor guarantees that this installation is in accordance with the terms of the Contract and is free from mechanical defects. He agrees to replace or repair, to the satisfaction of the Owner's Representative, any part of this installation which may fail or be determined unacceptable within a period of one (1) year after final acceptance. See also the General Conditions of these specifications. Failed equipment in the repair or replacement shall be guaranteed for one full year from the date of recommission."

Compile and assemble the warranties required by Division 22 into a separated set of vinyl covered, insert sheets, tabulated and indexed for each reference, included in the O & M Manual.

Provide complete warranty information for each item to include product or equipment to include data of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

Mechanical systems and equipment shall not be considered for substantial completion and initiation of warranty until they have performed in service continuously without malfunction for at least thirty (30) working days.

1.15 TESTS AND CERTIFICATIONS: Make all tests required by code or specification in the presence of a representative of the Owner, recorded and certified by the Contractor and Representative. Involve local authorities where required.

1.16 PERMITS, FEES, LICENSES: Pay for all permits, fees and licenses required for the conduct of the specified work and be responsible for all criteria associated with the same. Comply with requirements for inspection, certifications, etc.

1.17 CEILING SPACE COORDINATION: Carefully coordinate ceiling cavity space with all trades; however, installation of plumbing equipment within the ceiling cavity space allocation, in the event of conflict, shall be in the following order: plumbing waste lines; supply, return and exhaust ductwork; domestic hot and cold water; fire protection; control conduit.

PART 2 - GENERAL MECHANICAL MATERIALS AND METHODS

2.1 QUALITY OF MATERIALS AND EQUIPMENT:

A. All equipment and materials shall be new, and shall be the standard products of manufacturers regularly engaged in the production of plumbing, heating, ventilating and air conditioning equipment, and shall be the manufacturer's latest design. Specific equipment shown in schedules on drawings and specified herein is to be the basis for the Contractor's bid. Provisions for substitute equipment are outlined in the General Conditions. All materials shall be produced by manufacturing plants located in the United States of America.

B. Furnish and install all major items of equipment specified in the equipment schedules on the drawings complete with all accessories normally supplied with catalog items listed, and all other accessories necessary for a complete and satisfactory installation.

2.2 PROTECTION OF MATERIALS AND EQUIPMENT:

A. Close pipe and duct openings with caps or plugs to prevent lodgment of dirt or trash during the course of installation. Cover equipment tightly and protect against dirt, water and chemical or mechanical injury. Plumbing fixtures intended for the final installation shall not be used by the construction forces. At the completion of the work, clean fixtures, equipment and materials and polish thoroughly and deliver in a factory dock condition for the Owner's acceptance. Make damage and defects developing before acceptance of the work good at Contractor's expense.

B. Do not make temporary use of project equipment, new or existing, during construction without the consent of Utah Valley State College Physical Plant. DO NOT USE SYSTEM FOR TEMPORARY HEAT!!

2.3 QUALIFICATIONS OF WORKMEN:

A. All mechanics shall be capable journeymen, skilled in the work assigned to them. Apprentices may be used with appropriate direction.

B. Employ no unskilled persons in the work which he is given to do; execute all work in a skillful and workmanlike manner. All persons employed upon this work shall be competent, faithful, orderly and satisfactory to the Owner. Should the Owner's Representative deem anyone employed on the work incompetent or unfit for his duties, and so certify, Contractor shall dismiss him and he shall not be again employed upon the work without permission of the Owner's Representative.

C. All welders involved in welding of pressure piping systems shall be certified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code. Written verification of successful test completion shall be submitted to Architect prior to initiating work.

2.4 FOREMAN: Designate a general mechanical foreman to the Owner's Representative to be consistently available on site for consultation. Do not replace this individual without prior approval from the Owner's Representative.

2.5 USE OF COMMON VENDORS: Regardless of subcontract delegations, coordinate purchasing between trades so that equipment and materials of similar nature come from a single vendor, i.e., all package HVAC units shall be common source. Valves, etc., the same. Do not burden the Owner with multiple brands of similar equipment unless so directed.

2.6 ROOF/WALL/FLOOR PENETRATIONS - FLASHINGS:

A. Sleeves through the floor into dry rooms shall be flush with the floor, caulked and sealed.

B. Pipe sleeves shall allow for movement of the pipe due to expansion and contraction, yet to include seismic restraint.

C. Refer to Section for fire stopping requirements.

D. FLASHINGS:

1. Flash all pipes and ducts penetrating the roof. Vent pipes terminating within 24" of the roof shall have a seamless flashing of 6-pound lead clamped to the pipe, and with a flashing shield extended horizontally not less than 12" all around. For single ply membrane roof, follow manufacturer's directions, provide required flashing components.

2. For built-up and gravel roof, clamp roof drains to a 6-pound lead flashing extending 18" all around. For single ply membrane roof, follow manufacturer's directions.

3. Other piping penetrating the roof shall be flashed and counter-flashed. See drawings or Architect/Engineer for additional detail.

4. Make all ductwork penetrating the roof watertight with flashings, counterflashing and sealant. Provide curbs for all such openings.

2.7 EXCAVATING AND BACKFILLING (GENERAL):

A. Provide all excavation, trenching and backfilling for Division 22 00 00 underground piping work. Excavation and backfilling shall comply with applicable paragraphs of Division 2. Tamp bottoms of trenches hard and, for soil and waste piping, grade to secure uniform fall of 1/4" per foot, or as noted. Excavate bell holes for hub and spigot pipes so that pipe rests on solid ground for its entire length. Lay sewer and water pipe in separate trenches, except where otherwise noted, as detailed.

B. After work has been tested, inspected and approved by the Owner's Representative and/or State/Local Inspector, and prior to backfilling, clean the excavation of all rubbish, and clean backfill materials free of trash. Backfill shall be placed in horizontal layers not exceeding 12" in thickness, properly moistened. Mechanically compact each layer with suitable equipment to a dry density of not less than 95 percent as determined by the Modified AASHO Test T-18O. See Division 2 for additional requirements.

1. Provide adequate shoring to safeguard workers from cave-ins for all excavations.

2. In areas where General Contractor has finish grade work to do, Mechanical Contractor shall backfill and compact to 8" below finish grade. Where no finish surface work is to be done, Mechanical Contractor shall backfill and compact to and match adjacent undisturbed surface with allowance for settling, etc.

3. Protect from damage all existing underground utilities or utility tunnels indicated on the contract drawings (or field located for the Contractor by the Owner prior to excavation operations). Any damage to identified existing utilities or utility tunnels shall be repaired by the Contractor at no cost to the Owner.

2.8 HANGERS AND SUPPORTS (GENERAL):

A. Provide hangers and/or supports for all equipment, piping and ductwork. Primary information is contained in these specifications and on the drawings.

B. Provide hangers and supports to correlate with seismic restraint and vibration isolation.

2.9 MANUFACTURER'S DIRECTIONS: Install all equipment in strict accordance with all directions and recommendations furnished by the manufacturer. Where such directions are in conflict with the plans and specifications, report such conflicts to the Architect, who shall direct adjustments as he deems necessary and desirable.

2.10 LUBRICATION: Lubricate equipment at startup. Then, provide all lubricants for the operation of all equipment until acceptance by the Owner. The Contractor is held responsible for all damage to bearings while the equipment is being operated by him.

2.11 ELECTRICAL WIRING AND CONTROL:

A. Motor starters, related motor starter equipment and power wiring indicated on the electrical drawings and control diagrams shall be furnished and installed under Division 16000 of this Specification. Items of electrical control equipment specifically mentioned to be furnished by the Division 15000 either in these specifications or on the electrical or mechanical drawings, shall be furnished and mounted by this Contractor and shall be connected under and as required by this Division 15000 and Division 16000 of these specifications.

B. Refer to the control equipment and wiring shown on the diagrams. Any changes or additions required by specific equipment furnished shall be the complete responsibility of the contractor.

C. Division must be fully coordinated with Division 26 to insure that all required components of the work are included and fully understood. No additional cost shall accrue to the Owner as a result of lack of coordination.

D. Where the detailed electrical work is not shown on the electrical drawings, the Mechanical Contractor shall furnish, install and wire or have prewired all specified and necessary controls for package air conditioning units and other equipment specified for this project. The objective of this paragraph is to make sure a complete operating system is obtained at no additional cost to the Owner for field wiring required related to the equipment.

2.12 FLUSHING AND DRAINING OF SYSTEMS/CLEANING OF PIPING: Fill, clean and flush and sterilize where appropriate, all water piping systems with water and drain these systems before they are placed in operation. Blow out all other piping systems with compressed air or nitrogen to remove foreign materials that may have been left or deposited in the piping system during its erection.

2.13 ARCHITECTURAL ACCESS DOORS:

A. Extent of Work: Provide architectural grade access doors at each point of required access to piping valves, and specialties, concealed equipment, etc. Coordinate this work with other sections for ceilings, walls, etc.

B. Material: Steel framed doors with heavy duty hinges and latch type locking mechanisms with surface finish configuration to accept, match or correlate with adjacent surface.

Product equivalent to Inland-Ryerson “Milcor”.

C. Installation: Complete, blended into adjacent work.

2.14 JOBSITE CLEANUP:

A. Keep site clean during progress of work.

B. At the conclusion of work, clean all installation thoroughly.

1. Leave equipment in a factory dock condition. Correct any damage and touch up or repaint if necessary.

2. Remove all debris from site.

END OF SECTION 220000

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SECTION 220100 - OPERATION AND MAINTENANCE OF PLUMBING

PART I - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specifications sections, apply to work of this section.

B. Division-22 Plumbing sections apply to work of this section.

1.2 SUMMARY:

A. Furnish two sets of bound operation and maintenance manuals. Manuals shall contain descriptive drawings and data which identify equipment installed at the project and detail the procedures and parts required to maintain and repair the equipment. Copies of approved submittals shall be included for all equipment.

1.3 OPERATION AND MAINTENANCE MANUAL FOR PLUMBING SYSTEMS:

A. General:

1. The "Operating and Maintenance Manual" is a single searchable and bookmarked pdf file containing a bound compilation of drawings and data that the owner requires for each building or project. This manual, complete with drawings and data, shall be furnished to the Owner.
2. The plumbing contractor has overall responsibility to obtain the necessary data from and compile the data as set forth in this specification, including items or equipment purchased by the Owner and delivered to the contractor for installation.
3. All information included shall be legible and sufficiently marked to indicate the exact size, model, type, etc., of equipment furnished and installed.

B. Purpose: The Operating and Maintenance Manual is prepared to provide a ready reference to all important pieces of plumbing and electrical equipment installed on the project. It is also to provide the necessary operating and maintenance data for use by service personnel. It is also to provide information required for checking equipment performance or for planning of plant expansion or redesign.

PART II - MATERIALS AND METHODS

2.1 PAGE SIZE: All pages shall be standard 8-1/2 x 11 inches size or approximate multiples (preferably 17 x 11 inches) The equipment name, drawing description and number shall be written on the face of each sheet.

2.2 DRAWINGS: The equipment name, drawing description and number shall be written on the face of each sheet.

2.3 PDF File: PDF file shall be for sheet size 8-1/2 x 11 inches.

A. The following information shall appear on the front cover sheet:

1. "Operation and Maintenance Manual".
2. Project Name (and volume number if more than one volume).
3. Building name.
4. Architect's name.
5. Engineer's name.
6. General Contractor's name.
7. Plumbing Contractor's name.

2.4 CONTENTS AND INDEXING:

A. Manuals shall contain descriptions of the building systems in sufficient detail to adequately indicate the type of systems installed and the basic details of their operation.

B. All purchased equipment data shall be used to designate the sections. Within each section additional indexing of component parts may be required.

C. Operation and Maintenance Manuals shall contain to the fullest extent all possible information pertinent to the equipment. The arrangement and type of information to be filed shall be as follows:

1. Copy of purchase order with changes (if any).

2. Outline drawings, special construction details, "as built" electrical wiring and control diagrams for all major and supplementary systems.

3. Manufacturer's test or calculated performance data and certified test curves.

4. Installation, operating, and maintenance instructions, including a complete parts list and sectional drawing with parts identification numbers. Mark with model, size and plan number.

5. Manufacturer's brochure marked to indicate exact equipment purchased. Brochures on component parts supplied by a manufacturer with his equipment, but not manufactured directly by him, shall also be included.

6. The serial numbers of each item of equipment installed are to be listed with the model numbers and plan symbols.

7. Include a Table of Contents. The contents shall be bookmarked into the following suggested parts:

a.	Part I	Building and System Descriptions
b.	Part II	Purchased Equipment Data
c.	Part III	Test Reports and Valve Charts
d.	Part IV	Preventative Maintenance Recommendations

8. A copy of the approved submittals for each piece of equipment.

9. A copy of all testing, adjusting and balancing reports.

10. Wiring diagrams, marked with model and size and plan symbol.

11. Operating and Maintenance Manuals data for Part I shall be obtained directly from the plumbing and electrical consultants. (Allow consultant preparation cost.)

12. The index shall contain the name and address of the manufacturer and, if different, where replacement and repair parts may be obtained.

END OF SECTION 220100

SECTION 220519 – METERS AND GAGES FOR PLUMBING PIPING

PART I - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. This section is Division-22 Plumbing section, and is part of each Division-22 section making reference to meters and gages specified herein.

1.2 SUMMARY

A. Extent of meters and gages required by this section is indicated on drawings and/or specified in this and other Division-22 sections.

B. Meters and gages specified in this section include the following:

1. Temperature Gages and Fittings.

    a. Glass Thermometers.
    b. Thermometer Wells.
    c. Temperature Gage Connector Plugs.

2. Pressure Gages and Fittings.

    a. Pressure Gages.
    b. Pressure Gage Valves.
    c. Pressure Gage Connector Plugs.

C. Meters and gages furnished as part of factory-fabricated equipment, are specified as part of equipment assembly in other Division-22 sections.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of meters and gages, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of meter and gauge. Include scale range, ratings and calibrated performance curves, certified where indicated. Submit meter and gage schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gage.

B. Maintenance Data: Submit maintenance data and spare parts lists for each type of meter and gauge. Include this data and product data in Maintenance Manual; in accordance with requirements of Division 1.

1.5 REFERENCES:

A. Codes And Standards:

1. UL Compliance: Comply with applicable UL standards pertaining to meters and gauges.

PART II - PRODUCTS

2.1 GLASS THERMOMETERS:

A. General: Provide glass thermometers of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.

B. Case: Die cast aluminum finished in baked epoxy enamel or extruded brass, glass front, spring secured, 9" long. Separable socket (union type).

C. Adjustable Joint: Die cast aluminum, finished to match case, 180 degrees adjustment in vertical plane, 360 degrees adjustment in horizontal plane, with locking device. Stainless steel bulb chamber.

D. Tube And Capillary: Stainless steel bulb chamber. Mercury filled, magnifying lens, 1% scale range accuracy, shock mounted.

E. Scale: Satin faced, non-reflective aluminum, permanently etched markings.

F. Stem: Copper-plated steel, or brass, for separable socket, length to suit installation.

G. Range: Conform to the following:

1. Hot Water: 30^{o} - 240^{o}F with 2^{o}F scale divisions.
2. Cold Water: 0^{o} - 100^{o}F with 2^{o}F scale divisions.

H. Manufacturer: Subject to compliance with requirements, provide glass thermometers of one of the following:

1. Marshalltown Instruments, Inc.
2. Marsh
3. Trerice (H.O.) Co.
4. Weksler
5. Weiss Instruments, Inc.
6. U.S. Gauge

2.2 THERMOMETER WELLS:

A. General: Provide thermometer wells constructed of brass or stainless steel, pressure rated to match piping system design pressure. Provide 2" extension for insulated piping. Provide cap nut with chain fastened permanently to thermometer well.

B. Manufacturer: Same as thermometers.

2.3 TEMPERATURE/PRESSURE GAGE CONNECTOR PLUGS:

A. General: Provide temperature gauge connector plugs pressure rated for 500 psi and 200 degrees F (93 degrees C). Construct of brass and finish in nickel-plate, equip with 1/2" NPS fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8" O.D. probe assembly from dial type insertion thermometer. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.

B. Manufacturer: Subject to compliance with requirements, provide temperature gauge connector plugs of one of the following:

Peterson Equipment Co., SISCO, Universal.

2.4 PRESSURE GAGES:

A. General: Provide pressure gauges of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.

B. Type: General use, 1% accuracy, ANSI B40.1 grade A, phosphor bronze bourdon type, bottom connection.

C. Case: Drawn steel or brass or phenolic, glass lens, 4-1/2" diameter.

D. Connector: Brass with 1/4" male NPT.

E. Scale: White coated aluminum, with permanently etched markings.

F. Range: Conform to the following; place operating pressure in mid-range.

1. Water: 0 - 100 psi - 160 psi, as needed.

G. Manufacturer: Subject to compliance with requirements, provide pressure gauges of one of the following:

1. U.S. Gauge
2. Marsh Instrument Co.
3. Marshalltown.
4. Trerice.
5. Weiss.
6. Weksler.

2.5 PRESSURE GAGE VALVES:

A. General: Provide pressure gauge valves between pressure gauges and gauge tees on piping systems. Construct gauge valve of brass bar stock with 1/4" female NPT on each end, and knurled handle brass plug.

B. Manufacturer: Same as for pressure gauges.

PART III - EXECUTION

3.1 INSPECTION: Examine areas and conditions under which meters and gauges are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF TEMPERATURE GAUGES:

A. General: Install temperature gauges in vertical upright position, and tilted so as to be easily read by observer standing on floor.

B. Locations: Install in the following locations, and elsewhere as indicated:

1. At inlet and outlet of each water heater.

C. Thermometer Wells: Install in piping tee where indicated, in vertical upright position. Fill well with oil or graphite, secure cap.

D. Temperature Gauge Connector Plugs: Install in piping tee where indicated, located on pipe at most readable position. Secure cap.

3.3 INSTALLATION OF PRESSURE GAGES:

A. General: Install pressure gages in piping tee with pressure gage bar stock valve located on pipe at most readable position.

B. Locations: Install in the following locations, and elsewhere as indicated:

1. At suction and discharge of each pump, single gage, mani-folded to include inlet strainer.

2. Across each pressure reducing valve.

3. At inlet and outlet of strainer.

C. Pressure Gage Valves: Install in piping tee with snubber for water.

D. Pressure Gage Connector Plugs: Install in piping tee where indicated, located on pipe at most readable position. Secure cap.

END OF SECTION 220519

SECTION 220523 – GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART I - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. This section is Division-22 Plumbing section and is part of each Division-22 section making reference to valves specified herein.

1.2 SUMMARY:

A. Extent of valves required by this section is indicated on drawings and/or specified in other Division-22 sections.

B. Types of valves specified in section include the following:

1. Drain Valves.
2. Ball Valves.
3. Check Valves.

C. Valves furnished as part of factory-fabricated equipment, are specified as part of equipment assembly in other Division-22 sections.

1.3 QUALITY ASSURANCE:

A. MANUFACTURER'S QUALIFICATIONS: Firms regularly engaged in manufacture of valves, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. VALVE TYPES: Provide valves of same type by same manufacturer.

C. VALVE IDENTIFICATION: Provide valves with manufacturer's name (or trademark) and pressure rating clearly marked on valve body.

1.4 SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's technical product data, including installation instructions for each type of valve. Include pressure drop curve or chart for each type and size of valve. Submit valve schedule showing Manufacturer's figure number, size, location, and valve features for each required valve.

B. SHOP DRAWINGS: Submit manufacturer's assembly-type (exploded view) shop drawings for each type of valve, indicating dimensions, weights, materials, and methods of assembly of components.

C. MAINTENANCE DATA: Submit maintenance data and spare parts lists for each type of valve. Include this data, product data, and shop drawings in Maintenance Manual; in accordance with requirements of Division 1.

1.5 REFERENCES:

A. CODES AND STANDARDS:

1. MSS Compliance: Mark valves in accordance with MSS-25 "Standard Marking System for Valves, Fittings, Flanges and Unions".
2. ANSI Compliance: For face-to-face and end-to-end dimensions of flanged- or welded-end valve bodies, comply with ANSI B16.10 "Face-to-Face and End-to-End Dimensions of Ferrous Valves".
3. UL and FM Compliance: Provide valves used in fire protection piping, which are UL-listed and FM approved.

PART II - PRODUCTS

2.1 VALVES:

A. GENERAL: Provide factory-fabricated valves recommended by manufacturer for use in service indicated. Provide valves of types and pressure ratings indicated; provide proper selection as determined by Installer to comply with installation requirements. Provide end connections which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is Installer's option.

B. SIZES: Unless otherwise indicated, provide valves of same size as upstream pipe size.

C. OPERATORS: Provide lever handle for quarter-turn valves.

D. CONNECTIONS: Unless otherwise noted for a particular reason, any valve 2" and larger shall have flanges.

2.2 MANUFACTURERS: Unless listed otherwise subject to compliance with requirements, provide valves of one of the following:

A. Apollo
B. Crane
C. Keystone
D. Powell
E. Nibco/Scott
F. Lunkenheimer
G. Stockham
H. Milwaukee

All valves of the same type shall be of the same manufacturer.

2.3 DOMESTIC COLD WATER, DOMESTIC HOT WATER, DOMESTIC HOT WATER RETURN (COPPER PIPE):

A. BALL VALVES:

1. 2" and Smaller: 125 psig WOG @ 220°F, bronze construction, threaded ends, bubble tight teflon seat at 100 psig under water, hard, stainless steel ball and stem. Operate with flow in either direction. Suitable for throttling and tight shut-off. Apollo 70-140 or equal by Watts, Hammond, Nibco.

B. SWING CHECK VALVES:

1. 2" and Smaller: Crane No. 37 bronze, threaded, Y-pattern, 200# WOG at swing check valve.

2. 2-1/2" and Larger: Crane No. 373, iron body, flanged, 200# WOG swing check valve with

bronze trim.

C. BALANCING VALVES: Bell and Gossett circuit setter plus or Armstrong CB circuit balancing valve with pressure taps or Flowset. Gate valves, Ball valves or butterfly valves may not be used as balancing valves. Provide schedule showing pressure drop and flow rate of each valve.

D. THERMOSTATIC MIXING VALVES:

1. (MV-1) Lavatory Mixing Valve:
   a. Maintain and limit hot water to desired selectable temperature between 80 and 120 degrees F, flow rates between .25 and 2.25 gpm, ASSE 1070 Standard, for single fixture applications, lead free construction.

2. (MV-2) Emergency Eye Wash:
   a. Tempering valve to blend hot and cold water, flow capacity of .5 to 6 gpm, valve to be used in single installation applications, temperature limit set to 90 degrees F, fail safe valve to deliver 4 gpm of cold water at 30 psi. ASSE Z358.1 standard.

2.4 MISCELLANEOUS VALVES AND SPECIALTIES:

A. GAUGE VALVES: Crane #88 bronze needle valve or Trerice barstock needle valve, or ball valve.

B. Pressure Reducing Valves For Water Services –Sizes 2 Inches and Smaller

1. Brass body construction with bronze working parts, Diaphragm operated with anti-siphon check valve and inlet strainer having Monel or stainless steel screen, Built-in thermal expansion bypass check valve, Lead free.

2. Approved Manufacturers and Models:
   a. AW Cash
   b. Cashco
   c. Watts Series U5B
   d. Wilkins
   e. Bell & Gossett

PART III - INSTALLATION

3.1 VALVE INSTALLATION:

A. Locate all valves in locations which will allow easy operation and facilitates maintenance.

B. Install valves with stems on horizontal or above.

C. Provide chain operators for any valves located more than 8 feet above finished floor. This means double acting lever handles for quarter turn valves, or chain wheels for multi-turn valves. Arrange valves and set up chain length for proper operation.

D. All branch lines which supply a specific area of the building (such as a toilet room or kitchen) shall be valved near the main so that each area may be isolated from the system for repairs without having to shut down both men and women's restrooms, other labs, or the whole building.

E. All valves located above a non-lay-in type ceiling or behind a wall shall be made accessible by means of an access door.

END OF SECTION 220523

SECTION 220529 – HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART I - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. This section is Division-22 Plumbing section, and is part of each Division-22 section making reference to supports and anchors specified herein.

1.2 SUMMARY:

A. Extent of supports and anchors required by this section is indicated on drawings and/or specified in other Division-22 sections.

B. Types of supports and anchors specified in this section include the following:

1. Horizontal-Piping Hangers and Supports.
2. Vertical-Piping Clamps.
3. Hanger-Rod Attachments.
4. Building Attachments.
5. Saddles and Shields.
6. Miscellaneous Materials.
7. Roof Equipment Supports.
8. Anchors.
9. Equipment Supports.

C. Supports and anchors furnished as part of factory-fabricated equipment, are specified as part of equipment assembly in other Division-22 sections.

D. Relate this section to Section 22 05 48 regarding seismic and vibration control.

1.3 QUALITY ASSURANCE:

A. MANUFACTURER'S QUALIFICATIONS: Firms regularly engaged in manufacture of supports and anchors, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

1.4 SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's technical product data, including installation instructions for each type of support and anchor.

B. SHOP DRAWINGS:

1. Submit manufacturer's assembly-type shop drawings for each type of support and anchor, indicating dimensions, weights, required clearances, and methods of assembly of components.

C. MAINTENANCE DATA: Submit maintenance data and parts list for each type of support and anchor. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 1.

1.5 REFERENCES:

A. CODES AND STANDARDS:

1. Code Compliance: Comply with applicable building, mechanical and plumbing codes pertaining to product materials and installation of supports and anchors.

2. UL and FM Compliance: Provide products which are UL-listed and FM approved.

3. MSS Standard Compliance:

a. Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-58.

b. Select and apply pipe hangers and supports, complying with MSS SP-69.

c. Fabricate and install pipe hangers and supports, complying with MSS SP-89.

d. Terminology used in this section is defined in MSS SP-90.

PART II - PRODUCTS

2.1 HORIZONTAL-PIPING HANGERS AND SUPPORTS:

A. GENERAL: Except as otherwise indicated, provide factory- fabricated horizontal piping hangers and supports complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide copper-plated hangers and supports for copper-piping systems.

B. ADJUSTABLE STEEL CLEVISES HANGERS: MSS Type 1. (For suspension of non-insulated or insulated stationary pipe lines; 1/2" to 30".)

C. STEEL DOUBLE BOLT PIPE CLAMPS: MSS Type 3. (For suspension of pipe requiring up to 4" of insulation and where flexibility of clamp is desirable; 3/4" to 24".)

D. STEEL PIPE CLAMPS: MSS Type 4. (For suspension of cold pipe lines or hot lines

where little or no insulation is required; 1/2" to 24".)

E. PIPE HANGERS: MSS Type 5. (For suspension of piping when off-center closure allowing installation of hanger before erection of piping is desired; 1/2" to 4".)

F. ADJUSTABLE SWIVEL PIPE RINGS: MSS Type 6. (For suspension of non-insulated stationary pipe lines; 3/4" to 8".)

G. ADJUSTABLE STEEL BAND HANGERS: MSS Type 7. (For suspension of non-insulated stationary pipe lines; 3/4" to 8".)

H. ADJUSTABLE BAND HANGERS: MSS Type 9. (For suspension of non-insulated stationary pipe liens; 1/2" to 8".)

I. ADJUSTABLE SWIVEL RINGS, BAND TYPE: MSS Type 10. (For suspension of non-insulated stationary pipe lines; 3/8" to 8".)

J. SPLIT PIPE RINGS: MSS Type 11. (For suspension of non-insulated stationary pipe lines; 3/8" to 3".)

K. EXTENSION SPLIT PIPE CLAMPS: MSS Type 12. (For suspension of non-insulated stationary pipe lines; 3/8" to 3".)

L. U-BOLTS: MSS Type 24. (For support of heavy loads; 1/2" to 30".)

M. CLIPS: MSS Type 26. (For support of uninsulated piping not subject to expansion or contraction.)

N. PIPE SADDLE SUPPORTS: MSS Type 36, including steel pipe base- support and cast-iron floor flange. (To support pipe from floor stanchion, using floor flange to secure stanchion to floor 4" to 36".)

O. PIPE STANCHION SADDLES: MSS Type 37, including steel pipe base support and cast-iron floor flange. (To Type 36 except U-bolt provided for retaining pipe.)

23 VERTICAL-PIPING CLAMPS:

A. GENERAL: Except as otherwise indicated, provide factory- fabricated vertical-piping clamps complying with MSS SP-58, of one of the following types listed, selected by Installer to suit vertical piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide copper-plated clamps for copper-piping systems.

B. TWO-BOLT RISER CLAMPS: MSS Type 8. (For support and steadying of pipe risers; 3/4" to 20". Also supports pipe covering or insulation.)

C. FOUR-BOLT RISER CLAMPS: MSS Type 42. (When longer ends are required for riser clamps.)

2.4 HANGER-ROD ATTACHMENTS:

A. GENERAL: Except as otherwise indicated, provide factory- fabricated hanger-rod attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper-piping systems.

B. STEEL TURNBUCKLES: MSS Type 13. (For adjustment up to 6" for heavy loads.)

C. STEEL CLEVISES: MSS Type 14. (For use on high temperature piping installations.)

D. SWIVEL TURNBUCKLES: MSS Type 15. (For use with split pipe rings, MSS type 11.)

E. MALLEABLE IRON SOCKETS: MSS Type 16. (For attaching hanger rod to various types of building attachments.)

2.5 BUILDING ATTACHMENTS:

A. GENERAL: Except as otherwise indicated, provide factory- fabricated building attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods. Provide copper-plated building attachments for copper-piping systems.

B. CONCRETE INSERTS: MSS Type 18. (For upper attachment for suspending pipe hangers from concrete ceiling.)

C. TOP BEAM C-CLAMP: MSS Type 19. (Use under roof installations with bar joist construction, for attachment to top flange of structural shape.)

D. SIDE BEAM OR CHANNEL CLAMPS: MSS Type 20. (For attachment to bottom flange of beams, channels, or angles.)

E. CENTER BEAM CLAMPS: MSS Type 21. (For attachment to center of bottom flange of beams)

F. WELDED BEAM ATTACHMENTS: MSS Type 22. (For attachment to bottom of beams where loads are considerable and rod sizes are large.)

G. C-CLAMPS: MS Type 23. (For attachment to structural shapes.)

H. TOP BEAM CLAMPS: MSS Type 25. (For attachment to top of beams when hanger rod is required tangent to edge of flange.)

I. SIDE BEAM CLAMPS: MSS Type 27. (For attachment to bottom of steel I-beams.)

J. STEEL BEAM CLAMPS W/EYE NUT: MSS Type 28. (Same as Type 28 with link extensions.)

K. LINKED STEEL CLAMPS W/EYE NUT: MSS Type 29. (Same as Type 28 with link extensions.)

L. MALLEABLE BEAM CLAMPS: MSS Type 30. (For attachment to structural steel.)

M. STEEL BRACKETS: One of the following for indicated loading:

1. Light Duty: MSS Type 31, to 570 pounds.

2. Medium Duty: MSS Type 32, to 1,500 pounds.

3. Heavy Duty: MSS Type 33, to 3,000 pounds.

N. SIDE BEAM BRACKETS: MSS Type 34. (For use on sides of steel or wooden beams.)

O. PLATE LUGS: MSS Type 57. (For attachment to steel beams where flexibility at the beam is desired.)

P. HORIZONTAL TRAVELERS: MSS Type 58. (For supporting piping systems subject to linear horizontal movements where head room is limited.

2.6 SADDLES AND SHIELDS:

A. GENERAL: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.

B. PROTECTION SADDLES: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.

C. PROTECTION SHIELDS: MSS Type 40; of length recommended by manufacturer to prevent crushing of insulation.

D. THERMAL HANGER SHIELDS: Constructed of 360 degrees insert of high density, 100 psi, water-proofed calcium silicate, encased in 360 degrees sheet metal shield. Provide assembly of same thickness as adjoining insulation.

E. MANUFACTURER: Subject to compliance with requirements, provide thermal hanger shields of one of the following:

1. Elcen Metal Products Co.
2. Pipe Shields, Inc.

2.7 MANUFACTURERS OF HANGERS AND SUPPORTS:

A. MANUFACTURER: Subject to compliance with requirements, provide hangers and supports of one of the following:

1. Kin-Line, Inc.
2. Fee & Mason Mfg. Co.; Div. Figgie International
3. ITT Grinnel Corp.
4. B-Line.

2.8 MISCELLANEOUS MATERIALS:

A. METAL FRAMING: Provide products complying with NEMA STD ML 1.

B. STEEL PLATES, SHAPES AND BARS: Provide products complying with ASTM A 36.

C. CEMENT GROUT: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration. Use Embeco grout for non-shrink applications.

D. HEAVY DUTY STEEL TRAPEZES: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.

E. PIPE GUIDES: Provide factory-fabricated guides, of cast semi- steel or heavy fabricated steel, consisting of bolted two- section outer cylinder and base with two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

PART III - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 PREPARATION:

A. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors and other building structural attachments.

B. Prior to installation of hangers, supports, anchors and associated work, Installer shall meet at project site with Contractor, installer of each component of associated work, inspection and testing agency representatives (if any), installers of other work requiring coordination with work of this section and Architect/Engineer for purpose of reviewing material selections and procedures to be followed in performing the work in compliance

with requirements specified.

3.3 INSTALLATION OF BUILDING ATTACHMENTS:

A. Install building attachments at required locations within concrete or on structural steel for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through the openings at the tops of inserts.

3.4 INSTALLATION OF HANGERS AND SUPPORTS:

A. GENERAL: Install hangers, supports, clamps and attachments to rigidly support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacing complying with MSS SP-69. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.

B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

C. Prevent electrolysis in support of copper tubing by the use of hangers and supports which are copper plated, or by isolating with foam rubber covering.

D. PROVISIONS FOR MOVEMENT: Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.

E. Install supports within 2 feet of non-vertical flex connectors.

F. LOAD DISTRIBUTION: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

G. PIPE SLOPES: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31 Pressure Piping Codes are not exceeded.

H. INSULATED PIPING: Hangers shall not come in contact with pipe where pipe is specified to be insulated.

I. CLAMPS: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.

J. SHIELDS: Where low-compressive-strength insulation or vapor barriers are indicated on cold or chilled water piping, install galvanized steel protective shields. Install calcium silicate blocks (12" long minimum) at support points.

K. SADDLES: Where insulation without vapor barrier is indicated, install protection saddles.

3.5 INSTALLATION OF ANCHORS:

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31, and to prevent transfer for loading and stresses to connected equipment.

B. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure. Comply with ANSI B31 and with AWS standards.

C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.

D. ANCHOR SPACINGS: Where not otherwise indicated, install anchors at ends of principal pipe-runs, at intermediate points in pipe-runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.6 EQUIPMENT SUPPORTS:

A. Provide concrete housekeeping bases for all floor mounted equipment including equipment on support stands furnished as part of the work of Division 15. Size bases to extend a minimum of 4" beyond equipment base in any direction, and 4" above finished floor elevation. Construct of reinforced concrete, roughen floor slab beneath base for bond, and provide steel rod anchors between floor and base. Locate anchor bolts using equipment manufacturer's templates. Chamfer top and edge corners.

B. Provide structural steel stands to support equipment not floor mounted or hung from structure. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks mounted on steel stands.

C. Furnish roof equipment supports to Contractor for installation as part of work of

Division 7; not work of this section.

3.7 ADJUSTING AND CLEANING:

A. HANGER ADJUSTMENT: Adjust hangers so as to distribute loads equally on attachments.

B. SUPPORT ADJUSTMENT: Provide grout under supports so as to bring piping and equipment to proper level and elevations.

C. CLEANING: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 220529

SECTION 220548 - VIBRATION AND SEISMIC CONTROL FOR PLUMBING PIPING AND EQUIPMENT

PART I - GENERAL:

1.1 RELATED DOCUMENTS: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

This section is Division-22 Basic Mechanical Materials and Methods section, and is part of each Division-22 section making reference to pipes and pipe fittings specified herein.

1.2 SUMMARY: Furnish and install complete seismic restraint and vibration control systems for all work installed under Division 22. Work to be responsive to the intent of the Uniform Building Code, latest adopted edition for the respective seismic zone.

1.3 QUALITY ASSURANCE:

A. MANUFACTURERS QUALIFICATIONS: Engage the services of an independent seismic and vibration control subcontractor who shall have the technology, the experience, computer capabilities and manufactured products to prepare the required computations, shop drawings and special devices to meet the minimum requirements described herein.

The seismic and vibration control subcontractor shall visit the site during construction at a minimum of two specific periods.

1. When equipment is set in place, prior to placement of seismic restraint devices for the purposes of directing the contractor in properly locating and installing the approved devices.

2. At the completion of the project, prior to final mechanical inspection, for the purpose of verifying the correctness of the seismic restraint and vibration isolation device installation and preparing certification of the seismic vibration-isolation work.

The seismic subcontractor shall exercise the quality control for this work and shall include, but not be limited to instructions direct to the Plumbing (Division 22) Contractor concerning:

Anchoring of equipment.
Vibration mounting of equipment.
Equipment base coordination with restraint requirements.
Snubbing of equipment.
Bracing and anchoring of ductwork piping and conduit.
Provision for expansion and vibration of piping.
Concrete and/or steel pads or bases to assure proper mounting of restraints and isolators.

Vibration isolation of pumps, convertor, chiller, exhaust fans, supply air fans, relief fans, etc.

The subcontractor shall be responsible for identifying the need for the size and location of steel sole plates and their attachment to structural steel or concrete.

The subcontractor shall certify in writing that he has inspected the installation and that all isolation, anchors and seismic restraint materials are installed correctly and functioning properly. Certification shall be provided after all corrective work has been completed.

1.4 SUBMITTALS: Submittal data is required and shall consist of computations, vibration isolation selection, equipment anchors, anchor bolt sizes, supports, seismic restraints, sole plate data, restraint locations and type of restraints.

Submittal data shall identify dimensions, load deflection data, center of gravity, standard connections, manufacturer's recommendations, behavior problems including vibrations, thermal expansion, building expansion joints, etc., associated with equipment, ductwork, piping and conduit.

Calculations need not be submitted when restraint devices for piping, conduit and ductwork are proposed in accordance with the SMACNA Guidelines for Seismic Restraints.

Selection of isolator anchors and restraints shall be clearly made known along with the basis for selection so that proposed systems can be reviewed.

Calculations furnished for anchors, anchor bolts, sole plates and other support steel for restraining devices shall be signed and stamped by an engineer licensed in one of the United States.

1.5 REFERENCES:

A. CODES AND STANDARDS:

International Building Code	2012 Edition
NFPA bulletin 90A,	Current Edition
UL Standard 181	
Seismic Restraint Manual Guidelines for Mechanical Systems published by SMACNA	

Guidelines for seismic restraint of Mechanical Systems and Plumbing Piping Systems. Published by the Sheet Metal Industry Fund of Los Angeles, California, and the Plumbing and Piping Industry Council, Inc., Los Angeles, California.

1.6 SEISMIC VENDORS: Mason, Amber Booth, Kinetics.

PART II - PRODUCTS:

2.1 MATERIALS - PRODUCTS: Restraint devices shall be especially designed to resist seismic fo

rces in all directions.

A. SNUBBERS: Restraint surfaces which engage under seismic motion shall be cushioned with a resilient elastomer neoprene (bridge bearing neoprene) to protect equipment. Restraints shall allow a maximum of 1/4" before engaging and shall not interfere in normal starting or stopping operation. Housing shall allow for visual inspection to determine clearances during system operation. Restraints shall be field adjustable and be positioned for up to 1/4" clearance both horizontally and vertically. Mountings and snubbers are to be manufactured under a Quality Assurance (QA) Program.

B. SNUBBERS AND ISOLATOR COMBINATION DEVICES: Combination unitized devices may be used where equipment isolation is required. They shall include the requirements listed for snubbers. Isolation portion shall be stable spring type with combination leveling bolt and equipment fastening device. Base plate shall have adequate means for bolting to structure. The spring assembly shall be removable and shall fit within a welded steel enclosure.

C. PIPING AND CONDUIT RESTRAINTS: Restraint materials for exposed installation shall be standard fabricated flat steel, angle rod and channel members. Restraint members shall be bolt connected. Cabling materials and methods shall be used only in chases or concealed ceiling spaces.

PART III - EXECUTION

3.1 SEISMIC RESTRAINT GUIDELINE:

Guidelines for SMACNA seismic restraints for conduit, piping and ductwork are to serve as the basis for restraint methods.

3.2 SEISMIC RESTRAINT-PIPING AND CONDUIT:

A. General: All piping and conduit shall be protected in all planes by restraints, designed to accommodate thermal movement as well as restrain seismic motion. Tanks and vessels connected to piping shall be restrained in the same manner as the piping.

B. Locations of the restraints shall include, but not be limited to:

1. At all drops or risers to equipment connections.

2. At all changes in direction of piping and conduit.

3. At all horizontal runs of pipe and conduit to keep it in alignment and prevent sagging with restraints not to exceed the following:

   Transverse bracing at 40'-0" O.C. maximum.
   Longitudinal bracing at 80'-0" O.C. maximum.

4. Provide flexibility in joints where pipes pass through building seismic or expansion joints.

5. On both sides of flexible connectors.

C. Exceptions:

1. Conduit under 2-1/2" size and piping under 1-1/2" size need not be additionally seismically restrained except as follows:

a. Brace all piping and conduit 1-1/4" and larger in boiler rooms, mechanical rooms, electrical equipment rooms and refrigeration machinery rooms.

b. Brace all fuel gas and oil piping, medical gas piping and compressed air piping 1" and larger.

2. Seismic bracing may be omitted:

a. When the top of the pipe is suspended 12" or less from the supporting structure member and the pipe or conduit is suspended by an individual hanger.

b. On all piping 3/4" and smaller.

3.3 SEISMIC RESTRAINT INSULATED PIPING: Where piping is designated to be insulated, the points of support shall be protected by a 360° sheet metal shield. Insert insulation shall be of the same thickness as the adjoining pipe insulation. (Pipe Shields, Inc.)

The sheet metal shield wrapped around the insert shall be of the following lengths and gauge thickness.

PIPE SIZE	SHIELD LENGTH	MINIMUM GAUGE
1/2 - 1-1/2"	4"	20
2 - 6"	6"	20
8 - 10"	9"	16
12 - 18"	12"	16
20 and up	18"	16

3.4 SEISMIC RESTRAINT - PIPING AT FIRE-WALL AND FLOOR PENETRATION WHERE WALL IS USED AS A RESTRAINT:

A. BARE PIPE: Encase pipe in minimum 24 gauge sheet metal can sized for one inch spacing between pipe and outer diameter of can. Spacing shall be packed in accordance with fire resistant/retardant materials in accordance with Section: FIRE PROTECTION, Section 07270.

B. INSULATED PIPE: Encase in adjustable or fixed length cans, minimum 24 gauge, sized for maximum one inch spacing between insulation and outer diameter of can. Insulation shall consist of 360° insert sized to extend a minimum of 1" beyond wall or floor penetration and of the same thickness as the adjoining insulation. Spacing between shield and can shall be packed in accordance with Section: FIRE PROTECTION, Section 07270.

3.5 SEISMIC RESTRAINT GROOVED PIPING: Where grooved piping is selected as the piping system, it must be seismically restrained as well as provide for thermal movement.

Pipes may not be fastened to differently moving structures such as a wall or a ceiling, or a ceiling and a floor. The intent is to have the piping system move with the structure and not separate from it.

In general, grooved piping shall be provided with additional flexible couplings to allow extreme deflections to occur, yet restrained to prevent movement beyond the limits of the flexible connections. Linear movement shall be incorporated as a part of the flexible connections or in a swing joint arrangement.

Groove piping systems shall be separated, analyzed and submitted from threaded or welded piping systems.

3.6 VIBRATION ISOLATION:

A. General: Furnish and install devices to isolate moving equipment from the structure. Review isolation furnished with factory package equipment, require conformance with project criteria.

B. Basic Criteria: Vibration isolation devices which have natural frequencies approximately 1/10 that of the related driving frequency.

C. Field Verify: All required devices and installation.

3.7 VIBRATION ISOLATION - PIPING:

A. Furnish and install devices to isolate all piping from other moving equipment. Provide flex connections, spring hangers, grooved joint couplings for pipe, etc., as required.

END OF SECTION 220548

SECTION 220553 – IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART I - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specifications sections, apply to work of this section.

B. Division-22 Plumbing sections apply to work of this section.

1.2 SCOPE OF WORK:

A. All plumbing piping and equipment (excluding thermostats and relays), and distribution systems shall be labeled. Electrical switches and starters for plumbing equipment shall also be labeled.

PART II - GENERAL PLUMBING MATERIALS AND METHODS

2.1 EQUIPMENT, VALVE PIPE AND DUCT IDENTIFICATION:

A. Items to be labeled shall include all items of plumbing equipment including pumps, and electrical switches and starters for plumbing equipment and gages.

B. Information to be put on label shall include the following:

1. Identification number and name. This number and name shall generally be the same as that shown on the plans or in these specifications.

2. Where the item is a pump, the flow and head shall be indicated and the system served.

3. If part of a unit, it shall have, in addition to its own number, the number of the main item it is serving.

4. Valves shall be tagged as to the area served and have their normal operating position indicated.

5. Where it is apparent which main unit a valve is serving, only the function of the valve need be included on the nameplate.

6. Type of nameplates shall be as follows:

a. Valve tags shall be aluminum embossed 3/4" tags with identification on one side for valves. Tags for magnetic starters shall be glued to the metal starter cover. Tags shall be as manufactured by Addressograph Company and shall be Addressograph No. B-5300.

b. Equipment nameplates shall be black face formica with white engraved lettering 3/16" high or larger.

7. Methods of attaching labels shall be as follows:

a. Valve tags to be connected to valve stem by steel rings or chains.

b. Screws for equipment labels.

8. Example of typical nameplate series:

a. Pump nameplate for above unit:

1) “DHW PUMP NO. 1
2) SERVES DHW
3) 2 GPM - 15 FT.”

b. Switch nameplate for above pump:

1) “DISCONNECT - PUMP 1"

c. Sample nameplate for valve where it is apparent what valve is serving:

1) “DOM. COLD WATER TO WATER HTR - N.O.”

9. NOTE: Above are samples and do not necessarily apply to actual conditions. Room numbers shall be as assigned by Owner to actual conditions.

C. Identification of Piping:

1. All piping shall bee painted under general painting section of this specification and be identified under this section in accordance with the following:

2. Means of Identification: All campus piping systems shall be identified according to one of the following schemes:

a. MECHANICAL/FAN ROOM SYSTEMS:

1) Completely Painted per Coding Scheme
2) Identifying Legend
3) Flow Direction Arrow

b. EXPOSED SYSTEMS:

1) Completely Painted per Coding Scheme

c. CONCEALED SYSTEMS:

1) Identifying Legend
2) Flow Direction Arrow

3. In concealed space, identify at the following interval:

a. Every 50 feet interval along continuous runs.

b. At least once in every room if less than 50 feet

c. At each riser or junction.

d. Above or behind ceiling or wall access doors.

4. Colors: The following colors shall be used in accordance with the pipe identification code hereinafter specified.

a. IMPORTANT! Painting contractor shall not vary from the colors listed below that match campus standard, except ONLY by the written permission from Architect/Engineer or campus Utility Services personnel; to change colors will result in piping being repainted at the sole expense of the contractor.

b. Color Coding as follows:

Material	Background Color	Identifying Legend	Lettering
Air	Blue	CA	White
Domestic Cold	Green	DCW	Black
Domestic Hot	Red	DHW	Black
Hydrogen	Yellow	HID	Black
Argon	Yellow	AR	Black
Oxygen	Yellow	O2	Black
Ro/DI	Green	Ro/DI	Black
Domestic Hot Return	Lime	DHWC	Black
Roof Drain	Black	RD	White
Secondary Roof Drain	Black	SRD	White

5. Identifying Legends: Legends shall be painted or stenciled on pipe over background color in such a location on the pipe as to be readily visible to operating personnel from the floor. Legends must be painted on in black or white as indicated. Self-adhesive or glue-on type labels will not be acceptable.

a. Letters for identifying legends shall be 2" high for 3" and larger pipe, 1" for 1-1/4" to 2-1/2" pipe and 1/2" for 1" pipe and smaller.

6. Flow Direction Arrows: Arrows to indicate direction of flow inside the pipe shall be painted over the background color in black or white, the same color as the identifying legend and point away from it.

   a. The “shaft” of the arrow shall be 2" long and shall be 1" in width on pipes 3" in diameter or more and 1/2" in width on pipes 2-1/2" in diameter or less. The “head” of the arrow shall be formed by an equilateral triangle having a base equal to twice the width of the “shaft”.

   b. Use double-headed arrow if flow can be in both directions, such as expansion lines.

   c. Identify direction in mechanical rooms not in exposed public ways at walls and every 20 feet.

2.2 PANEL IDENTIFICATION:

A. All panel devices on panel faces shall have engraved plastic labels.

B. All internal panel components shall have engraved plastic labels. Fasten label beneath each device.

C. All panel wiring and tubing shall be numerically or alphabetically coded.

END OF SECTION 220553

SECTION 22 07 00 - PLUMBING INSULATION

PART I - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections apply to work of this section.

B. Division-22 Section 22 00 00 - Plumbing applies to work of this section.

1.2 SUMMARY:

A. Extent of plumbing insulation required by this section is indicated on drawings and schedules as required by the current Model Energy Code, and by requirements of this section. Use no asbestos in this work.

B. Types of plumbing insulation specified in this section include the following:

1. Piping Systems Insulation:

a. Fiberglass.

C. Refer to Division-22 section "Hangers and Supports for Plumbing Piping and Equipment" for protection saddles, protection shields, and thermal hanger shields.

D. Refer to Division-22 section "Identification for Plumbing Piping and Equipment" for installation of identification devices for piping and equipment.

1.3 QUALITY ASSURANCE:

A. MANUFACTURER'S QUALIFICATIONS: Firms regularly engaged in manufacture of mechanical insulation products, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

B. INSTALLER'S QUALIFICATIONS: Firm with at least 5 years successful installation experience on projects with mechanical insulations similar to that required for this project.

C. FLAME/SMOKE RATINGS: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.

1.4 SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's specifications and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each plumbing system requiring insulation.

B. MAINTENANCE DATA: Submit maintenance data and replacement material lists for each type of plumbing insulation. Include this data and product data in maintenance manual.

1.5 DELIVERY, STORAGE AND HANDLING:

A. Deliver insulation, coverings, cements, adhesives and coatings to site in containers with manufacturer's stamp or label affixed showing fire hazard ratings of products.

B. Protect insulation against dirt, water and chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

PART II - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. MANUFACTURER: Subject to compliance with requirements, provide plumbing insulation materials of one of the following (except as noted):

1. Armstrong World Industries, Inc.
2. Babcock and Wilcox Co., Insulating Products Div.
3. CertainTeed Corp.
4. Knauf Fiber Glass GmbH.
5. Manville Products Corp.
6. Owens-Corning Fiberglass Corp.
7. Pittsburgh Corning Corp.

2.2 PIPING INSULATION MATERIALS:

A. PREFORMED FIBERGLASS PIPING INSULATION: ASTM C 547. (Class 1 for use to 450^{o}F (230^{o}C); Class 2 for use to 650^{o}F (345^{o}C); Class 3 for use to 1200^{o}F (650^{o}C).

B. JACKETS FOR PIPING INSULATION: All purpose (ASJ) fire retardant jacket, ASTM C 921, Type I for piping with temperatures below ambient, Type II for piping with temperatures above ambient. Type I may be used for all piping at Installers option.

C. Encase pipe fittings insulation with one-piece pre-molded PVC fitting covers, fastened as per manufacturer's recommendations.

D. Encase exterior fittings insulation and piping with aluminum jacket with weather-proof construction.

E. Staples, Bands, Wires, and Cement: As recommended by insulation manufacturer for applications indicated.

F. Adhesives, Sealers, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

2.3 PIPING SEALANT THROUGH WALLS:

A. Sealant shall be a two-part foamed silicone elastomer equal to Dow Corning 3-6548 Silicone RTV foam. Sealant shall be applied at any piping or duct penetration through fire or smoke walls to prevent air from passing through the opening.

B. Sealant cell structure, foamed in place, shall be U.L. classified and shall meet the smoke development and fuel contribution ratings specified. Sealant shall be stable at extreme temperatures, and shall effectively confine such hazards as fire, smoke and gases.

C. Sealant required at any fire/smoke wall penetration to be according to approved detail for each specific wall assembly. Contractor shall submit detail for engineer approval.

2.4 FIRE/SMOKE ENCASEMENT:

A. Any and all PVC, PVDF, polypropylene, acid waste and vent and any other plastic piping located in return air plenums shall be encased in rated flame and smoke system. The encasement shall be equal to Firemaster "Plastic Pipe Fire Protection System." The enclosure shall meet all codes.

PART III - EXECUTION

3.1 GENERAL:

A. Piping insulation shall be fiberglass one-piece performed pipe insulation with all purpose (ASJ) fire retardant jacket.

B. Fittings and valves shall be insulated and covered with Zeston covers.

C. All cold water, roof drains or any other lines upon which condensate moisture could form, shall have a vapor-proof jacket.

D. Fire and smoke hazard for a complete insulation system shall not exceed:

1. Flame spread - 25
2. Fuel contribution - 50
3. Smoke development - 50

E. Insulation protection shields equal to Grinnell Figure 167 shall be installed on all insulated pipe 1" and larger. Hangers shall not contact pipe where pipe is specified to be insulated.

3.2 INSPECTION:

A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.3 PLUMBING PIPING SYSTEM INSULATION:

A. INSULATION OMITTED: Omit insulation on chrome-plated exposed piping (except for handicapped fixtures), air chambers, unions strainers check valves, balance cocks, flow regulators, drain lines from water coolers, drainage piping located in crawl spaces or tunnels, fire protection piping, and pre-insulated equipment.

B. COLD PIPING:

Application Requirements: Insulate the following cold plumbing piping systems:

1. Potable cold water piping

2. Plumbing vents within 6 lineal feet of roof or wall outlet.

Insulate each piping system specified above with one of the following types and thicknesses of insulation:

1. Fiberglass with all service jacket, self sealing lap:
   1/2" thickness.

C. HOT PIPING:

Application Requirements: Insulate the following hot plumbing piping systems:

1. Potable hot water piping.
2. Potable hot water recirculating piping.
3. Hot drain piping.

Insulate each piping system specified above with one of the following types and thicknesses of insulation:

1. Fiberglass with all service jacket, self-sealing lap K factor of .24 to .28 at 100^{o} mean rating temperature; 1" thick for pipe sizes up to and including 1-1/4"; 1-1/2" thick for pipe sizes 1-1/2" and larger.

3.4 INSTALLATION OF PIPING INSULATION:

A. GENERAL: Install insulation products in accordance with the manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing and acceptance of tests.

C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete the run. Do not use cut pieces or scraps abutting each other.

D. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to

ensure a complete and tight fit over surfaces to be covered.

E. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage.

F. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated.

G. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.

H. Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3" wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3" wide vapor barrier tape or band.

3.5 PROTECTION AND REPLACEMENT:

A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

B. PROTECTION: Insulation Installer shall advise Contractor of required protection for insulation work during construction period to avoid damage and deterioration.

END OF SECTION 220700

SECTION 221100 – FACILITY WATER DISTRIBUTION

PART I - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 SUMMARY:

A. This Section specifies the water distribution piping system, including potable cold, hot, and recirculated hot water piping, fittings, and specialties within the building connecting to existing water piping in existing building and connecting to new equipment.

B. Water Supply Systems:

1. Domestic Water
2. Rough-in and Connect

C. Domestic Water Equipment:
1. Domestic Water Expansion Tank

D. Related Sections:

1. Separate sections in Division 22 specify Basic Piping Materials and Methods, Hangers and Supports, Expansion Compensation, piping system identification materials and requirements, general duty valves, pipe insulation, water conditioning equipment, domestic hot water heaters and plumbing fixtures and equipment.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications:

1. Firms regularly engaged in the manufacture of plumbing piping products and equipment of types, materials and sizes required, whose products have been in service for not less than five years.

B. Installer's Qualifications:

1. Firm with at least three years history of successful experience on projects of similar nature.

2. Licensed as a firm in the Contractor state of origin and in the State of Utah.

3. Have a publicly registered bonding capacity of sufficient amount to cover this work and all other work in progress by the Contractor.

4. All workmen employed on the project shall carry state licenses as journeyman or apprentice pipe fitters with additional certification for welders.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical literature indicating source, brand, type, model, performance characteristics, installation instructions, etc. Color chart for finished surfaces and fixtures.

B. Record Drawings: See Section 220000.

C. Operation and Maintenance Information: Provide information for all equipment including a comprehensive system operating description. See Section 220100.

1.5 REFERENCES:

A. Codes and Standards: Comply with applicable sections, follow recommended practices.

1. State Boiler and Pressure Vessel Regulations
2. ASME Codes for Boilers and Pressure Vessels
3. International Plumbing Code
4. International Building Code
5. International Mechanical Code
6. Americans with Disabilities Act.
7. HI Compliance: Design, manufacture, and install plumbing pumps in accordance with HI "Hydraulic Institute Standards".
8. UL Compliance: Design, manufacture, and install plumbing pumps in accordance with UL 778 "Motor Operated Water Pumps".
9. UL and NEMA Compliance: Provide electric motors and components which are listed and labeled by Underwriters Laboratories and comply with NEMA standards.

1.6 DELIVERY, STORAGE, AND HANDLING:

A. Store pipe in a manner to prevent sagging and bending.

1.7 SEQUENCING AND SCHEDULING:

A. Coordinate the installation of pipe sleeves for foundation wall penetrations.

PART II - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturer Uniformity: Conform with the requirements specified in Basic Mechanical Requirements, under "Product Options."

2.2 PIPE AND FITTINGS:

A. Domestic Water Pipe With-in Building (except below slab):

1. Pipe Sizes 4" and Smaller: Copper tubing. Conform to ASTM B88, Type K or L, hard temper, copper tube; ANSI B16.22 streamlined pattern wrought-copper fittings, with soldered joints using 95-5 tin-antimony solder or non-lead bearing solders such as “Silvabrite”.

2.3 VALVES:

A. Ball, check, and drain valves are specified in Section 22 05 23 – General-Duty Valves for Plumbing Piping.

2.4 DOMESTIC WATER EXPANSION TANKS:

A. Extent of Work: Furnish and install captive air type shock absorbing expansion tanks as indicated on drawings.

B. Delivery Storage and Handling: Handle carefully. Verify integrity of bladder before activating system.

C. Submittals: Submit shop drawings for review.

D. Materials and Installation:

1. NSF approved.

2. Butyl rubber diaphragm, propylene lined reservoir. Welded steel tank.

3. Air charging valve, threaded water side connection.

4. Approved Manufacturers:

a. Amtrol
b. ProFlo
c. Watts
d. Elbi

5. Install complete with system isolation and water side drain valves, seismic restraint. Charge air side of tank to system water pressure before connection.

PART III - EXECUTION

3.1 EXAMINATION

A. Verify all dimensions by field measurements. Verify that all water distribution piping may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.

B. Examine rough-in requirements for plumbing fixtures and other equipment having water connections to verify actual locations of piping connections prior to installation.

C. Do not proceed until the unsatisfactory conditions have been corrected.

3.2 JOINING PIPES AND FITTINGS:

A. Copper Tubing: Solder joints in accordance with the procedures specified in ANSI B9.1.

3.3 PIPING INSTALLATION:

A. Refer to the separate Division 15 section: Basic Piping Materials and Methods, for general piping installation instructions.

B. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.

C. Install piping level with no pitch.

3.4 INSTALLATION OF VALVES:

A. Installation requirements for general duty valves are specified in a separate section of Division 22.

B. Valves: Install in locations shown on drawings. Provide isolation valves for brand lines and service to all equipment, shown or not.

C. Check Valves: Install swing check valves on discharge side of each pump, and elsewhere as indicated.

3.5 EQUIPMENT CONNECTIONS:

A. Piping Runouts to Fixtures: Provide hot and cold water piping runouts to fixtures of sizes indicated, but in no case smaller than required by Plumbing Code.

B. Mechanical Equipment Connections: Connect hot and cold water piping system to mechanical equipment as indicated. Provide shutoff valve and union for each connection, provide drain valve on drain connection. For connections 2-1/2" and larger, use flanges instead of unions.

3.6 FIELD QUALITY CONTROL:

A. Inspections: Do not enclose, cover, or put into operation water distribution piping system until it has been inspected and approved by the authority having jurisdiction.

B. During the progress of the installation, notify the plumbing official having jurisdiction, at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.

C. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.

D. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to insure compliance with the requirements of the plumbing code.

E. Re-inspections: Whenever the plumbing official finds that the piping system will not pass the test or inspection, make the required corrections and arrange for re-inspection by the plumbing official.

F. Reports: Prepare inspection reports, signed by the plumbing official.

G. Piping System Test:

H. Test for leaks and defects all new water distribution piping systems and parts of existing systems, which have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.

I. Leave uncovered and unconcealed all new, altered, extended, or replaced water distribution piping until it has been tested and approved. Expose all such work for testing that has been covered or concealed before it has been tested and approved.

J. Cap and subject the piping system to a static water pressure of 50 psig above the operating pressure without exceeding the pressure rating of the piping system materials. Isolate the test source and allow to stand for a period of 4 hours. Leaks and loss in test pressure constitute defects which must be repaired.

K. Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.

L. Prepare reports for all tests and required corrective action.

3.7 ADJUSTING AND CLEANING:

A. Cleaning and Disinfecting:

1. Purge all new water distribution piping systems prior to use.

2. Follow AWWA guidelines. Thoroughly sterilize the entire domestic water system with a solution containing not more than 50 parts per million of available chlorine. Introduce the chlorinating materials into the system in a manner approved by the Owner's representative. Allow the sterilization solution to remain in the system for a period of 24 hours, during which time, open and close all valves and faucets several times. After sterilization, flush the solution from the system with clean water until the residual chlorine content is not greater than 0.2 parts per million. Water system will not be accepted until a negative bacteriological test is made on water taken from the system. Repeat dosing as necessary until such negative test is accomplished.

B. Reports:

1. Prepare reports for all purging and disinfecting activities.

3.8 INSTRUCTION OF OWNER'S PERSONNEL: Participate in specified instruction. See Section 15000.

END OF SECTION 221100

SECTION 22 13 00 – FACILITY SANITARY SEWERAGE

PART I - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and General provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 SUMMARY:

A. This Section specifies building sanitary, storm drainage and vent, acid waste and vent and equipment, vent and drain piping systems, including drains and drainage specialties.

B. Related Sections:

1. Separate sections in Division 2 specify sanitary sewage systems and trenching and backfilling. Provide a complete transition between work components.

2. Separate sections in Division 7 specify flashing and sheet metal and joint sealers.

3. Division 22 Plumbing section applies to the work of this section.

4. Separate sections of Division 22 specify Basic Piping Materials and Methods, Hangers and Supports, Expansion Compensation, piping system identification materials and requirements, pipe insulation, and plumbing equipment.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications:

1. Firms regularly engaged in the manufacture of plumbing piping products and equipment of types, materials and sizes required, whose products have been in service for not less than five years.

B. Installer's Qualifications:

1. Firm with at least three years history of successful experience on projects of similar nature.

2. Licensed as a firm in the Contractor state of origin and in the State of Utah.

3. Have a publicly registered bonding capacity of sufficient amount to cover this work and all other work in progress by the Contractor.

4. All workmen employed on the project shall carry state licenses as journeyman or apprentice pipe fitters.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical literature indicating source, brand, type, model, performance characteristics, installation instructions, etc. Color chart for finished surfaces and fixtures.

B. Record Drawings: See Section 22 00 00.

C. Operation and Maintenance Information: Provide information for all equipment including a comprehensive system operating description. See Section 22 01 00.

1.5 REFERENCES:

A. Codes and Standards: Comply with applicable sections, follow recommended practices.

1. State Boiler and Pressure Vessel Regulations
2. ASME Codes for Boilers and Pressure Vessels
3. State and Local Plumbing and Mechanical Codes
4. International Building Code
5. International Mechanical Code
6. Americans with Disabilities Act.

1.6 SEQUENCING AND SCHEDULING:

A. Coordinate the installation of floor drains, floor sinks and floor/roof penetrations.

B. Coordinate flashing materials installation of roofing, waterproofing, and adjoining substrate work.

C. Coordinate the installation of drains in poured-in-place concrete slabs, to include proper drain elevations, installation of flashing, and slope of slab to drains.

D. Coordinate with installation of sanitary sewer systems as necessary to interface building drains with drainage piping systems.

PART II - PRODUCTS

2.1 WASTE, DRAIN AND VENT SYSTEMS:

A. Industrial Waste, Sanitary Soil Drain, Waste and Vent Piping:

1. Below Slab PVC: Schedule 40 solid wall plastic pipe meeting requirements of ASTM D 2665 joined using cement primer meeting requirements of ASTM F 656 and Pipe cement meeting requirements of ASTM D 2564.

2. Above Grade: PVC Schedule 40 solid wall plastic pipe meeting requirements of ASTM D 2665 joined using cement primer meeting requirements of ASTM F 656 and pipe cement meeting requirements of ASTM D 2564. Do not install PVC piping in plenum spaces.

3. Fittings: PVC Schedule 40 solid wall plastic pipe fittings meeting requirements of ASTM D 2665 joined using cement primer meeting requirements of ASTM F 656 and Pipe cement meeting requirements of ASTM D 2564.

4. Cleanout Plugs and Ferrules: Cleanouts shall be of the same size as pipe, except that cleanout plugs larger than 4" will not be required. Floor cleanouts shall be Zurn Figure Z-1324, or equivalent Josam, Wade, or Smith, caulked into the hub of the fitting and finished flush with the floor. Where cleanouts are shown in connection with threaded pipe and are accessible, 90-degree branch fittings with square head brass screw plugs of the same size as the pipe, up to and including 4". All outside soil, waste and drain lines shall have two-way cleanouts at all changes of direction.

B. Sanitary Soil Drain, Waste and Vent Piping: (Below Grade)

1. Piping: To conform to the requirements of CISPI Standard 301, ASTM A-888 or ASTM A-74 and shall be cast iron soil pipe and fittings supplied by AB&I, Charlotte Pipe or Tyler Pipe.

2. Joints for Hubless Pipe: Hubless pipe and fittings joints shall conform to the requirements of ASTM Standard C-564 and Factory Mutual Standard 1680 and shall be heavy duty type 304 stainless steel full shielded couplings having 4 sealing clamps for pipe sizes 1 ½" thru 4" and 6 sealing clamps for pipe sizes 5" thru 15" as supplied by AB&I, Husky, Charlotte Pipe or Tyler.

3. Joints for Hub and Spigot Pipe: Hub and Spigot pipe and fittings joints shall be installed with compression gaskets conforming to the requirements of ASTM Standard C-564 as supplied by Charlotte Pipe or Tyler Pipe.

C. Sanitary Soil Drain, Waste and Vent Piping: (Above Grade Only)

1. Piping: To conform to the requirements of CISPI Standard 301, ASTM A-888 or ASTM A-74 and shall be cast iron soil pipe and fittings as supplied by AB&I, Charlotte Pipe or Tyler Pipe.

2. Joints for Hubless Pipe: Hubless pipe and fittings joints shall conform to the requirements of CISPI Standard 310, ASTM Standard C-564 and local code requirements as supplied by AB&I, Husky, Charlotte Pipe or Tyler.

3. Joints for Hub and Spigot Pipe: Hub and Spigot pipe and fittings joints shall be installed with compression gaskets conforming to the requirements of ASTM Standard C-564 as supplied by Charlotte Pipe or Tyler Pipe.

4. Schedule 40 galvanized steel pipe with drainage pattern cast iron screwed fittings.

2.2 EQUIPMENT AND SYSTEM VENTS AND DRAINS:

A. Piping:

1. Piping on closed side of system to match primary system served.

2. Open vent and drain piping of Schedule 40 galvanized steel or Type K or L copper.

B. Valves: Provide valves appropriate for duty.

1. Locate air vent valves accessibly mounted on wall, 5'-0" above floor, extended to drain.

C. Installation Notes:

1. Slope all drains at 1/4" per foot or more.

2. Provide complete condensate drain systems for all air handling units, etc., for all equipment which has a need for such service.

Terminate such drain systems near floor drains, floor sinks or other authorized point of discharge.

2.3 DRAINAGE PIPING SPECIALTIES:

A. VENT FLASHING AND TERMINATION:

1. Vent pipes penetrating the roof shall be flashed and made watertight at the roof with sheet flashing. Flashing shall weigh at least 6 pounds per square foot, shall be square and shall be turned up around the pipe and into the top of the pipe. Vent pipes shall extend at least 12" above roof. Use cast iron flashing clamps for pipe smaller than 3" rather than turning lead into pipe.

B. TRAPS: Each fixture and piece of equipment connecting to the drainage system shall be equipped with a trap. Each trap shall be placed as near to the fixture as possible and no fixture shall be double trapped.

PART III - EXECUTION

3.1 EXAMINATION:

A. Verify all dimensions by field measurements. Verify that all drainage and vent piping and specialties may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.

B. Verify all existing grades, inverts, utilities, obstacles, and topographical conditions prior to installations.

C. Examine rough-in requirements for plumbing fixtures and other equipment having drain connections to verify actual locations of piping connections prior to installation.

D. Examine walls, floors, roof, and plumbing chases for suitable conditions where piping and specialties are to be installed.

E. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION FOUNDATION FOR UNDERGROUND BUILDING DRAINS:

A. Grade trench bottoms to provide a smooth, firm, and stable foundation, free from rock, throughout the length of the pipe.

B. Remove unstable, soft, and unsuitable materials at the surface upon which pipes are to be laid and backfill with clean sand or pea gravel to indicated invert elevation.

C. Shape bottom of trench to fit bottom of pipe for 90-degrees (bottom 1/4 of the circumference). Fill unevenness with tamped sand backfill. At each pipe joint dig bell holes to relieve the bell of the pipe of all loads, and to ensure continuous bearing of the pipe barrel on the foundation.

3.3 JOINING PIPES AND FITTINGS:

A. Copper Tubing: Solder joints in accordance with the procedures specified in ANSI B9.1.

3.4 INSTALLATION:

A. Refer to the separate Division 22 section: Basic Piping Materials and Methods, for general piping installation instructions.

B. Install supports and anchors in accordance with Division-22 Basic Mechanical Materials and Methods section "Supports and Anchors".

C. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into account many design considerations. So far as practical, install piping as indicated.

D. Make changes in direction for drainage and vent piping using appropriate 45-degree wyes, half-wyes, or long sweep quarter, sixth, eighth, or sixteenth bends. Sanitary tees or short quarter bends may be used on vertical stacks of drainage lines where the change in direction of flow is from horizontal to vertical, except use long-turn tees where two fixtures are installed back to back and have a common drain. Straight tees, elbow, and crosses may be used on vent lines. No change in direction of flow greater than 90 degrees shall be made. Where different sizes of drainage pipes and fittings are connected, use proper size, standard increasers and reducers. Reduction of the size of drainage piping in the direction of flow is prohibited.

E. Install underground building drains to conform with the plumbing code. Lay underground building drains beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.

F. Install building drain pitched down at minimum slope of 1/4" per foot (2 percent) for piping 3" and smaller, and 1/8" per foot (1 percent) for piping 4" and larger.

G. Extend building drain to connect to sewer piping, of size and in location indicated for service entrance to building. Sewer piping is specified in a separate section of Division 2.

3.5 INSTALLATION OF PIPING SPECIALTIES:

A. Install flexible connection joints on roof drains.

B. Above Ground Cleanouts: Install in above ground piping and building drain piping as indicated, and:

1. as required by plumbing code;
2. each change in direction of piping greater than 45 degrees;
3. at minimum intervals of 50' for piping 4" and smaller and 100' for larger piping;
4. at base of each vertical soil or waste stack.

C. Cleanout Covers: Install floor and wall cleanout cover for concealed piping, types as indicated.

D. Flashing Flanges: Install flashing flange and clamping device with each stack and cleanout passing through waterproof membranes.

E. Vent Flashing Sleeves: Install on stacks passing through roof, secure over stack flashing in accordance with manufacturer's instructions.

F. Vent Cap: Install on all vents terminating through the sidewall. Secure to vent.

3.6 INSTALLATION OF FLOOR DRAINS:

A. Install floor drains in accordance with manufacturer's written instructions and in locations indicated.

B. Install floor drains at low points of surface areas to be drained, or as indicated. Set tops of drains flush with finished floor.

C. Trap all drains connected to the sanitary sewer.

D. Install drain flashing collar or flange so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.

E. Position drains so that they are accessible and easy to maintain.

3.7 CONNECTIONS:

A. Piping Runouts to Fixtures: Provide drainage and vent piping runouts to plumbing fixtures and drains, with approved trap, of sizes indicated; but in no case smaller than required by the plumbing code.

B. Locate piping runouts as close as possible to bottom of floor slab supporting fixtures or drains.

3.8 FIELD QUALITY CONTROL:

A. Inspections:

1. Do not enclose, cover, or put into operation drainage and vent piping system until it has been inspected and approved by the authority having jurisdiction.

2. During the progress of the installation, notify the plumbing official having jurisdiction, at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.

3. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.

4. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to insure compliance with the requirements of the plumbing code.

5. Re-inspections: Whenever the piping system fails to pass the test or inspection, make the required corrections, and arrange for re-inspected by the plumbing official.

6. Reports: Prepare inspection reports, signed by the plumbing official.

B. Piping System Test:

1. Test for leaks and defects all new drainage and vent piping systems. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.

2. Leave uncovered and unconcealed all new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose all such work for testing that has been covered or concealed before it has been tested and approved.

3. Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.

4. Prepare reports for all tests and required corrective action.

3.9 ADJUSTING AND CLEANING:

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Clean drain strainers, domes, and traps. Remove dirt and debris.

3.10 PROTECTION:

A. Protect drains during remainder of construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

END OF SECTION 221300

SECTION 223436 – COMMERCIAL WATER HEATERS

PART I - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the contract, Division 01, etc., apply to the work of this section.

B. Other Division 22 to the extent applicable apply to the work of this section.

1.2 EXTENT OF THE WORK:

A. Provide heat pump type domestic hot water heaters as scheduled and detailed.

B. Provide all supporting installation with water piping and valves, relief valves, drains, expansion tank, circulation pump, seismic restraint, etc., all required for a complete installation.

1.3 SUBMITTALS:

A. Product Data: Submit information for each water heater and related material and equipment. Include dimensional data. Verify adequate clearance and support service before submitting data.

1.4 REFERENCES:

A. Codes and Standards:

1. Energy Code for commercial and high-rise buildings. (ASHRAE 90.1-1989 Chapter 4). Building Service Systems and Equipment.

   Comply with efficiencies and heat loss requirements of this code.

2. International Plumbing Code 2018 with Utah State Amendments

PART II - PRODUCTS

2.1 (WH-1) COMMERCIAL WATER HEATERS:

A. Internal indoor condensing tankless water heater, direct vented with Schedule 40 PVC/CPVC pipe with concentric vent kit. Burner to be Ultra-Low NOx type.

B. Manufacturer: Subject to compliance with requirements, provide commercial gas-fired water heaters of one of the following:

1. Rinaii (Model number on plumbing schedule sheet, P-001)
2. Engineer Prior Approved Equal

2.3 (DET-1) DOMESTIC WATER EXPANSION TANKS:

A. Extent of Work: Furnish and install captive air type shock absorbing expansion tanks as indicated on drawings.

B. Delivery Storage and Handling: Handle carefully. Verify integrity of bladder before activating system.

C. Submittals: Submit shop drawings for review.

D. Materials and Installation:

1. NSF approved.
2. Butyl rubber diaphragm, propylene lined reservoir. Welded steel tank.
3. Air charging valve, threaded water side connection.
4. Install complete with system isolation and water side drain valves, seismic restraint. Charge air side of tank to system water pressure before connection.

E. Manufacturer: Subject to compliance with requirements, provide commercial gas-fired water heaters of one of the following:

1. Amtrol
2. Watts
3. Bell and Gossett
4. Taco

PART III - EXECUTION

3.1 INSTALLATION:

A. Install complete. Place water heater, connect piping with isolation and bypass valving, install relief valves and relief extension, connect to electric power service, seismically restrain units to structure.

3.2 FIELD QUALITY CONTROL:

A. General: Provide the services of a factory-authorized service representative to test and inspect unit installation, provide start-up service, and demonstrate and train Company's maintenance personnel as specified below.

1. Test and adjust operating and safety controls. Replace damaged and malfunctioning controls and equipment.

B. Train Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventative maintenance.

C. Review data in Operating and Maintenance Manuals. Refer to Division 1 Section

"Project Closeout."

3.3 CHECK OUT

A. Perform the following before start-up final checks:

1. Fill water heaters with water.
2. Piping systems test complete.
3. Check for piping connections leaks.
4. Check for correct power connection.
5. Test operation of safety controls and devices.

B. Perform the following start-up procedures:

1. Energize circuits.
2. Adjust operating controls.
3. Adjust hot water outlet temperature setting.

END OF SECTION 223436

SECTION 224200 – COMMERCIAL PLUMBING FIXTURES

PART I - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division 22, "Basic Plumbing Requirements" sections apply to work of this section.

1.2 SUMMARY:

A. This Section specifies plumbing fixtures and trim. The types of fixtures specified includes the following:
   1. Water Closet
   2. Lavatory
   3. Sink with Emergency Eye Wash
   4. Service Sink
   5. Ice Maker Connection Box
   6. Floor Drains
   7. Trench Drains
   8. Cleanouts
   9. Trap Seal Protection Device

1.3 SUBMITTALS:

A. Product Data: Submit Product Data and installation instructions for each fixture, faucet, specialties, accessories, and trim specified; clearly indicate rated capacities of selected models of water coolers.

B. Shop Drawings: Submit rough-in drawings. Detail dimensions, rough-in requirements, required clearances, and methods of assembly of components and anchorages. Coordinate requirements with fixtures installed in countertops and cabinets. Furnish templates.

C. Color Charts: Submit manufacturer's standard color charts for fixture colors.

D. Maintenance Data: Include data in Maintenance Manual specified in Division 1 and Section 220100.

1.4 REFERENCES:

A. Codes and Standards:
   1. ANSI Standards A117.1: "Specifications for Making Buildings and Facilities Accessible To and Usable By Physically Handicapped People."
   2. ADA: Americans with Disability Act.
   3. Utah Plumbing Code – International Plumbing Code 2021 with State Amendments.

1.5 DELIVERY, STORAGE, AND HANDLING:

A. Store fixtures where environmental conditions are uniformly maintained within the manufacturer's recommended temperatures to prevent damage.

B. Store fixtures and Trim in the manufacturer's original shipping containers. Do not stack containers or store in such a manner that may cause damage to the fixture or trim.

1.6 SEQUENCE AND SCHEDULING:

A. Schedule rough-in installations with the installation of other building components.

PART II - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturer uniformity shall be as specified in Section 220000, Basic Mechanical Requirements under Project Options.

2.2 FIXTURES:

A. Water Closet

1. Floor Mounted Flush Valve Type, ADA Compliant Fixture (P-1)

   a. Bowl: Floor mounted, vitreous china, elongated bowl, 1.28 Gallons per flush, 16-1/2” rim height, siphon jet, top spud, 12” rough-in. Flush handle to be on accessible side of tank to meet ADA requirements (Left Side).

   b. Tank: Provide with gravity flush valve, 3” diameter flapper style.

   c. Approved Manufacturer:

      1) Kohler Model K-26077
      2) Sloan
      3) Zurn

2. Water Closet Seat (P-1)

   a. (White) extra heavy weight and injection molded solid plastic, elongated, open front, self-sustaining check hinge, Sta-Tite fastening system, less cover.

   b. Approved Manufacturer:

      (1) Olsonite Model 95SSCT.
      (2) Bemis

B. Lavatory:

1. Wall Mounted – ADA Compliant Fixture (P-2)

a. Wall mounted, vitreous china, front overflow, 18" x 20", white.

b. Approved Manufacturers:

1) Kohler Model K-2032
2) Sloan
3) Zurn

2. Lavatory Faucet (P-2)

a. 0.5 GPM vandal resistant sensor faucet, variable time-out settings, multi-function sensor and an electronically operated solenoid valve, vandal-resistant, seamless, cast brass spout with single post mounting, in-line filter screen and compression fitting

b. Power: Plug-in AC transformer with 6 foot long power cord. Sloan option SFP-6.

c. Thermostatic Mixing Valve: ASSE 1070 Sloan Model BDT

d. Approved Manufacturer:

1) Sloan Optima Plus Model EBF-615-BDT
2) Chicago Faucet
3) Symmons

3. Lavatory Supplies and Stops (P-2)

a. Chrome plated cast brass angle stop, ball type quarter turn valve. Provide with flexible chrome plated copper riser, chrome plated escutcheon, compression type connections.

b. Approved Manufacturers:

1) Watts "Kwikstop"
2) Brass Craft KT Series
3) McGuire
4) ProFlo

4. Lavatory Pre-formed Insulation and Protective Cover (P-2)

a. Per-formed foam or fiberglass insulation with two piece white PVC snap on cover with Velcro closure, to fit P-trap and hot and cold water stops and supplies, meet 25/50 flame/smoke rating.

b. Approved Manufacturers:

1) Truebro

2) Plumberex
3) ProFlo

5. Lavatory P-Trap (P-2):

a. 17-gauge, tubular brass, chrome plated and chrome escutcheons.

b. Approved Manufacturers:

1) Dearborn
2) McGuire
3) Jameco
4) Zurn
5) ProFlo
6) McGuire

6. Lavatory Strainer (P-2):

a. Drain with grid pattern strainer, cast brass, chrome plated. Provide offset type drain as required to maintain ADA clearances.

b. Approved Manufacturers:

1) Kohler K-7715 (Offset type No. K-13885)
2) Jameco
3) Sanitary Dash
4) McGuire

C. Sinks:

1. Lab Sink (P-3):

a. Single compartment, undermount sink, 18” x 14” x 7-5/8” deep inside dimension of bowl, 18 gauge type-304 stainless steel, sound deadened.

b. Trim and Accessories: Provide with gooseneck sink faucet, emergency eye wash (deck mounted) water supplies with stops, outlet strainer and P-trap.

c. Approved Manufacturers:

1) Elkay No. LR2219
2) Just

2. Sink Faucet (P-3):

a. Deck mounted, 8” fixed centers, 5-1/4” rigid/swing gooseneck spout, 2.2 gpm aerator, lever handles, ceramic ¼ turn operating cartridges, cast brass construction, meeting ASME A113.18.1.

b. Approved Manufacturers:

1) Chicago Faucet Model 786-E3-369XKABCP

2) T & S Brass
3) Zurn

3. (P-3) Emergency Eye Wash:

   a. Eye-face wash unit, deck mounted swing to active, meeting the requirements of ANSI Z358.1. Complete with emergency type thermostatic mixing valve (MV-2).

   b. Approved Manufacturers:

      1) Bradley No. S19274C
      2) Guardian
      3) Chicago
      4) Speakman
      5) Haws
      6) Stingray

4. Sink Supplies and Stops (P-3)

   a. Chrome plated cast brass angle stop, ball type quarter turn valve. Provide with flexible chrome plated copper riser, chrome plated escutcheon, compression type connections.

   b. Approved Manufacturers:

      1) Watts “Kwikstop”
      2) Brass Craft KT Series
      3) McGuire
      4) ProFlo

5. Sink P-Trap (P-3):

   c. 17-gauge, tubular brass, chrome plated and chrome escutcheons.

   d. Approved Manufacturers:

      1) Dearborn
      2) McGuire
      3) Zurn
      4) ProFlo
      5) McGuire

6. Sink Strainer (P-3):

   a. Strainer basket with metal stem and rubber seal, type 304 stainless steel body, 3-1/2” diameter drain connection.

   b. Approved Manufacturers:

1) Elkay No. LK35
2) ProFlo
3) Kohler

7. Service Sink (P-4):

a. Floor mounted, 24” x 24” molded stone, 3” outlet, with rim guards.

b. Approved Manufacturers:

1) Mustee Model 63M
2) Fiat

8. Service Sink Faucet (P-4):

a. Wall-mounted mixing faucet, bucket hook, vacuum breaker, integral stops in shanks, polished chrome finish, mount so inlets are 36" above finished floor. Provide 5 ft. of 3/4" commercial grade rubber hose with male and female connectors.

b. Approved Manufacturers:

1) Kohler No. K-8906
2) Chicago No. 305-VBRCF
3) Moen

9. Service Sink Outlet (P-4):

a. 3” Threaded outlet and chrome plated flat metal grid strainer with cleanout plug.

b. Approved Manufacturers:

1) Kohler No. k-9146
2) Ceco No. B71-3

E. Drains:

1. Floor Drains (FD-1):

a. 6” diameter stainless steel strainer, cast iron body with 2” outlet and deep seal P-trap, clamping collar.

b. Approved Manufacturers:

1) Zurn No. ZN-415.
2) J.R. Smith No. 2010
3) Josam
4) Wade
5) Mifab
6) Watts

2. Trench Drains (TD-1):

a. 12” wide trench drain system, 96” long channels with sloped and flat sections, constructed of High-density Polyethylene (HDPE). Provide with black acid resistant coated top frame and Class E ductile iron slotted grate.

b. Approved Manufacturers:

1) Zurn No. Z-882-DGE-CBF.
2) J.R. Smith

F. Accessories:

1. Carriers:

a. Lavatory: Provide floor mounted carrier system with adjustable support plates, dura-coated rectangular steel uprights with welded feet and mounting fasteners.

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b. Approved Manufacturers:

1) J. R. Smith
2) Josam
3) Wade
4) Zurn
5) Mifab

2. Barrier Type Trap Seal Protection device (TSPD):

a. ASSE 1072, Barrier type floor drain trap seal protection device made of high-density polyethylene (HDPE).

b. Approved Manufacturers:

1) J.R. Smith Quad Close
2) ProVent Systems Trap Guard
3) Mifab MI-Gard-3
4) RectorSeal Sure Seal

G. Cleanouts:

1. Finished Floors:

a. Approved Manufacturers:

1) Zurn No. Z-1400-2
2) J.R. Smith No. 56010
3) Wade No. W-7000
4) Josam No. 56010

2. Finished Walls:

a. Approved Manufacturers:

1) Zurn No. Z-1445-1
2) J.R. Smith No. 4530
3) Wade No. W-8460-R
4) Josam No. 58790

PART III - PLUMBING FIXTURES

3.1 EXAMINATION:

A. Verify all dimensions by field measurements. Verify that all plumbing fixtures may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.

B. Examine rough-in for potable water and waste piping systems to verify actual locations of piping connections prior to installing fixtures.

C. Examine floors, floors, and cabinets for suitable conditions where fixtures are to be installed.

D. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION:

A. Install plumbing fixtures level and plumb, in accordance with fixture manufacturer's written instructions, rough-in drawings, and pertinent codes and regulations, the original design, and the referenced standards.

B. Comply with the installation requirements of ANSI A117.1 and Public Law 90-480 with respect to plumbing fixtures for the physically handicapped.

C. Fasten plumbing fixtures securely to supports or building structure. Secure supplies behind or within wall construction to provide rigid installation.

D. Install a stop valve in an accessible location in the water connection to each fixture.

E. Install escutcheons at each wall, floor, and ceiling penetration in exposed finished locations and within cabinets and millwork.

F. Seal fixtures to walls and floors using silicone sealant. Match sealant color to fixture color.

3.3 FIELD QUALITY CONTROL:

A. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning units, the retest. Also test for rigidity of fixtures hung on carriers, flush valves, etc.

B. Inspect each installed unit for damage. Replace damaged fixtures.

3.4 ADJUSTING:

A. Adjust water pressure at faucets and flush valves to provide proper flow stream.

B. Replace washers of leaking or dripping faucets and stops.

3.5 CLEANING:

A. Clean fixtures, trim, and strainers using manufacturer's recommended cleaning methods and materials.

3.6 PROTECTION:

A. Provide protective covering for installed fixtures, water coolers, and trim.

B. Do not allow use of fixtures for temporary facilities unless expressly approved in writing by the Owner.

END OF SECTION 224000

SECTION 23 05 00
GENERAL HVAC REQUIREMENTS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

Sections of other Divisions which relate to HVAC work apply to the work of this section. See various Sections on sitework, underfloor work, structural work, finish materials, etc.

Related Sections: Refer to Section 23 06 07 "Motors, Drives & Electrical Requirements' for basic electrical requirements for all HVAC equipment. Special and specific electrical requirements are specified within each respective equipment specification section.

1.2 SUMMARY: This Section specifies the basic requirements for HVAC installations and includes requirements common to more than one of the Division 23 HVAC sections. It expands and supplements the requirements of Division 1 and the Mechanical Section 22.

This Division does not define, nor is it limited by, trade jurisdictions. All work described herein is a part of the General Contract and is required of the Contractor regardless.

1.3 DESCRIPTION OF PROJECT: The HVAC work described in these Division 23 specifications is for Anderson Water Treatment Plan project located in West Valley City, Utah. Design weather conditions are: 95°F db, 63°F wb and winter 0°F. Altitude readings, unless otherwise noted, are for an elevation of approximately 4,500 feet above sea level. Make adjustment to manufacturer's performance data as needed.

Work includes:

A. HVAC systems for the New Water Treatment Plant Building and related facilities.

1.4 CODES AND PERMITS, AUTHORITIES HAVING JURISDICTION:

A. Perform the HVAC work in strict accordance with the applicable provisions of the various codes. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications govern.

B. Hold and save the Owner and Engineer free and harmless from liability of any nature or kind arising from Contractor failure to comply with codes and ordinances.

C. Secure permits necessary for the prosecution of the work under this contract. Contractor to pay all fees.

D. Referenced Standards:
American Welding Society
International Mechanical Code/State Code
International Building Code/State Code

International Plumbing Code with amendments
International Fuel Gas Code 2006
SMACNA Duct Design Standards
Locally enforced NFPA Codes
NFPA 90A related to general Heating and Ventilation
NFPA 820 related to Ventilation of Water Treatment Plants
Local Fuel Utility Regulations
Local Power Utility Regulations
American Gas Association Standards
ASME Codes for Pressure Vessels and Piping
ANSI B31.1 Piping

E. Review of work in progress will be made throughout the course of the work. Final review by the Engineer will not be made nor Certificate of Substantial Completion issued until certificates of acceptability from the Authorities having jurisdiction are delivered.

1.5 DEFINITION OF PLANS AND SPECIFICATIONS: The HVAC drawings at reduced scale show the general arrangement of piping, ductwork, equipment, etc., and, after prior coordination, are to be followed as closely as the actual building construction and the work of other trades will permit. The architectural and structural drawings shall be considered as part of the work insofar as these drawings furnish the Contractor with information relating to design and construction of the building. Structural, Architectural, Mechanical and Electrical drawings take precedence over HVAC drawings. Request clarification and participate in resolution in the event of conflict.

Because of the small scale of the HVAC drawings, it is neither possible nor intended to indicate all offsets, fittings and accessories which may be required. Investigate the structural and finish conditions affecting the work and arrange the work accordingly, providing such extensions, offsets, adaptations, fittings, valves and accessories to meet the conditions as may be required. Some small scale work is not shown such as control conduit and piping, incidental piping, and specialties. Only those who are experienced in this type of construction are invited to the work. Provide in complete detail as directed by note, specification, and common "good practice or standard."

Examine the actual construction site prior to bidding and obtain an understanding of the existing conditions under which the work will be performed. No allowances will be made for failure to make such examination.

During construction, set up the rough work, and verify the evolving dimensions governing the HVAC work at the building. Do not claim or expect extra compensation because of differences between actual dimensions and those indicated on the drawings. Examine adjoining work on which HVAC work is dependent for perfect efficiency, and report any work of other trades which must be corrected. No waiver of responsibility for defective work shall be claimed or allowed due to unfavorable construction consequent conditions affecting the HVAC work.

1.6 ROUGH-IN:

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment specifications in Divisions 3 through 44 for rough-in requirements.

1.7 HVAC INSTALLATIONS:

A. Equipment Arrangement: Unless specifically indicated otherwise, the arrangement of equipment indicated is based upon information available at the time of design and is not intended to show exact dimensions particular to a specific manufacturer. Some aspects of the drawings are diagrammatic and some features of the illustrated equipment arrangement may require revision to meet the actual equipment requirements. Structural supports, foundations, piping and valve connections, and electrical and instrumentation connections indicated may have to be altered to accommodate the equipment provided. No additional payment will be made for such revisions and alterations. Substantiating calculations and drawings shall be submitted prior to beginning the installation of equipment.

B. Coordinate HVAC equipment and materials installation with other building components.

C. Verify all dimensions by field measurements.

D. Arrange for chases, slots, and openings in other building components to allow for HVAC installations.

E. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.

F. Sequence, coordinate, and integrate installations of HVAC materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing-in the building.

G. Coordinate the cutting and patching of building components to accommodate installation of HVAC equipment and materials.

H. Where mounting heights are not detailed or dimensioned, install HVAC services and overhead equipment to provide the maximum headroom possible.

I. Install HVAC equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

J. Coordinate the installation of HVAC materials and equipment above ceilings with suspension system, light fixtures, and other installations.

K. Coordinate connection of HVAC systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

L. Where HVAC work penetrates other trade work such as poured in place concrete, gypsum board or masonry walls, etc., penetration shall be neatly cut and sleeved, and the rough wall opening shall be filled and patched.

1.8 EQUIPMENT SUPPORTS AND FOUNDATIONS

A. Equipment Supports: Unless otherwise indicated, equipment supports, anchors, and restrainers shall be adequately designed for static, dynamic, wind, and seismic loads as stated in the 2015 (or latest edition) International Building Code (IBC), Chapter 16 and ASCE 7-05. Submitted design

calculations for equipment supports and anchorage shall bear the signature and seal of a Registered Professional Engineer licensed in the State of Utah, unless otherwise indicated. Calculations shall account for forces and distribution of forces on supporting structures resulting from normal operation, normal operation plus seismic loadings, normal operation plus wind loadings, as well as the other load combinations stated the 2006 IBC.

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

B. Wind Load: The wind load shall be calculated in accordance with ASCE 7-05, Chapter 6, using the following design parameters:

1. Wind Speed: 90 mph
2. Exposure: C
3. Importance Factor: Iw = 1.15

C. Seismic Loads: The seismic lateral and vertical forces shall be calculated in accordance with the ASCE 7-05, Chapters 11 and 13, using the appropriate design parameters for the respective site location. Provide values for the following categories as part of the Seismic Submittal.

1. Site Class
2. Seismic Design Category (SDC)
3. Seismic Importance Factor:
4. Short Period Spectral Acceleration
5. 1 Second Period Spectral Acceleration

D. Hydrodynamic Forces: Hydrodynamic forces calculated in accordance with AWWA D100, API 650 or ACI 350.3-06 shall be based on the appropriate parameters for the respective site location. Provide values for the following categories as part of the Seismic Submittal.

1. Site Class
2. Seismic Design Category (SDC)
3. Seismic Importance Factor:
4. Short Period Spectral Acceleration
5. 1 Second Period Spectral Acceleration

E. Anchors: Anchor bolts shall be in accordance with Section 05500 - Miscellaneous Metalwork, and shall be designed to resist the above loads. Anchor bolt calculations shall clearly show that the capacity of the anchor and the capacity of the concrete that the anchor is embedded in are adequate to resist all loads stated in the 2015 (or latest edition) IBC and ASCE 7-05, including lateral wind

and lateral and vertical seismic loads. Reduction factors associated with edge distance embed length, and bolt spacing shall all be considered and based on the actual dimensions of the concrete that resists the anchorage forces. Anchor bolt details shall include required bolt diameter, embed, and edge distances. Further, the design of Anchors shall consider the ductility requirements stated in ASCE 7-05, Chapter 13, Section 13.4.2 and Chapter 15, Section 15.7.3. Anchor bolt calculations and details shall be submitted and shall bear the signature and seal of a Registered Professional Engineer licensed in the State of Utah.

F. Equipment Foundations: Mechanical equipment, tanks, control cabinets, enclosures, and related equipment shall be mounted on minimum 4-inch high concrete bases, unless otherwise indicated. Equipment foundations are indicated on Drawings. The CONTRACTOR, through the equipment manufacturer, shall verify the size and weight of equipment foundation to insure compatibility with equipment. The dimensions of all concrete bases shall be sufficient to provide the edge distances required by the anchor bolt calculations.

1.9 ACCESSIBILITY

A. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing.

B. Extend all grease fittings to an accessible location.

C. Establish required clearance to all installation features involving operation and maintenance. Respect manufacturer's recommendations for access and clearance.

D. Access Doors - General: All items of HVAC equipment which may require maintenance, replacement or which control a system function shall be made readily accessible to personnel operating the building.

1. Provide access doors in all ductwork or plenums as required to maintain filters, dampers, equipment, controls or other elements of the system. Doors shall be double wall, framed, hinged and provided with latches and shall conform to SMACNA standards, unless otherwise detailed or specified.

1.10 CHANGE ORDERS: See General Conditions.

1.11 ALTERNATIVE CONSTRUCTION/SUBSTITUTION: These documents outline a way in which the Owner may be delivered a functional and reliable facility. Drawings and specifications describe reasonable engineering practice for the Contractor to follow.

Coordination between trades may result in periodic needs to adjust the installation from that indicated, but in no case shall the intended function be compromised.

The Contractor may perceive some material or work methods which differ from those specified which could save time and effort without compromising quality. These may be presented to the Engineer with a breakdown of possible cost savings for review. Implement changes only with authorization.

Materials substitutions will generally be covered in a review process prior to bidding. After

bidding, material or equipment substitutions shall be proposed only on the basis of definitive cost accounting and implemented only with authorization.

1.12 CUTTING AND PATCHING

A. Lay out the project where new work is involved ahead of time, providing sleeves and block outs, and have work specifically formed, poured and framed to accommodate HVAC installations. Cut and patch only as needed. Repair wall or floor where cutting and patching is needed to match existing.

B. Refer to Division 16 for requirements for cutting and patching for electrical equipment, components, and materials.

C. Do not endanger or damage installed Work through procedures and processes of cutting and patching.

D. Arrange for repairs required to restore other and any work damaged as a result of HVAC installations.

E. No additional compensation will be authorized for cutting and patching Work that is necessitated by ill-timed, defective, or non-conforming installations.

F. Perform cutting, fitting, and patching of HVAC equipment and materials required to:

1. Uncover Work to provide for installation of ill-timed Work;

2. Remove and replace defective Work;

3. Remove and replace Work not conforming to requirements of the Contract Documents;

4. Remove samples of installed Work as specified for testing:

5. Install equipment and materials in existing structures.

G. Upon written instructions from the Engineer, uncover and restore Work to provide for Engineer observation of concealed Work.

H. Cut, remove and legally dispose of selected HVAC equipment, components, and materials as indicated, including, but not limited to removal of HVAC piping and other HVAC items made obsolete by the new Work.

I. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

J. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

1.13 SUBMITTALS: Submittal of shop drawings, product data, and samples will be accepted only from the Contractor to the Engineer. Submittal shall meet the requirements of section 01 30 00 – Submittals. Data submitted from subcontractors and material suppliers directly to the Engineer

will not be processed. There is opportunity and allowance for discussion prior to submittal. Document each transmittal at each transfer level of the process, and sign and stamp the submittal indicating that it has been reviewed and is in compliance with the criteria of the project, any exceptions being clearly noted. Submittals are to include all supporting calculations for the equipment, supports and anchorage of the equipment.

A. SHOP DRAWINGS: As soon as possible after the contract is awarded, submit to the Engineer, an electronic copy of the descriptive literature covering all equipment and materials to be used in the installation of HVAC systems for this project. Obtain written confirmation of acceptable review by the Owner's Representative before ordering, purchasing, acquiring or installing any such equipment or materials for the project.

   Prepare the submittals in an orderly manner after the order of this specification, with identification tabs for each item or group of related items. Clearly indicate performance, quality, utility requirements, dimensions of size, connection points and other information pertinent to effective review.

   Equipment must fit into the available space with allowance for operation, maintenance, etc. The Contractor shall take full responsibility for space and utility requirements for equipment installed. Do not submit anything that will not fit or will not work.

   Factory-wired equipment shall include shop drawings of all internal wiring to be furnished with unit.
   Review by the Engineer will be for general conformance of the submitted equipment of the project specification; in no way does such approval relieve Contractor of his obligation to furnish equipment and materials that comply in detail to the specification, nor does it relieve the Contractor of his obligation to lay out ahead of time to determine actual field dimensions and conditions which may affect his work.

B. Record Drawings: See Division 1. During the course of construction, maintain a set of drawings, specifications, change orders, shop drawings, addenda, etc., for reference and upon which all deviations from the original layout are recorded. Turn these marked up documents over to the Engineer within 90 days of system acceptance so that the original tracings can be revised. If the Contractor fails to mark up the prints, he shall reimburse the Engineer for the time required to do so.

1.14 OPERATION AND MAINTENANCE TRAINING

A. Instruction of Owner's Personnel: At a time prior to Owner making use of a device or system, and in general after testing and balance work for a building or major system is complete, prepare, schedule and conduct a series of training sessions for Owner's operating and supervisory personnel. Instructions shall cover each device and system with emphasis on understanding of the purpose and function, the maintenance requirements and the proper adjustment and operating technique.

B. Instruct building operating staff in operation and maintenance of HVAC systems utilizing Operation and Maintenance Manual when so doing.

C. Contractor to video tape instruction sessions, and give video tape to owner.

D. Minimum instruction periods shall be as follows:

1. HVAC - 8 hours, or more as needed.

2. Temperature Control - 8 hours, or more. Programming help as needed. Coordinate with Divisions 16 for Instrumentation and HVAC control.

E. Initial instruction periods shall occur after pre-final inspection when systems are properly working and before final payment is made. Schedule subsequent visits with the Building Operation Personnel throughout the first year.

F. Vendors for each piece of equipment, controls, etc., shall participate along with the Contractor(s).

1.15 GUARANTEE/WARRANTY: The following guarantee is a part of this specification and is binding on the part of the Contractor and his assigns:

"Contractor guarantees that this installation is in accordance with the terms of the Contract and is free from HVAC defects. He agrees to replace or repair, to the satisfaction of the Owner's Representative, any part of this installation which may fail or be determined unacceptable within a period of one (1) year after final acceptance. See also the General Conditions of these specifications. Failed equipment in the repair or replacement shall be guaranteed for one full year from the date of “Substantial Completion."

Compile and assemble the warranties required by Division 23 into a separated set of vinyl covered, insert sheets, tabulated and indexed for each reference, included in the O & M Manual.

Provide complete warranty information for each item to include product or equipment to include date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

HVAC systems and equipment shall not be considered for substantial completion and initiation of warranty until they have performed in service continuously without malfunction for at least thirty (30) working days.

1.16 TESTS AND CERTIFICATIONS: Make all tests required by code or specification in the presence of a representative of the Owner, with tests recorded and certified by the Contractor and Representative. Involve local authorities where required.

1.17 PERMITS, FEES, LICENSES: Refer to General Conditions.

1.18 CEILING SPACE AND OPEN SPACE COORDINATION: Carefully coordinate ceiling cavity and open space with all trades; however, installation of HVAC equipment within the ceiling cavity space allocation, in the event of conflict, shall be in the following order: process piping, cable tray plumbing waste lines; supply, return and exhaust ductwork; domestic hot and cold water; fire protection; control conduit. Respect clearances required for lights, electrical conduits, protected structure, etc. All spaces above any and all ceilings shall be defined and considered as return air plenum space.

1.19 HVAC RELATED CONTROLS AND INSTRUMENTATION

A. The Instrumentation and Controls for HVAC systems installed by this project are to be provided under Divisions 16 but to be fully supported and complemented in a conventional way by providers of Sections 23 work. Extent of control systems work required by this section is indicated on drawings and schedules, and by requirements of this section.

1. Control sequences will be provided for Owner's programming. See Division 16.

B. Provide for installation of instrument wells, valve bodies, and dampers in mechanical HVAC systems.

C. Include Divisions 16 sections in the following work.

1. Power supply wiring from power source to power connection on controls and/or unit control panels. Includes starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.

2. Interlock wiring between electrically operated equipment units; and between equipment and field installed control devices. Interlock wiring specified as factory installed is work of this section.

3. Control wiring between field installed equipment, controls, indicating devices, and unit control panels.

4. 24 volt and 120 volt service work required by instrumentation/control systems.

D. Participate in "System Commissioning, Testing and Balancing".

PART 2 – PRODUCTS

2.1 QUALITY AND CHARACTER OF MATERIALS AND EQUIPMENT:

A. New and conventional: All equipment and materials shall be new, and shall be the standard products of manufacturers regularly engaged in the production of plumbing, heating, ventilating and air conditioning equipment, and shall be the manufacturer's latest design. Specific equipment shown in schedules on drawings and specified herein is to be the basis for the Contractor's bid. Provisions for substitute equipment are outlined in the General Conditions.

B. Complete: Furnish and install all major items of equipment herein specified and/or called out in the equipment schedules on the drawings complete with all accessories normally supplied with catalog items listed, and with all other accessories necessary for a complete and satisfactory installation.

C. Code Compliant: There are certain Code defined hazards associated with the Waste Water Treatment Plant environment, generally outlined in NFPA Standard 820. The Contractor in all if its entities should be familiar with the standard and provide installations which will be compliant in all regards. Of particular interest are the requirements where vagrant flammable process gases such as methane and hydrogen sulfide may develop. Such areas include the Wet Wells, Grinder Rooms and other similarly classified spaces where exhaust fans are involved to dilute the concentration of gases. All HVAC equipment involved in these areas must have an “explosion-proof” characteristic. Impose this requirement on all materials, motors, etc. provided by these Division 23 specifications.

2.2 PROTECTION OF MATERIALS AND EQUIPMENT:

A. Close pipe and duct openings with caps or plugs to prevent lodgement of dirt or trash during the course of installation. Cover equipment tightly and protect against dirt, water and chemical or HVAC injury. Plumbing fixtures intended for the final installation shall not be used by the construction forces. At the completion of the work, clean fixtures, equipment and materials and polish thoroughly and deliver in a factory dock condition for the Owner's acceptance. Make damage and defects developing before acceptance of the work good at Contractor's expense.

B. Do not make temporary use of project equipment, during construction. DO NOT USE PERMANENT HVAC SYSTEMS FOR TEMPORARY HEAT!!

2.3 QUALIFICATIONS OF WORKMEN:

A. All mechanics shall be capable journeymen, skilled in the work assigned to them. Apprentices may be used with appropriate direction.

B. Do not employ unskilled persons in the work; execute all work in a skillful and workmanlike manner. All persons employed shall be competent, faithful, orderly and satisfactory to the Owner. Should the Owner's Representative deem anyone employed on the work incompetent or unfit for his duties, and so certify, Contractor shall remove that employee from this project and he shall not be again employed upon the project without permission of the Owner's Representative.

C. All welders involved in welding of pressure piping systems shall be certified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code. Written verification of successful test completion shall be submitted to Architect prior to initiating work.

2.4 FOREMAN: Designate an experienced and qualified general HVAC foreman for the project work to be consistently available on site during the life of the project for consultation. Do not replace this individual without prior approval from the Owner's Representative.

2.5 USE OF COMMON VENDORS: Regardless of subcontract delegations, coordinate purchasing between trades so that equipment and materials of similar nature come from a single vendor, i.e., all package HVAC units shall be common source. Valves, variable volume boxes, etc., the same. Do not burden the Owner with multiple brands of similar equipment unless so directed.

2.6 ROOF/WALL/FLOOR PENETRATIONS - FLASHINGS:

A. Install sleeves through the floor into dry rooms flush with the floor, caulked and sealed. Into wet rooms, extend piping above floor level to create 1" dam. Use Schedule 40 galvanized steel pipe for all pipe sleeves.

B. Let pipe sleeves allow for movement of the pipe due to expansion and contraction, yet to include seismic restraint.

C. Fire stopping: Provide fire stopping for all Division 23 penetrations of rated walls, floors, structure, etc. in conformance with ASTM E814 and with UL 1479.

D. Flashings:

1. Flash all equipment supports, pipes and conduit penetrating the roof. Provide required flashing components. See drawings or Architect/Engineer for additional detail.

2. Clamp roof drains to roof membrane, follow manufacturer's directions.

3. Make all ductwork penetrating a roof watertight with flashings, counter flashing and sealant. Provide curbs for any and all such openings.

2.7 EXCAVATING AND BACKFILLING (GENERAL): Reference, if required.

A. Provide all excavation, trenching and backfilling for HVAC underground duct and piping work. Excavation and backfilling shall comply with applicable paragraphs of Division 31. Tamp bottoms of trenches hard and, for soil and waste piping, grade to secure uniform fall of 1/4" per foot, or as noted. Excavate bell holes for hub and spigot pipes so that pipe rests on solid ground for its entire length. Lay sewer and water pipe in separate trenches, except where otherwise noted, as detailed.

B. After work has been tested, inspected and approved by the Owner's Representative and/or State/Local Inspector, and prior to backfilling, clean the excavation of all rubbish, and clean backfill materials free of trash. Place backfill in horizontal layers not exceeding 12" in thickness, properly moistened. Compact each layer with suitable equipment to a dry density of not less than 95 percent as determined by the Modified AASHO Test T-18O. See Division 31 for additional requirements.

1. Provide adequate shoring to safeguard workers from cave-ins for all excavations.

2. In areas where General Contractor has finish grade work to do, HVAC Contractor shall backfill and compact to 8" below finish grade. Where no finish surface work is to be done, HVAC Contractor shall backfill and compact to and match adjacent undisturbed surface with allowance for settling, etc.

3. Protect from damage all existing underground utilities or utility tunnels indicated on the contract drawings (or field located for the Contractor by the Owner prior to excavation operations). Any damage to identified existing utilities or utility tunnels shall be repaired by the Contractor at no cost to the Owner.

2.8 HANGERS AND SUPPORTS (GENERAL):

A. Provide mountings, hangers and/or supports for all HVAC equipment, piping and ductwork. Primary information is contained in these specifications as noted in, but not limited to, paragraph 1.8 above and on the drawings. Correlate HVAC work with the work of other trades to obtain a consistent manner of installation.

B. Provide hangers and supports to correlate with seismic restraint, expansion/contraction, and vibration isolation.

2.9 MANUFACTURER'S DIRECTIONS: Install all equipment in strict accordance with directions and recommendations furnished by the manufacturer. Where such directions are in conflict with the plans and specifications, report such conflicts to the Engineer.

2.10 LUBRICATION: Lubricate equipment at startup. Then, provide all lubricants for the operation of all equipment until acceptance by the Owner. The Contractor is held responsible for all damage to equipment consequent to pre-acceptance operation.

2.11 ELECTRICAL WIRING AND CONTROL:

A. In general, primary motor starters, related motor starter equipment and power wiring indicated on the electrical drawings and control diagrams are to be furnished and installed under the Division 16 Specification. Items of electrical control equipment specifically mentioned to be furnished by the HVAC/Instrumentation (Controls) Contractor either in these specifications or on the related drawings, shall be obtained and mounted by this Contractor and shall be connected under and as required by specifications, all in compliance with the National Electric Code, and Division 16. Many control devices and fan motors are to be furnished and terminal block wired to a unit mounted power or control panel. The project requires this single location of connection for fan and pump motors, damper actuators, valve actuators, sensors smoke detectors and the like.

B. Refer to the control equipment and wiring shown on the diagrams. Any changes or additions required by specific equipment furnished shall be the complete responsibility of the contractor.

C. HVAC electrical work must be fully coordinated with Division 16 to insure that all required components of the work are included and fully understood. No additional cost shall accrue to the Owner as a result of lack of coordination.

D. Where the detailed electrical work is not shown on the electrical drawings, the HVAC Contractor shall furnish, install and wire or have prewired all specified and necessary controls for package air equipment specified for this project. The objective of this paragraph is to make sure a complete operating system is obtained at no additional cost to the Owner for field wiring required related to the equipment.

2.12 FLUSHING AND DRAINING OF SYSTEMS/CLEANING OF PIPING AND DUCTS: Blow out all refrigerant piping systems with compressed air or nitrogen to remove foreign materials that may have been left or deposited in the piping system during its erection. Duct systems shall have all debris removed and fans shall be run to blow out all dust and foreign matter before outlets are installed and connected.

Damp wipe all ductwork on installation, cap open ducts, cover fan inlets, vacuum fan plenums and related installation before starting fans. Run fans only with filters in place.

2.13 JOBSITE CLEANUP:

A. Keep site clean during progress of work.

B. At the conclusion of work, clean all installation thoroughly.

Leave equipment in a factory dock condition. Correct any damage and touch up or repaint if necessary.

Remove all debris from site.

END OF SECTION

SECTION 23 05 20
HVAC IDENTIFICATION

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-23 Basic HVAC Materials and Methods section apply to work of this section.

1.2 SUMMARY:

A. Label all heating, air conditioning, automatic temperature control equipment (excluding thermostats), and distribution systems. Also label all electrical switches and starters for all HVAC equipment.

PART 2 – GENERAL MECHANICAL MATERIAL AND METHODS

2.1 EQUIPMENT, PIPE AND DUCT IDENTIFICATION:

A. Equipment Identification:

1. Identify all equipment including, but not limited to, all mechanical equipment, ATC panels, controller, etc., and all other devices with signs made of laminated plastic with 1/8" or larger engraved letters.

2. Give each piece of equipment its own unique equipment number or symbol.

3. Information on sign shall include name of equipment, identification on plans and schedules, rating, maintenance instructions, and any other important data not included on factory attached name plate.

4. Signs shall be attached to equipment so they can be easily read. Attachment shall be by rust proof screws or rivets. Do not use adhesive.

5. Identification signs for equipment shall be similar to the following:

   a. Supply Fan (F-2)

      Rating: 49,850 cfm @ 3.5" s.p. (At 1600 ft. elevation)

      Maintenance: Check bearings for lubrication every 30 days and lubricate as required with S.A.E. 30 oil.

   b. “ATC Panel A”

2.2 PANEL IDENTIFICATION:

A. Provide all panel devices on panel faces with engraved black face Formica with white engraved lettering labels.

B. Provide all internal panel components with engraved black face Formica labels with white engraved lettering. Fasten label beneath each device.

C. Numerically or alphabetically code all panel wiring and tubing.

END OF SECTION

SECTION 23 05 30
HVAC OPERATION & MAINTENANCE MANUALS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specifications sections, apply to work of this section.

B. Division-23, Section 23 05 00 General HVAC Requirements sections apply to work of this section.

1.2 SUMMARY:

A. Furnish four sets of bound operation and maintenance (O&M) manuals within 90 days of system acceptance. Manuals shall contain descriptive drawings and data which identify equipment installed at the project and detail the procedures and parts required to operate, maintain and repair the equipment. Copies of approved submittals shall be included for all equipment.

1.3 OPERATION AND MAINTENANCE MANUAL FOR MECHANICAL HVAC SYSTEMS:

A. General:

1. The "Operating and Maintenance Manual" is a bound compilation of drawings and data that the owner requires for each building or project. Furnish these manuals, complete with drawings and data, to the Owner through the Engineer.

2. The mechanical contractor has overall responsibility to obtain the necessary data from and compile the data as set forth in this specification.

3. The number of binders (or "volumes") required will depend on the amount of information to be catalogued. Total "sets" see paragraph 1.2A.

4. Make all information legible and sufficiently marked to indicate the exact size, model, type, etc., of equipment furnished and installed.

B. Purpose: The Operating and Maintenance Manual is prepared to provide a ready reference to all important pieces of mechanical and electrical equipment installed on the project. It is also to provide the necessary operating and maintenance data for use by service personnel. It is also to provide information required for checking equipment performance or for planning of plant expansion or redesign.

PART 2 – MATERIALS AND METHODS

2.1 PAGE SIZE: All pages shall be standard 8-1/2 x 11 inches size or approximate multiples (preferably 17 x 11 inches) folded to 8-1/2 x 11 inch.

2.2 DRAWINGS: All drawings larger than 8-1/2" x 11" shall be folded and inserted in individual 8-1/2" x 11" manila pockets, which shall have standard three-ring side punching for insertion in the binders. The equipment name, drawing description and number shall be written on the face of each manila pocket.

2.3 BINDERS: Binders shall be piano hinge, bar-lock type, Buckram (stiffened fabric cover) binders with block lettering for sheet size 8-1/2 x 11 inches with 2" to 3-1/2" expandable metal capacity as required for the project. The number of binders, on not filling them beyond 4".

A. Place the following information on the front cover and backbone:

1. "Operation and Maintenance Manual".

2. Project Name (and volume number if more than one volume).
   Project Number (Per owner's project number).

3. Building name and number.

4. Owner's name.

5. (Architect's name.)

6. Engineer's name.

7. General Contractor's name.

8. HVAC Contractor's name.

Items 5 through 7 need not be printed on the backbone.

2.4 CONTENTS AND INDEXING:

A. Manuals shall contain descriptions of the building systems in sufficient detail to adequately indicate the type of systems installed and the basic details of their operation.

B. All purchased equipment data shall be used to designate the sections. Within each section additional indexing of component parts may be required.

C. Operation and Maintenance Manuals shall contain to the fullest extent all possible information pertinent to the equipment. The arrangement and type of information to be filed shall be as follows:

1. 11 x 17 size project drawings in "As-built" condition.

2. Outline drawings, special construction details, "As built" electrical wiring and control diagrams for all major and supplementary systems.

3. Manufacturer's test or calculated performance data and certified test curves.

4. Installation, operating, and maintenance instructions, including a complete parts list and sectional drawing with parts identification numbers. Mark with model, size and plan number.

5. Manufacturer's brochures marked to indicate exact equipment purchased. Brochures on component parts supplied by a manufacturer with his equipment, but not manufactured directly by him, shall also be included. Include performance data similar if not equivalent to the shop drawing submittal.

6. List the serial numbers of each item of equipment installed with the model numbers and plan symbols.

7. Include a Table of Contents. The contents shall be divided with tabbed index dividers into the following suggested parts:

Part I	Building and System Descriptions
Part II	Purchased Equipment Data
Part III	Test Reports and Valve Charts
Part IV	Start-Up and Operation
Part V	Preventative Maintenance Recommendations

8. A copy of the approved submittals for each piece of equipment.

9. A copy of all testing, adjusting and balancing reports.

10. Wiring diagrams, marked with model and size and plan symbol.

11. Operating and Maintenance Manuals data for Part I shall be obtained directly from the mechanical and electrical consultants. (Allow consultant preparation cost.)

12. The index for each section shall contain the name and address of the manufacturer and, if different, where replacement and repair parts may be obtained.

PART 3 – EXECUTION

(Not Used)

END OF SECTION

SECTION 23 05 93
TESTING, ADJUSTING & BALANCING

PART 1 - GENERAL

1.1 GENERAL CONDITIONS:

A. Work of this section shall be subject to the requirements of the General Conditions of this contract, the Mechanical - General Requirements, HVAC General Requirements, General Electrical Requirements and other sections where this work shares a responsibility.

B. System commissioning and startup of the HVAC systems shall be the responsibility of the HVAC Division 23 Contractor and his subcontractors with the participation of the Divisions 26/40 Electrical and Instrumentation Contractor(s) related to electrical and instrumentation work and the General Contractor related to general construction items.

C. Testing and balancing shall be under the direction of the General Contractor with the full participation of all of the mechanical and electrical trades employed on the project and shall include the participation of an independent testing and balance subcontractor to coordinate all elements of the work and to perform special technical services outlined herein.

1.2 SYSTEM COMMISSIONING - SCOPE OF WORK:

A. The work required under this section shall include but not necessarily be limited to the following:

1. The pre-startup inspection of all HVAC systems and subsequent correction of any incorrect items.
2. The initial first run inspections.
3. System operations inspection.

B. The intent of this section is to provide for proper installation, startup, service and operation of the mechanical systems in preparation for system balancing. See section for balancing of air system. After completion of the balancing, the mechanical system shall be ready for owner occupancy, with all systems operating as intended.

C. Repair, replacement or adjustment of each item shall be performed by the respective installing subcontractor.

1.3 TESTING AND BALANCING - SCOPE OF WORK:

A. This work incorporates a checkout of construction work, individual component activation and overall system activation into one work program which shall serve as the transition period from the Contractor's job to Owner's facility.

B. The Contractor shall be skilled in the operation and manipulation of systems and in the direction of parties involved in the work.

C. The Contractor shall participate in the startup and shakedown of all mechanical systems installed and modified in this contract; test adjust and balance these systems to obtain optimum performance at a level which minimizes the required energy input, prepare and submit a complete report of work done and the final system condition obtained, participate in the instruction of Owner's personnel in the proper operation of systems and equipment.

1.4 QUALIFICATIONS OF SYSTEM COMMISSIONING AND TAB TEAM:

A. Representatives of Contractor shall be available on a daily basis through the commissioning and adjustment period. These men shall be experienced journeymen with prior experience in system operation and with specific experience on the construction of this project. Section 23 09 00 – HVAC Control Systems is a particular participant in the work.

B. Balancing shall be done at the Contractor's expense by an independent firm specializing in this work. A definition of independent shall mean the firm is not associated with any engineering, contracting, or manufacturing firm and derives its income solely from testing, adjusting and balancing mechanical systems. Approved firms to do this work include:

Bob's Test and Balance – Salt Lake City, UT
Certified Test and Balance – Salt Lake City, UT
Barnett, Inc. (Payson Sheet Metal) – Payson, UT

C. The balancing work shall be performed by the same firm having total professional responsibility for the final testing, adjusting and balancing of the entire system. A principal of the firm shall be directly involved in the project.

D. The testing and balancing firm shall furnish all necessary tools, scaffolding and ladders that are required and shall provide all required instruments, take all readings and make all necessary adjustments.

E. After all adjustments are made a detailed written report shall be prepared and submitted for approval, and shall bear the signature of the professional supervising the work. Final acceptance of this project will not be made until a satisfactory report is received. Furnish an electronic copy of the report for Engineer Review.

F. Treat each individual system as separate elements for reporting purposes.

PART 2 – EXECUTION, SYSTEM COMMISSIONING

2.1 PRE-STARTUP INSPECTION:

A. The pre-startup inspection of all systems shall provide for verifying that each piece of equipment is properly installed and prepared for startup.

B. All pertinent items shall be checked, including but not necessarily limited to the following:
1. Removal of shipping stops.
2. Vibration isolators properly aligned and adjusted.
3. Flexible connections properly aligned.

4. Belts properly adjusted.
5. Belt guards and safety shields in place.
6. Safety controls, safety valves and high or low limits in operation.
7. Filters in place and seal provided around edges.
8. All test stations and measuring devices installed.
9. Initial lubrication of equipment is complete.
10. Filters are clean.
11. Motor rotations are correct.
12. Voltages match nameplate.
13. Control system is in operation.
14. All interlocks are wired and verified.
15. All controls have been connected and verified.
16. All dampers and operators are properly installed and operating.
17. All ductwork is installed and connected.
18. All other items necessary to provide for proper startup.

C. Correct all incomplete or defective items.

2.2 FIRST RUN INSPECTION:

A. Recheck all items outlined in pre-startup inspection to insure proper operation.

B. Check the following items:

1. Excessive vibration or noise.
2. Loose components.
3. Initial control settings.
4. Motor amperages.
5. Heat buildup in motors, bearings, etc.
6. Control system is properly calibrated and functioning as required.

C. Correct all items which are not operating properly.

2.3 SYSTEM OPERATION INSPECTION:

A. Observe the mechanical systems under operating conditions for sufficient time to verify proper operation under varying conditions, such as day-night and heating-cooling.

B. Periodically check the following items:

1. Filters.
2. Visual checks of air flow for "best guess" settings for preparation for system air balancing under section applying.
3. Control operation, on-off sequences, system cycling, etc.
4. Visual checks of seals, packings, operation pressures.
5. Cleaning of excessive oil or grease.
6. Dampers close tightly.
7. All other items pertaining to the proper operation of the mechanical system whether specifically listed or not.

PART 3 – EXECUTION – TESTING AND BALANCING

3.1 TOTAL MECHANICAL SYSTEM BALANCE:

A. The mechanical systems consist of many elements. Total system balance requires that all elements be not only individually correct, but also correct as a composite system. Therefore, participation of all parties is required in the test and balance procedure.

B. Prior to beginning work, submit a written description of the anticipated sequence of action to the Engineer for review and comment.

C. The testing and balance specialist shall review the contract drawings during the bid period and shall advise the Engineer of any modifications to the layout which he might suggest to facilitate the balance procedure. Modifications will be incorporated into the contract by Addendum during the bidding period.

D. The test and balance specialist shall visit the project from time to time during the rough installation making a thorough inspection of those items which will affect his subsequent work. He shall advise the Contractor in writing with a copy to the Engineer of any work required by the contract which is not being performed adequately. This is in addition to the regular review efforts of the Engineer.

3.2 AIR SYSTEMS BALANCE:

A. Before any adjustments are made, the systems shall be checked for such items as dirty filters, duct leakage, filter leakage, damper leakage, equipment vibrations, correct damper operations, etc. All fan systems are to be adjusted to deliver design air quantities within +5%. Design static pressure is based on filters approximately 50% loaded with dirt. Pressure drop across filters during balancing shall be simulated to that condition. After balancing is completed, check motor amperage with the filters clean.

B. Adjust exhaust air systems for air quantities shown on drawings and the proper relationship between supply and exhaust established.

C. Exchange sheaves and/or belts as needed to adjust the RPM of all fans so they handle specified air quantity.

1. Determine the sheave on supply fans so that the VFD driven fan will deliver not less than 100% cfm with fully loaded filters.

2. Determine the sheave on the exhaust fans so that the VFD driven fan will fully load the motor at design cfm and 100% speed.

D. Verify the proper operation of all air side related control functions.

3.3 MAJOR EQUIPMENT:

A. The Testing and Balancing subcontractor shall work with the Instrumentation/Controls Contractor, Owners technical staff, and Electrician in placing new fans, and other major equipment in operation. The factory representative of the equipment manufacturer shall also participate in a team effort to place this system(s) in all anticipated operating modes and make adjustments as required to obtain correct operation. The Project Engineer shall witness the final operating sequence.

3.4 INSTRUMENTATION/CONTROL SYSTEMS:

A. The Testing and Balancing Contractor shall go through the entire HVAC portion of the PLC based instrumentation and control system with the Instrumentation Contractor and Owner's technical staff, verifying proper operation of each and every device and the proper function of each system. The report shall indicate and certify such effort.

3.5 MISCELLANEOUS:

A. Observe all furnished thermal overload protection and note such in the data sheets. If thermal overload protection is incorrect, it shall be the responsibility of the trade or vendor which furnished the overload devices to furnish and install the correct size overload protection devices, and it is the responsibility of the balancing firm to verify that proper overload protection has been installed at the completion of the job.

B. The adjusting crew shall measure and set any special conditions such as minimum air quantities; coordinate outside air, return air and relief air damper operation; check and adjust outside and return air intakes so that the system will deliver substantially the same volume on either; make tests and record data as required in "REPORT" below.

C. When deemed necessary, take 24-hour space temperature recording and any required partial rebalance of the system shall be performed without additional cost. Successful function supercedes nominal settings in order of importance.

3.6 REPORT:

A. Provide a bound report in four copies which shall contain a general information sheet listing instruments used, method of balancing, altitude correction, and manufacturer's grille, register and diffuser data.

B. Provide equipment data sheets listing make, size, serial number, rating, etc., of all mechanical equipment including fans, motors, starters and drives. Operating data shall include rotational speed, pressure drop across filters, coils, and other system components and measured motor current and voltage.

C. Reports shall contain a reduced set of contract drawings with outlets marked thereon for easy identification of the nomenclature used in the data sheets.

D. The report shall contain any abnormal or notable conditions not covered in the above.

E. Keep and submit a copy of a daily log of all work performed with a list of work scheduled for the day and the workers on the job.

END OF SECTION

SECTION 23 06 03
SUPPORTING DEVICES FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

B. This section is a Division-23 Basic HVAC Materials and Methods section, and is part of each Division-23 HVAC section making reference to supports and anchors specified herein.

C. This section heavily references Manufacturers Standardization Society of the Valve and Fittings Industry (MSS) manuals of standard practices.

1.2 SUMMARY:

A. Extent of supports and anchors described by this section is generally indicated on drawings and/or specified in other Division-23 HVAC sections. Much support and anchorage is implied in that all HVAC installation, piping, ductwork, equipment and specialties require support and restraint. Correlate this section with Section 23 06 05 related to sound, vibration and seismic restraint.

B. Types of supports and anchors specified in this section include the following:

1. Hanger-Rod Attachments.
2. Building Attachments.
3. Saddles and Shields.
4. Miscellaneous Materials.
5. Anchors.
6. Equipment Supports.

C. Supports and anchors furnished as part of factory-fabricated equipment are specified or presumed as part of equipment assembly.

D. Relate this section to Section 23 06 05 regarding seismic and vibration control.

1.3 QUALITY ASSURANCE:

A. Manufacturer’s Qualifications: Firms regularly engaged in manufacture of supports and anchors, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years. Typical vendors of support systems include Grinnell.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of support and anchor.

B. Shop Drawings:

1. Submit manufacturer's assembly-type shop drawings for each type of support and anchor,

indicating dimensions, weights, required clearances, and methods of assembly of components.

C. Maintenance Data: Submit maintenance data and parts list for each type of support and anchor. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division-1.

1.5 REFERENCES:

A. Codes and Standards:

1. Code Compliance: Comply with applicable building, mechanical and plumbing codes pertaining to product materials and installation of supports and anchors.

2. UL and FM Compliance: Provide products which are UL-listed and FM approved.

3. MSS Standard Compliance:

Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-58.

Select and apply pipe hangers and supports, complying with MSS SP-69.

Fabricate and install pipe hangers and supports, complying with MSS SP-89.

Terminology used in this section is defined in MSS SP-90.

PART 2 – PRODUCTS

2.1 HANGER-ROD ATTACHMENTS:

A. General: Except as otherwise indicated, provide factory- fabricated hanger-rod attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper-piping systems.

B. Steel Turnbuckles: MSS Type 13. (For adjustment up to 6" for heavy loads.)

C. Steel Clevises: MSS Type 14. (For use on high temperature piping installations.)

D. Swivel Turnbuckles: MSS Type 15. (For use with split pipe rings, MSS type 11.)

E. Malleable Iron Sockets: MSS Type 16. (For attaching hanger rod to various types of building attachments.)

2.2 BUILDING ATTACHMENTS:

A. General: Except as otherwise indicated, provide factory- fabricated building attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods. Provide copper-plated building

attachments for copper-piping systems.

B. Concrete Inserts: MSS Type 18. (For upper attachment for suspending pipe hangers from concrete ceiling.)
C. Top Beam C-Clamp: MSS Type 19. (Use under roof installations with bar joist construction, for attachment to top flange of structural shape.)

D. Side Beam or Channel Clamps: MSS Type 20. (For attachment to bottom flange of beams, channels, or angles.)

E. Center Beam Clamps: MSS Type 21. (For attachment to center of bottom flange of beams.)

F. Welded Beam Attachments: MSS Type 22. (For attachment to bottom of beams where loads are considerable and rod sizes are large.)

G. C-Clamps: MS Type 23. (For attachment to structural shapes.)

H. Top Beam Clamps: MSS Type 25. (For attachment to top of beams when hanger rod is required tangent to edge of flange.)

I. Side Beam Clamps: MSS Type 27. (For attachment to bottom of steel I-beams.)

J. Steel Beam Clamps with Eye Nut: MSS Type 28. (Same as Type 28 with link extensions.)

K. Linked Steel Clamps with Eye Nut: MSS Type 29. (Same as Type 28 with link extensions.)

L. Malleable Beam Clamps: MSS Type 30. (For attachment to structural steel.)

M. Steel Brackets: One of the following for indicated loading:

1. Light Duty: MSS Type 31, to 570 pounds.

2. Medium Duty: MSS Type 32, to 1,500 pounds.

3. Heavy Duty: MSS Type 33, to 3,000 pounds.

N. Side Beam Brackets: MSS Type 34. (For use on sides of steel or wooden beams.)

O. Plate Lugs: MSS Type 57. (For attachment to steel beams where flexibility at the beam is desired.)

P. Horizontal Travelers: MSS Type 58. (For supporting piping systems subject to linear horizontal movements where head room is limited.

2.3 MANUFACTURERS OF HANGERS AND SUPPORTS:

A. Manufacturer: Subject to compliance with requirements, provide hangers and supports of one of the following:

1. Kin-Line, Inc.
2. Fee & Mason Mfg. Co.; Div. Figgie International
3. ITT Grinnel Corp.

4. B-Line
5. Unistrut

2.4 OUTSIDE AREAS: Use galvanized hangers, attachments, rods, nuts, bolts, and other accessories for

all outside areas.

2.5 MISCELLANEOUS MATERIALS:

A. Metal Framing: Provide products complying with NEMA STD ML 1.

B. Steel Plates, Shapes and Bars: Provide products complying with ASTM A 36.

C. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration. Use Embeco or Engineer approved equal grout for non-shrink applications.

D. Heavy Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.

E. Pipe Guides: Provide factory-fabricated guides, of cast semi- steel or heavy fabricated steel, consisting of bolted two- section outer cylinder and base with two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

PART 3 – EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 PREPARATION:

A. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors and other building structural attachments.

B. Prior to installation of hangers, supports, anchors and associated work, Installer shall meet at project site with Contractor, installer of each component of associated work, inspection and testing agency representatives (if any), installers of other work requiring coordination with work of this section and Engineer for purpose of reviewing material selections and procedures to be followed in performing the work in compliance with requirements specified.

3.3 INSTALLATION OF BUILDING ATTACHMENTS:

A. Install building attachments at required locations within concrete or on structural steel for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms.

Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through the openings at the tops of inserts.

3.4 INSTALLATION OF HANGERS AND SUPPORTS:

A. General: Install hangers, supports, clamps and attachments to rigidly support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacing complying with MSS SP-69. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.

B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

C. Prevent electrolysis in support of copper tubing by the use of hangers and supports which are copper plated, or by isolating with foam rubber covering or 30 mil insulating tape.

D. Provisions for Movement:

Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.

Install supports within 2 feet of non-vertical flex connectors

E. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

F. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31 Pressure Piping Codes are not exceeded.

G. Insulated Piping: Do not allow hangers to come in contact with pipe where pipe is specified to be insulated.

H. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.

I. Shields: Where low-compressive-strength insulation or vapor barriers are indicated on cold or chilled water piping, install galvanized steel protective shields. Install calcium silicate blocks (12" long minimum) at support points.

J. Saddles: Where insulation without vapor barrier is indicated, install protection saddles.

3.5 INSTALLATION OF ANCHORS:

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31, and to prevent transfer for loading and stresses to connected equipment.

B. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure. Comply with ANSI B31 and with AWS standards.

C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.

D. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe-runs, at intermediate points in pipe-runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.6 EQUIPMENT SUPPORTS:

A. Concrete curbs for exterior mounted HVAC equipment shall be provided by the General Contractor. Anchor to curbs provided. Provide weather tight seal.

B. Provide structural steel supports for equipment not floor or wall mounted. Construct of structural steel members or steel pipe and fittings.

3.6 ADJUSTING AND CLEANING:

A. Hanger Adjustment: Adjust hangers so as to distribute loads equally on attachments.

B. Support Adjustment: Provide grout under supports so as to bring piping and equipment to proper level and elevations.

C. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION

SECTION 23 06 05
MECHANICAL SOUND, VIBRATION AND SEISMIC CONTROL

PART 1 – GENERAL

1.1 RELATED DOCUMENTS: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

This section is a Division-23 Basic HVAC Materials and Methods section, and is part of each Division-23 HVAC section making reference to pipes and pipe fittings specified herein.

1.2 SUMMARY: Furnish and install complete support, restraint and vibration control systems for all work installed under Division 23 HVAC sections. Work to be responsive to the intent of the International Building Code, latest adopted edition, for the respective seismic zone. Correlate this work with 23 06 03 related to general supports of Mechanical / HVAC systems and equipment.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Engage the services of an independent support, restraint and vibration control subcontractor who has the technology, the experience, computer capabilities and manufactured products to prepare the required computations, shop drawings and special devices to meet the minimum requirements described herein.

The support, restraint and vibration control subcontractor shall visit the site during construction at a minimum of two specific periods.

1. When equipment is set in place, prior to placement of seismic restraint devices for the purposes of directing the contractor in properly locating and installing the approved devices.

2. At the completion of the project, prior to final mechanical inspection, for the purpose of verifying the correctness of the support, restraint and vibration isolation device installation and preparing certification of the vibration-isolation work.

The support, restraint, vibration control subcontractor shall exercise the quality control for this work and shall include, but not be limited to instructions direct to the Mechanical (Division-23 and Division-33) Contractor concerning:

Anchoring of all mechanical equipment.

Vibration mounting of equipment.

Equipment base coordination with restraint requirements.

Snubbing of equipment.

Bracing and anchoring of ductwork, piping and conduit.

Provision for vibration of piping.

Concrete and/or steel pads or bases to assure proper mounting of restraints and isolators.

Vibration isolation of exhaust fans, ventilation fans, other rotating equipment.

The subcontractor shall be responsible for identifying the need for the size and location of steel sole plates and their attachment to structural steel or concrete.

The subcontractor shall certify in writing that he has inspected the installation and that all isolation, anchors and seismic restraint materials are installed correctly and functioning properly. Certification shall be provided after all corrective work has been completed.

1.4 SUBMITTALS: Submittal data is required and shall consist of computations, vibration isolation selection, equipment anchors, anchor bolt sizes, supports, seismic restraints, sole plate data, restraint locations and type of restraints.

Submittal data shall identify dimensions, load deflection data, center of gravity, standard connections, manufacturer's recommendations, behavior problems including vibrations, thermal expansion, building expansion joints, etc., associated with equipment, ductwork, piping and conduit.

Calculations need not be submitted when restraint devices for piping, conduit and ductwork are proposed in accordance with the SMACNA Guidelines for Seismic Restraints.

Selection of isolator anchors and restraints shall be clearly made known along with the basis for selection so that proposed systems can be reviewed.

Calculations furnished for anchors, anchor bolts, sole plates and other support steel for restraining devices shall be signed and stamped by an engineer licensed in the State of Utah.

1.5 REFERENCES:

A. Codes and Standards:

International Building Codes	Latest Adopted Edition
NFPA bulletin 90A,	Latest Adopted Edition
UL Standard 181	Latest Adopted Edition
National Electric Code	Latest Adopted Edition

Guidelines for seismic restraint of Mechanical Systems and Plumbing Piping Systems. Published by the Sheet Metal Industry Fund of Los Angeles, California, and the Plumbing and Piping Industry Council, Inc., Los Angeles, California.

PART 2 - PRODUCTS

2.1 **MATERIALS - PRODUCTS**: Restraint devices shall be especially designed to resist system induced forces in all directions.

A. Snubbers: Restraint surfaces which engage under seismic motion shall be cushioned with a resilient elastomer neoprene (bridge bearing neoprene) to protect equipment. Restraints shall allow a maximum of 1/4" before engaging and shall not interfere in normal starting or stopping operation. Housing shall allow for visual inspection to determine clearances during system operation. Restraints shall be field adjustable and be positioned for up to 1/4" clearance both horizontally and vertically. Mountings and snubbers are to be manufactured under a Quality Assurance (QA) Program.

B. Snubbers and Isolator Combination Devices: Combination unitized devices may be used where equipment isolation is required. They shall include the requirements listed for snubbers. Isolation portion shall be stable spring type with combination leveling bolt and equipment fastening device. Base plate shall have adequate means for bolting to structure. The spring assembly shall be removable and shall fit within a welded steel enclosure.

C. Piping, Conduit and Duct Restraints: Restraint materials for exposed installation shall be standard fabricated flat steel, angle rod and channel members.
Restraint members shall be bolt connected. Cabling materials and methods shall be used only in chases or concealed ceiling spaces.

PART 3 – EXECUTION

3.1 RESTRAINT GUIDELINE:

Guidelines for SMACNA seismic restraints for conduit, piping and ductwork are to serve as the basis for restraint methods. (Exception – Use rigid member bracing and attachment concepts. No cabling shall be used in the restraint systems except as noted.)

3.2 SEISMIC RESTRAINT - DUCTWORK: Ductwork, four feet square and larger in cross sectional area or 26" diameter and larger shall be protected in all places by restraints. Locations shall include, but not be limited to:

A. At all equipment connections.

B. At all duct turns and duct run ends (transverse bracing).

C. Transverse bracing to occur 30'-0" O.C. maximum. Rectangular ducts 61" and larger in either direction may be braced at 32'-0" O.C.

D. Longitudinal bracing shall occur at 60'-0" O.C. maximum.

A group of ducts may be combined in a larger size frame using the overall dimensions with maximum weight for selection of restraint members.

No bracing is required if the top of the duct is suspended 12" or less from supporting member and attached to the top of the duct.

3.3 VIBRATION ISOLATION:

A. General: Furnish and install devices to isolate moving equipment from the structure. (Or confirm that equipment may be securely fastened directly to the structure without negative effect.) Review isolation furnished with factory package equipment, require conformance with project criteria.

B. Basic Criteria: Vibration isolation devices which have natural frequencies approximately 1/10 that of the related driving frequency.

C. Equipment to Include:

Exhaust Fans:

D. Field Verify: All required devices and installation.

3.4 VIBRATION ISOLATION - DUCTWORK AND PIPING:

A. Furnish and install devices to isolate all piping and ductwork from other moving equipment. Provide flex connections, spring hangers, grooved joint couplings for pipe, etc., as required.

END OF SECTION

SECTION 23 06 07
MOTORS, DRIVES & ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Related Sections: Separate electrical components and materials required for field installation and electrical connections are specified in Division 16.

1.2 SUMMARY:

A. This section specifies the basic requirements for motors furnished by Division-23 HVAC and for electrical components which are an integral part of packaged HVAC equipment. Package components include, but are not limited to factory installed motors, starters, and disconnect switches, etc.

B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for HVAC equipment are noted within these documents.

1.3 QUALITY ASSURANCE:

A. For items with electrical aspects furnished by this Division and these Sections, provide electrical components and materials which are UL labeled and assembled with U.L. listings.

1.4 SUBMITTALS:

A. Submit product data for motors, belts, drives, starters, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification sections. Verify project electrical characteristics with submittal. Confirm suitability for altitude, maintaining full nameplate rating plus service factor. Include this data in maintenance manual in accordance with 23 05 30 "HVAC Operation and Maintenance Manuals".

1.5 REFERENCES:

A. NEMA Standards MG 1: Motors and Generators.

B. NEMA Standards ICS 2: Industrial Control Devices, Controllers, and Assemblies.

C. NEMA Standards 250: Enclosures for Electrical Equipment.

D. NEMA Standards KS 1: Enclosed Switches.

E. IEEE Standard 519: Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.

F. Comply with National Electrical Code (NFPA 70).

PART 2 - PRODUCTS

2.1 MOTORS: See Division 16 “Electric Motors” but not less than the following:

A. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are given in the individual equipment specifications.

1. Torque characteristics shall be sufficient to satisfactorily accelerate and maintain the driven loads.

2. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range.

3. Provide two-speed motors with two separate windings for poly-phase motors. Confirm 2-speed starter requirements with Division-16.

4. Fraction Horsepower Single speed motors shall be of the permanent split capacitor type. (PSC)

5. Temperature Rating: Minimum rate for 40^{o}C environment with maximum 90^{o}C temperature rise for continuous duty at full load (Class H Insulation for altitude, Class B leads allowed).

6. Starting Capability: Capable of handling not less than 6 evenly timed/spaced starts per hour, (10 minute cycle time) or more as indicated by the automatic control system,

7. Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors, 1.0 for TEFC motors.

8. Motor Construction: NEMA Standard MG 1, TEFC, continuous duty, design "B", except design "C" where required for high starting torque. Provide motors rated for “Inverter duty” where motors are fed power from variable frequency drives.

9. Motor Frames: NEMA Standard No. 48 or 54; T-frame, use driven equipment manufacturer's standards to suit specific application.

10. Bearings:

    a. Ball or roller bearings with inner and outer shaft seals. Provide with electrically isolated bearings when the motor is fed power from a variable frequency drive.
    b. Re-greasable with zerk fittings, except permanently sealed where motor is normally inaccessible for regular maintenance;
    c. Designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust on motor;
    d. For fractional horsepower, light duty motors, sleeve type bearings are permitted;

11. Enclosure Type: Totally enclosed fan cooled (TEFC) for wet or harsh/dirty environments. Typical throughout this project. Explosion proof (EP) rating for all installation in hazardous locations.

12. Overload Protection: Provide motors with built-in thermal overload protection. Where indicated for industrial motor applications, Provide motors with an internal sensing device suitable for signaling and stopping motor at starter.

13 Noise Rating: "Quiet"

14. Efficiency: "Premium Energy Efficient" motors shall have a minimum efficiency as scheduled in accordance with IEEE Standard 112, test method B. If efficiency not specified, motors shall have a higher efficiency than "average standard industry motors", in accordance with IEEE Standard 112. Motors used with Variable Frequency Drives shall be compatible and designed for use with Variable Frequency Drives. Any "explosion proof" motor set in a classified area and scheduled for use with a variable frequency drive shall be listed for inverter duty applications.

15. Nameplate: indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.

16. Acceptable Manufacturers: Allis-Chalmers, Baldor, Century, General Electric, Gould, Lincoln, Louis-Allis, Marathon, Reliance, U.S. Motors, Westinghouse.

2.2 MOTOR DRIVES:

A. Provide fan/motor-compressor/motor drives with cast steel sheaves and V-belts of fabric and rubber construction by Browning, Dodge, or Woods. Match multiple belts and adjust the assembly to properly drive the apparatus and to prevent slippage and undue wear in starting. Design drives for 150 percent or more of the specified motor nameplate rating. Furnish all drives with shaft bushings. Belts shall be A, B or C section belts. Narrow gauge belts are not acceptable. Provide adjustable driver sheaves for motors five horsepower and smaller, adjust drives or replace sheaves (on larger motors) as needed to obtain required driven speeds and system capacities.

B. Provide shaft to shaft coupled drives for pumps and blowers equivalent to the Dodge "Paraflex" design by Browning, Dodge or Woods.

C. Provide a removable (for maintenance) galvanized steel guard for each V-belt drive, coupled drive or rotating shaft constructed around an angle iron frame, securely bolted to the floor or apparatus. Design the guard to completely enclose drives and pulleys and be constructed to comply with all safety requirements. Provide hinged access doors not less than 6" x 6" for access to motor and fan shaft for test purposes. For double inlet fans, construct the belt guard cover of 1/2" mesh expanded metal, arranged as not to restrict the air flow into the fan inlet.

END OF SECTION

SECTION 230719
REFRIGERENT PIPING INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Includes But Not Limited To

1. Furnish and install insulation on above-ground refrigerant piping and fittings as described in Contract Documents.

B. Related Sections

1. Section 232300 - Refrigerant Piping Systems

PART 2 PRODUCTS

2.1 MATERIALS

A. Flexible Foamed Pipe Insulation

1. Thickness -

a. 1/2 inch for one inch outside diameter and smaller pipe.

b. 3/4 inch for 1-1/8 through 2 inch outside diameter pipe.

c. One inch for 2-1/8 inches outside diameter and larger pipe (two layers of 1/2 inch.)

d. One inch sheet for fittings as recommended by Manufacturer.

2. Approved Products -

a. AP Armaflex by Armacell

b. Rubatex

B. Joint Sealer

1. Approved Products -

a. Armaflex 520 by Armacell

b. BFG Construction Adhesive No. 105

c. Rubatex R-373

C. Insulation Tape

1. Approved Products -

a. Armaflex AP Tape by Armacell

b. R-180-FS Tape by Rubatex

D. Exterior Finish

1. Approved Products -

a. WB Armaflex Finish by Armacell

b. Protective Coating 67x944 by Rubatex

2.2 MANUFACTURERS

A. Armacell, Mebane, NC (800) 232-3341 www.armaflex.com

B. BFG Industries, West Columbia, SC (800) 845-2220 or (803) 796-1380

C. Rubatex, Roanoke, VA 782-2839 or (540) 561-6000 www.rbxcorp.com

PART 3 EXECUTION

3.1 INSTALLATION

A. General

1. Install insulation in snug contact with pipe and in accordance with Manufacturer's recommendations.

a. Insulate flexible pipe connectors.

b. Insulate thermal expansion valves with insulating tape.

c. Insulate fittings with sheet insulation and as recommended by Manufacturer.

2. Slip insulation on tubing before tubing sections and fittings are assembled keeping slitting of insulation to a minimum.

3. Do not install insulation on lines through clamp assembly of pipe support. Butt insulation up against sides of clamp assembly.

4. Provide 6 inch long, 20 ga galvanized steel sleeve around pipe insulation at each support. Extend insulation through pipe support clamps.

5. Stagger joints on layered insulation. Seal joints in insulation.

6. Install insulation exposed outside building so 'slit' joint seams are placed on bottom of pipe.

7. Paint exterior exposed insulation with two coats of specified exterior finish.

B. System Requirements

1. Install insulation on refrigerant on all refrigerant suction, liquid and discharge piping and fittings, including thermal bulb, from thermal expansion valve.

END OF SECTION

SECTION 23 1123
FACILITY NATURAL GAS PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Furnish all labor, materials, equipment, tools and services required to fully complete all Gas Piping work as is indicated on the drawings and/or specified herein including, but not limited to, the following described items.
   1. Pipes, tubes, and fittings.
   2. Piping specialties.
   3. Piping and tubing joining materials.
   4. Valves.
   5. Pressure regulators.
   6. Mechanical sleeve seals.
   7. Grout.
   8. Concrete bases.
   9. This division is to pay all costs associated with the gas meter that are required by the local gas company/authority.

1.02 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.03 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:
   1. Piping and Valves: 100 psig minimum unless otherwise indicated.
B. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 2 psig but not more than 5 psig, and is reduced to secondary pressure of more than 0.5 psig but not more than 2 psig.

C. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.04 SUBMITTALS

A. Product Data: For each type of the following:
   1. Piping specialties.

2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
3. Pressure regulators. Indicate pressure ratings and capacities.
4. Dielectric fittings.
5. Dielectric fittings.
6. Mechanical sleeve seals.
7. Escutcheons.

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
   1. Shop Drawing Scale: 1/4 inch per foot.

C. Delegated-Design Submittal: For natural-gas piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Detail fabrication and assembly of seismic restraints.
   2. Design Calculations: Calculate requirements for selecting seismic restraints.

D. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

E. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.

F. Qualification Data: For qualified professional engineer.

G. Welding certificates.

H. Field quality-control reports.

I. Operation and Maintenance Data: For pressure regulators to include in emergency, operation, and maintenance manuals.

1.05 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

D. Protect stored PE pipes and valves from direct sunlight.

1.07 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.
B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 08 Section "Access Doors and Frames."

PART 2 PRODUCTS

2.01 BASIC PIPES AND PIPE FITTINGS

A. Underground Gas Service Piping:
   1. Pipe Sizes ½" Through 12": Thermoplastic (polyethylene) gas pressure pipe, tubing, and fittings complying with ASTM D 2513. Provide anodeless riser.

B. Building Distribution Piping:
   1. Pipe Size 2" and Smaller: Black steel pipe; Schedule 40; malleable-iron threaded fittings, press fittings (ANSI LCT), welded fittings and joints.

2.02 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
   1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
   2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
   3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
   4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
      a. Material Group: 1.1.
      b. End Connections: Threaded or butt welding to match pipe.
      c. Lapped Face: Not permitted underground.
      d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
      e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
B. PE Pipe: ASTM D 2513, SDR 11.
   1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
   2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
   3. Anodeless Service-Line Risers: Factory fabricated and leak tested.
      a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
      b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering. Vent casing aboveground.

c. Aboveground Portion: PE transition fitting.
d. Outlet shall be threaded or flanged or suitable for welded connection.
e. Tracer wire connection.
f. Ultraviolet shield.
g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

4. Transition Service-Line Risers: Factory fabricated and leak tested.

a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
b. Outlet shall be threaded or flanged or suitable for welded connection.
c. Bridging sleeve over mechanical coupling.
d. Factory-connected anode.
e. Tracer wire connection.
f. Ultraviolet shield.
g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

5. Plastic Mechanical Couplings,NPS 1-1/2 and Smaller: Capable of joining PE pipe to PE pipe.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Lyall, R. W. & Company, Inc.
      2) Mueller Co.; Gas Products Div.
      3) Perfection Corporation; a subsidiary of American Meter Company.
   b. PE body with molded-in, stainless-steel support ring.
   c. Buna-nitrile seals.
   d. Acetal collets.
   e. Electro-zinc-plated steel stiffener.

6. Plastic Mechanical Couplings,NPS 2 and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Lyall, R. W. & Company, Inc.
      2) Mueller Co.; Gas Products Div.
      3) Perfection Corporation; a subsidiary of American Meter Company.
   b. Fiber-reinforced plastic body.
   c. PE body tube.
   d. Buna-nitrile seals.
   e. Acetal collets.
   f. Stainless-steel bolts, nuts, and washers.

7. Steel Mechanical Couplings: Capable of joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Dresser Piping Specialties; Division of Dresser, Inc.
      2) Smith-Blair, Inc.
   b. Stainless-steel flanges and tube with epoxy finish.

c. Buna-nitrile seals.
d. Stainless-steel bolts, washers, and nuts.
e. Factory-installed anode for steel-body couplings installed underground.

2.03 PIPING SPECIALTIES

A. Appliance Flexible Connectors:
1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches.

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.
1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

C. Y-Pattern Strainers:
1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: [40] [60]-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

D. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.04 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.05 MANUAL GAS SHUTOFF VALVES

A. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
1. CWP Rating: 125 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.

5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

B. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
1. CWP Rating: 125 psig.
2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

C. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
1. Manufacturers: Subject to compliance with requirements, [provide products by one of the following:
   a. BrassCraft Manufacturing Company; a Masco company.
   b. Conbraco Industries, Inc.; Apollo Div.
   c. Lyall, R. W. & Company, Inc.
   d. McDonald, A. Y. Mfg. Co.
   e. Perfection Corporation; a subsidiary of American Meter Company.
   f. Nibco
2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated brass.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Separate packnut with adjustable-stem packing threaded ends.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. BrassCraft Manufacturing Company; a Masco company.
   b. Conbraco Industries, Inc.; Apollo Div.
   c. Lyall, R. W. & Company, Inc.
   d. McDonald, A. Y. Mfg. Co.
   e. Perfection Corporation; a subsidiary of American Meter Company.
   f. Nibco
2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.

7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Bronze Plug Valves: MSS SP-78.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Lee Brass Company.
   b. McDonald, A. Y. Mfg. Co.
2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.
1. McDonald, A. Y. Mfg. Co.
2. Mueller Co.; Gas Products Div.
3. Xomox Corporation; a Crane company.
4. Body: Cast iron, complying with ASTM A 126, Class B.
5. Plug: Bronze or nickel-plated cast iron.
6. Seat: Coated with thermoplastic.
7. Stem Seal: Compatible with natural gas.
8. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
9. Operator: Square head or lug type with tamperproof feature where indicated.
10. Pressure Class: 125 psig.
11. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
12. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

G. Cast-Iron, Lubricated Plug Valves: MSS SP-78.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Flowserve.
   b. Homestead Valve; a division of Olson Technologies, Inc.
   c. McDonald, A. Y. Mfg. Co.
   d. Milliken Valve Company.
   e. Mueller Co.; Gas Products Div.
   f. R&M Energy Systems, A Unit of Robbins & Myers, Inc.
2. Body: Cast iron, complying with ASTM A 126, Class B.
3. Plug: Bronze or nickel-plated cast iron.

4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.
6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.06 EARTHQUAKE VALVES

A. Earthquake Valves: Comply with ASCE 25.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Pacific Seismic Products, Inc.
      b. Koso
   2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   3. Maximum Operating Pressure: 7 psig.
   4. Cast-aluminum body with stainless-steel internal parts.
   5. Nitrile-rubber, reset-stem o-ring seal.
   6. Valve position, open or closed, indicator.
   7. Composition valve seat with clapper held by spring or magnet locking mechanism.
   8. Level indicator.
   9. End Connections: Threaded for valves NPS 2 and smaller; flanged for valves NPS 2-1/2 and larger.

2.07 PRESSURE REGULATORS

A. General Requirements:
   1. Single stage and suitable for natural gas.
   2. Steel jacket and corrosion-resistant components.
   3. Elevation compensator.
   4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Line Pressure Regulators: Comply with ANSI Z21.80.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Actaris.
      b. American Meter Company.
      c. Eclipse Combustion, Inc.
      d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
      e. Invensys.
      f. Maxitrol Company.
      g. Richards Industries; Jordan Valve Div.
   2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
   3. Springs: Zinc-plated steel; interchangeable.

4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 5 psig.

2.08 DIELECTRIC FITTINGS

A. Dielectric Unions:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Capitol Manufacturing Company.
      b. Central Plastics Company.
      c. Hart Industries International, Inc.
      d. McDonald, A. Y. Mfg. Co.
      e. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
      f. Wilkins; Zurn Plumbing Products Group.
   2. Minimum Operating-Pressure Rating: 150 psig.
   3. Combination fitting of copper alloy and ferrous materials.
   4. Insulating materials suitable for natural gas.
   5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

B. Dielectric-Flange Kits:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Advance Products & Systems, Inc.
      b. Calpico Inc.
      c. Central Plastics Company.
      d. Pipeline Seal and Insulator, Inc.
   2. Minimum Operating-Pressure Rating: 150 psig.
   3. Companion-flange assembly for field assembly.
   4. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or PE bolt sleeves, phenolic washers, and steel backing washers.
   5. Insulating materials suitable for natural gas.
   6. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

2.09 SLEEVES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.10 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Advance Products & Systems, Inc.
   b. Calpico Inc.
   c. Metraflex Company (The).
   d. Pipeline Seal and Insulator, Inc.
2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe and sleeve.
3. Pressure Plates: Stainless steel.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

2.11 ESCUTCHEONS

A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to fit around pipe or tube, and OD that completely covers opening.

B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Escutcheons: With set screw.
1. Finish: Polished chrome-plated or rough brass.

D. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.
1. Finish: Polished chrome-plated or rough brass.

E. One-Piece, Stamped-Steel Escutcheons: With set screw or spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Escutcheons: With concealed hinge, set screw or spring clips, and chrome-plated finish.

G. One-Piece, Floor-Plate Escutcheons: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

2.12 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
1. Characteristics: Post-hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.13 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
B. Inspect natural-gas piping according to the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.
C. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

3.03 OUTDOOR PIPING INSTALLATION

A. Comply with NFPA 54 and the International Fuel Gas Code for installation and purging of natural-gas piping.
B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 312000 "Earth Moving" for excavating, trenching, and backfilling.
    1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.
C. Install underground, PE, natural-gas piping according to ASTM D 2774.
D. Install fittings for changes in direction and branch connections.
E. Install pressure gage upstream and downstream from each service regulator.

3.04 INDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.
B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
G. Locate valves for easy access.
H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
I. Install piping free of sags and bends.
J. Install fittings for changes in direction and branch connections.
K. Install escutcheons at penetrations of interior walls, ceilings, and floors.
    1. New Piping:
        a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
        b. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
        c. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
        d. Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
        e. Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and set screw.
        f. Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
        g. Piping in Unfinished Service Spaces: One-piece, stamped-steel type with set screw or spring clips.
        h. Piping in Equipment Rooms: One-piece, cast-brass type.
        i. Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.
        j. Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."
M. Verify final equipment locations for roughing-in.
N. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
O. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
    1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
P. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
Q. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
R. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe

with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
    a. Exception: Tubing passing through partitions or walls does not require striker barriers.
5. Prohibited Locations:
    a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
    b. Do not install natural-gas piping in solid walls or partitions.

S. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
T. Connect branch piping from top or side of horizontal piping.
U. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
V. Do not use natural-gas piping as grounding electrode.
W. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
X. Install pressure gage upstream and downstream from each line regulator.

3.05 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
B. Install underground valves with valve boxes.
C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
D. Install earthquake valves aboveground outside buildings according to listing.
E. Install anode for metallic valves in underground PE piping.

3.06 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.
B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
C. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

D. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

E. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.07 HANGER AND SUPPORT INSTALLATION

A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

B. Comply with requirements for pipe hangers and supports specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.08 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.09 LABELING AND IDENTIFYING

A. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 PAINTING

A. Comply with requirements in Division 09 painting Sections for painting interior and exterior natural-gas piping.

B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
   1. Alkyd System: MPI EXT 5.1D.
      a. Prime Coat: Alkyd anticorrosive metal primer.
      b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
      c. Topcoat: Exterior alkyd enamel (semigloss).
      d. Color: Gray.

C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
   1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
      a. Prime Coat: Quick-drying alkyd metal primer.
      b. Intermediate Coat: Interior latex matching topcoat.
      c. Topcoat: Interior latex (flat).
      d. Color: Gray.
   2. Alkyd System: MPI INT 5.1E.
      a. Prime Coat: Quick-drying alkyd metal primer.
      b. Intermediate Coat: Interior alkyd matching topcoat.
      c. Topcoat: Interior alkyd (flat).
      d. Color: Gray.

D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base.
   1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
   3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to supported equipment.
   6. Use 3000-psig 28-day, compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.12 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.
C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
D. Prepare test and inspection reports.

3.13 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

3.14 OUTDOOR PIPING SCHEDULE

A. Underground natural-gas piping shall be the following:
   1. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.

3.15 INDOOR PIPING SCHEDULE

A. Aboveground, piping NPS 2 and smaller shall be the following:
   1. Steel pipe with wrought-steel fittings and welded or threaded joints.
B. Aboveground, piping NPS 2-1/2" and larger shall be the following:
   1. Steel pipe with wrought-steel fittings and welded joints.
C. Underground, below building, piping shall be the following:
   1. Steel pipe with wrought-steel fittings and welded joints in a vented conduit.
D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.16 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be one of the following:
   1. One-piece, bronze ball valve with bronze trim.
   2. Bronze plug valve.
B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be one of the following:
   1. Bronze plug valve.
   2. Cast-iron, nonlubricated plug valve.

END OF SECTION

SECTION 23 23 00
REFRIGERATION PIPING

PART 1 – GENERAL

1.1 GENERAL MECHANICAL REQUIREMENTS:

A. All pertinent sections of Section 23 00 00 - General HVAC Requirements are a part of the work described in this section.

B. All pertinent sections of Section 23 10 00 – General HVAC Pipes and Fittings are a part of the work described in this section.

1.2 SUMMARY:

A. This section specifies:

1. Piping, valves, specialties.

1.3 STANDARDS:

A. International Building Code/International Mechanical Code

B. Local Codes and Ordinances

C. EPA Requirements.

D. ANSI/ASHRAE 15 - Safety Code for Mechanical Refrigeration.

E. ANSI/ASHRAE 90A - Energy Conservation in new Building Design.

1.4 SHOP DRAWINGS/SUBMITTALS:

A. Submit a list of all materials to be used indicating brand or source, type and service.

B. Submit shop drawings for all refrigerant piping, valves and specialties, including shop drawing showing proposed pipe routing, sizing, valving, etc.

1.5 CONTRACTOR QUALIFICATION:

A. The Piping Contractor for this work shall be licensed as a firm in the Contractor state of origin and in the state of Utah.

B. The Subcontractor shall have a publicly registered bonding capacity of sufficient amount to cover this work and all other work in progress by the Subcontractor.

C. All workmen employed in the project shall carry state licenses as journeyman or apprentice pipe fitters with additional certification for welders.

1.6 SCOPE OF THE WORK:

A. Furnish and install all field fabricated refrigeration piping and related work to effect a complete installation.

1. Piping, valves, specialties.

2. Other refrigerant piping work indicated on the drawings.

1.7 INSTRUCTION OF OWNER'S PERSONNEL:

A. Purpose is to provide a transition of the systems from the Contractor to the Owner, leaving the Owner's personnel familiar with and well qualified to operate and maintain the systems.

B. Instruction to cover purpose and function of each system and its components, to show proper operating technique, to show proper maintenance technique.

1.8 WARRANTIES: See Section 23 05 00 “General HVAC Requirements”.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS: Piping materials shall be as follows unless otherwise indicated on the applicable contract drawing:

A. Pipe: "ACR" Type L, hard drawing, degreased, sealed at mill copper tubing, ASTM B88-62, cleaned and sealed at the mill. Pre-charged refrigerant lines shall not be used.

B. Fittings: Long radius, wrought copper type equal to Mueller Streamline, ASA B16.22.1963.

2.2 VALVES, SPECIALTIES, ETC:

A. Filter-Dryer: On lines smaller than 3/4" O.D. filter-dryer shall be a sealed type using male flare fittings. Size shall be full line size. Filter-dryer shall be Sporlan, Mueller or Alco.

B. Sight Glass: Shall be a combination moisture and liquid indicator with protection cap. Sight glass shall be Alco, Mueller, Sporlan or Henry. Size shall be full line size.

C. Flexible Connection: Corrugated bronze hose with single layer of stainless steel exterior braiding, minimum 9 inches long with copper tube ends; for system working pressure.

D. Solenoid Valve:

1. Valve: ARI 760, pilot operated, copper or brass body and internal parts, synthetic seat, stainless steel stem and plunger assembly with flared, solder, or threaded ends; for system working pressure. Stem shall permit manual operation in case of coil failure.

2. Coil Assembly: UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color coded lead wires, integral junction box 24 volt, confirm and coordinate with DDC controls.

2.3 REFRIGERANT AND LUBRICATING OIL: Furnish and install all of the refrigerant required to develop the system to its full rating, and in addition to the initial charge, provide, without cost to the Owner, all required refrigerant for the proper operation of the refrigeration apparatus during the first year's operation. The contractor shall be required to provide the initial charge of lubricating oil for all refrigeration apparatus and related equipment. Loss of refrigerant and oil during the first year of operation shall be made good at the contractor's expense.

PART 3 – EXECUTION

3.1 INSTALLATION:

A. General: Use best practices of the trade in all installation. Installation shall conform to the American Standard Code for Pressure Piping, ASA B31.5-1962 Refrigeration Piping. Installed piping shall not interfere with the operation and accessibility of doors or windows; shall not encroach on aisles, passageways, and equipment; and shall not interfere with the servicing or maintenance of equipment. Pipe shall be cut accurately to measurements established at the construction site and shall be worked into place without springing or forcing, properly clearing all openings and equipment. Cutting or weakening of structural members to facilitate piping installation is not permitted. Pipes shall have burrs removed by reaming and shall be so installed as to permit free expansion and contraction without damage to joints or hangers. Piping shall be installed in a straight manner, free from traps, and shall be provided with capped or plugged ends, as it is erected, to prevent dirt from entering the system. The piping system shall be provided with isolating hangers as required to prevent vibration of the compressor operation being carried to the building structure. The piping system shall be provided with gauges as required for the operation of the system, and the suction connection from each coil shall be provided with a test thermometer wall in the pipe for adjustment of the thermostatic expansion valves.

B. Slope of Refrigerant Lines: Slope suction lines down toward compressor 1" per 10 feet. Locate oil traps every 10 feet at all vertical rises against flow in suction lines. Suction line traps shall be standard one-piece traps.

C. Cleanliness: All refrigerant lines and fittings shall be absolutely clean to avoid system operating difficulties and contamination. Use a good cleaning agent such as trichloroethylene.

D. Joints:

Brazed joints: Cut tubing square and remove burrs. Clean both the inside of fittings and outside of tubing with steel wool, wire brush, or fine emery cloth before brazing.

Pass an inert gas (such as oil pumped dry nitrogen) through the copper piping when brazing joints to prevent formation of copper oxide. Take care to prevent annealing of fittings and tubing when making connections. Make up joints with silver bearing brazing material.

3.2 TESTING OF REFRIGERATION PIPING SYSTEM: After the installation of the refrigeration piping system has been completed and before insulation is applied, test all pipes and prove tight for a period of 24 hours, at a pressure of 300 pounds per square inch, using oil pumped dry nitrogen.

3.3 EVACUATION AND CHARGING: After completion of the piping pressure test, the

refrigeration systems shall be evacuated and dehydrated using a vacuum pump capable of producing at least 1 mm Hg absolute. Use the following procedure unless otherwise directed:

Connect an accurate high vacuum gauge, such as Stokes or Zimmeril gauge to the system.

Connect the vacuum pump to both the high and low side of the system. Leave the compressor suction and discharge service valves closed. Start the vacuum pump.

Keep ambient air temperatures above 60^{o} during the evacuation process.

Operate the vacuum pump until the system is evacuated to 2.5 mg Hg absolute.

Break the system vacuum with oil pumped dry nitrogen. Open the compressor suction and discharge service valves and re-evacuate the system to 2.5 mm Hg absolute.

After the system has been double evacuated to 2.5 mm Hg absolute, close the vacuum pump suction valve and stop the pump. Allow the system to stand under a vacuum a minimum of 12 hours. If no noticeable rise in pressure has taken place after 12 hours, the system may be charged. Make this test in the presence of the Owner's representative.

3.4 CLOSEOUT PROCEDURES:

A. Participate in Owner’s Instruction.

END OF SECTION

SECTION 23 31 00
DUCTWORK

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-23 Basic HVAC Materials and Methods Sections apply to work of this section.

1.2 SUMMARY:

A. Extent of metal and high density polypropylene ductwork is indicated on drawings and in schedules, and by requirements of this section.

B. Types of ductwork required for the project include the following:

1. Rectangular

C. Refer to Section 23 05 93 for system commissioning, testing and balancing.

D. Refer to Section 23 31 10 for ductwork accessories.

E. Refer to Section 23 34 23 for power ventilators.

F. Refer to Section 23 90 00 for filters.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of metal and high density polypropylene ductwork products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: A firm with at least 3 years of successful installation experience on projects with metal and high density polypropylene ductwork systems work similar to that required for project.

The installer shall have a publicly registered bonding capacity of sufficient amount to cover this work and all other work in progress by the Contractor.

All workmen on the project shall carry Utah state licenses as journeymen or apprentice sheet metal workers with additional certification for welders.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data and installation instructions for metal and high density polypropylene ductwork materials and products.

B. Shop Drawings: Submit coordinated scaled layout drawings of metal ductwork and fittings including, but not limited to, duct sizes, locations, elevations, and slopes of horizontal runs, wall and floor penetrations, and connections. Show interface and spacial relationship between ductwork and proximate equipment. Show modifications of indicated requirements, made to conform to local

shop practice, and how those modifications ensure that free area, materials, and rigidity are not reduced.

C. Record Drawings: At project closeout, submit record drawings of installed metal ductwork and ductwork products, in accordance with requirements of Division-1.

D. Maintenance Data: Submit maintenance data and parts lists for metal ductwork materials and products. Include this data, product data, shop drawings, and record drawings in maintenance manual; in accordance with requirements of Division-1.

1.5 REFERENCES:

A. Codes and Standards:

1. SMACNA Standards: Comply with SMACNA "HVAC Duct Construction Standards, Metal and Flexible" for fabrication and installation of metal ductwork.

2. ASHRAE Standards: Comply with ASHRAE Handbook, Equipment Volume, Chapter 1 "Duct Construction", for fabrication and installation of metal ductwork.

3. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air-Conditioning and Ventilating Systems" and NFPA 90B "Standard for the Installation of Warm Air Heating and Air-Conditioning Systems".

4. International Building Code/International Mechanical Code/equivalent Utah Codes: Comply with all sections pertaining to mechanical work.

B. Field Reference Manual: Have available for reference at project field office, copy of SMACNA "HVAC Duct Construction Standards, Metal and Flexible".

1.6 DELIVERY, STORAGE, AND HANDLING:

A. Protection: Protect shop-fabricated and factory-fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.

B. Storage: Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade and enclosed with waterproof wrapping.

PART 2 - PRODUCTS

2.1 DUCTWORK - GENERAL:

A. Standards: All duct fabrications shall comply with standards and techniques detailed by SMACNA "Duct Construction Manuals" for the appropriate pressure class, and with the ASHRAE Handbook, HVAC Systems and Equipment, 2016 edition, Chapter 19, Duct Construction

2.2 SHEET METAL DUCTWORK:

A. General: For all rectangular ductwork and fittings construct/fabricate from aluminum, PVC coated galvanized steel or stainless steel. Contractor may choose between aluminum, PVC coated galvanized steel or stainless steel except where specifically directed on the drawings.

If using galvanized sheet steel, provide galvanized sheet steel complying with ASTM A 527, lock

forming quality, with G 120 zinc coating in accordance with ASTM A 525; mill phosphatized for exposed locations.

If using stainless steel, fabricate of Type 304 SS or Type 316 SS stainless steel sheet complying with ASTM A-167 with all welded joints and seams. Provide polished No. 4 satin finish for all duct exposed to view, No. 1 finish elsewhere. Protect finished surfaces with mill applied adhesive protective paper through fabrication and installation.

If using aluminum ductwork, aluminum ductwork shall be constructed of 3003-H-14 aluminum using construction for nominal 4" SMACNA rated systems. Seal all transverse joints with duct cement.

B. Exposed Ductwork Materials: Provide materials which are free from visual imperfections including pitting, seam marks, roller marks, stains and discolorations, and other imperfections, including those which would impair painting. Installation of exposed ductwork shall be laid out in advance and submitted for review. Ductwork shall be hung straight and uniform, points shall be true, and seams shall show continuity.

C. Note a special requirement for hangers and supports for process areas. Project rejects strap hangers for ductwork. Make angle, insert, or clamp attachment to structure and hang suspended duct with rod or angle iron verticals and angle, channel or Unistrut horizontals. Brace and restrain ductwork as for piping with rigid assemblies. Do not use a cabling system for such duty.

2.3 FITTINGS AND FABRICATION:

A. Fittings: Provide radius type fittings fabricated of multiple sections with maximum 15^{o} change of direction per section.

B. Fabricate duct fittings to match adjoining ducts, and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with center-line radius equal to associated duct width. Limit angular tapers to 30^{o} for contracting tapers and 20^{o} for expanding tapers.

C. Fabricate ductwork with accessories installed during fabrication to the greatest extent possible. Refer to Division-23 section "Duct Accessories' for accessory requirements.

D. Offset, transition, and adapt ductwork to structural obstacles and work of other trades in a coordinated effort. Layout work to avoid conflict with piping, etc. With review of conditions, teardrop around conflicting piping, lights, etc., all at no added cost to the project.

2.3 MISCELLANEOUS DUCTWORK MATERIALS:

A. General: Provide miscellaneous materials and products of types and sizes indicated and, where not otherwise indicated, provide type and size required to comply with ductwork system requirements including proper connection of ductwork and equipment.

B. Duct Sealing Compound for metal ductwork: Use a U.L. listed, fiber reinforced, water based adhesive duct sealing compound by Foster, Hard cast, United-McGill, Nova, Miracle, 3M, Duct mate, Duro Dyne. Verify that the material is listed for use in a moist, corrosive environment compatible with duct material. Follow manufacturer’s directions for joint cleaning and preparation; seal all duct and plenum joints prior to and during assembly. Use mastics that will not weep if the duct is warmed above room temperature.

PART 3 – EXECUTION

3.1 INSPECTION:

A. General: Examine areas and conditions under which metal ductwork is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION OF METAL DUCTWORK:

A. General: Assemble and install ductwork in accordance with recognized industry practices which will achieve air tight (5% leakage for systems rated 3" and under; 1% for systems rated over 3") and noiseless (no objectionable noise) systems, capable of performing each indicated service. Install each run with minimum number of joints. Align ductwork accurately at connections, within 1/8" misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true to shape and to prevent buckling. Support vertical ducts at every floor.

All necessary allowance and provisions shall be made in the installation of sheet metal ducts for the structural conditions of the building, and ducts shall be transformed or divided as may be required. Whenever this is necessary, the required area shall be maintained. All of these changes, however, must be approved and installed as directed at project. During the installation, the open ends of ducts shall be protected to prevent debris and dirt from entering.

B. Field Fabrication: Complete fabrication of work at project as necessary to match shop-fabricated work and accommodate installation requirements.

C. Routing: Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, details and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building. Limit clearance to 1/2" where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork for 1" clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.

D. Electrical Equipment Spaces: Except as indicated, do not run ductwork through transformer vaults and other electrical equipment spaces and enclosures. Maintain clearances above of and in front of electrical panels.

E. Ducts at Structural and Architectural Penetrations: Where ducts are shown connecting to or passing through concrete, gypsum board, masonry openings and along edges of all plenums at floors and walls, provide a continuous 2" x 2-1/8" stainless steel angle iron which shall be bolted to the construction and made airtight to the same by applying caulking compound. Sheet metal in these locations shall be bolted to the angle iron. Round high velocity ducts in vertical chases shall be supported with rolled angle rings. Close openings between duct and structure.

F. Cross Breaking: Rectangular sheet metal ducts shall be cross broken or rolled rib reinforced on the four sides of each 4-foot panel. All vertical and horizontal sheet metal barriers, duct offsets, elbows, as well as 4-foot panels of straight sections of ducts shall be cross broken. Cross breaking shall be applied to the sheet metal between the standing seams or reinforcing angles; the center of cross break shall be of the required height to assure surfaces being rigid. Larger ducts shall include

intermediate reinforcing angles or members to stiffen the panel faces.

G. Coordination: Coordinate duct installations with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system.

H. Installation: Install metal ductwork in accordance with SMACNA HVAC Duct Construction Standards.

Related to final installation cleanliness, damp wipe all ductwork on installation. Cap open duct ends, cover fan inlets, vacuum fan plenums and related installation before starting fans. Run fans only with filters in place.

3.4 HANGERS AND SUPPORTS FOR METAL DUCTWORK.

A. It is essential that all ducts shall be rigidly supported. Hangers for low velocity ducts up to 18" in width shall be placed on not more than 10' centers.

Low velocity ducts 19" through 35" in width and greater shall be supported on not more than 5' centers. Where vertical ducts pass through floors or roofs, heavy supporting angles shall be attached to ducts, and to structure. Angles shall be of sufficient size to support the ductwork rigidly and shall be placed on at least two sides of the duct.

B. For rectangular ducts 36" and greater in width, construct hangers with all-thread rods and aluminum channel, galvanized iron channel, or Unistrut sections, minimum dimension 2” x 2” x 1/8".

C. Ductwork Support Materials for ductwork in Process Areas: Provide 316 stainless steel fasteners, anchors, and rods, washers, nuts and provide 316 stainless steel or 6061-T6 aluminum alloy angles for support of ductwork in process areas. Do not use straps.

D. Supporting Dampers: Parallel and opposed blade motor operated dampers shall be supported by reinforcing the ductwork or sheet metal walls at the damper locations to carry the weight of the dampers and the force exerted on the dampers due to air pressure, or shall be supported independent of ductwork from the ceiling or floor, as conditions at the site determine.

3.5 CONNECTIONS: All duct joints, transverse and longitudinal, shall be made airtight by coating joints with duct sealing compound before joining, and then sealing the joint with one layer of "Glass Fab" reinforcing tape set in a coating of the compound. Tape and sealant shall not exceed a flame spread of 25 or a smoke development of 50.

3.6 WELDED JOINTS: Welded metal ductwork shall have either an angle or a piece of 1/8" steel bar behind each weld to allow lying of a neat and continuous bead.

3.7 FIELD QUALITY CONTROL:

A. Leakage Tests: After each duct system which is constructed for duct classes over 3" is completed, test for duct leakage in accordance with SMACNA HVAC Air Duct Leakage Test Manual. Air leaks which are in excess of that required to bubble the soap suds (that is, actually blow the suds away) shall be sealed by additional taping and caulking to reduce the leakage to a rate not to exceed slow bubbles forming. Repair leaks and repeat tests until total leakage conforms with Chart of Figure 4-1, Seal Class A, Leakage Class 3 for round/oval, 6 for rectangular.

B. Allow 24 hours for the HDPE ductwork sealant to cure after final assembly before testing the duct system. Additional curing time may be required in high ambient conditions.

3.8 EQUIPMENT CONNECTION:

A. General: Connect metal and high density polypropylene ductwork to equipment as indicated; provide flexible connection for each ductwork connection to equipment mounted on vibration isolators, and/or equipment containing rotating machinery. Provide access doors where indicated.

3.9 ADJUSTING AND CLEANING:

A. Clean ductwork internally of dust and debris, as follows: With filters in place where applicable, operate the fans at full capacity to blow out dirt and debris from ducts. If it is not practical to use the main supply blower for this test, the ducts may be blown out in sections by a portable fan.

B. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.

C. Balancing:

1. Refer to Section 23 05 93 section "Testing, Adjusting and Balancing" for air distribution balancing of metal or high density propylene ductwork; not work of this section. However, the Sheet Metal Contractor shall participate fully in this work. Seal any leaks in ductwork that become apparent in balancing process.

2. If specified conditions cannot be obtained due to deficiencies in equipment performance or improper installation or workmanship, the Mechanical Contractor and his subcontractors shall make any changes necessary to obtain the specified conditions.

END OF SECTION

SECTION 23 31 10
DUCTWORK ACCESSORIES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-23 Basic HVAC Materials and Methods sections apply to work of this section.

1.2 SUMMARY:

A. Extent of ductwork accessories work is indicated on drawings and in schedules, and by requirements of this section.

B. Types of ductwork accessories required for project include the following:

1. Duct hardware.
2. Flexible connections.

C. Refer to 23 05 93 for testing, adjusting, and balancing of ductwork accessories; not work of this section.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of ductwork accessories, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data for each type of ductwork accessory, including dimensions, capacities, and materials of construction; and installation instructions.

B. Shop Drawings: Submit manufacturer's assembly type shop drawings for each type of ductwork accessory showing interfacing requirements with ductwork, method of fastening or support, and methods of assembly of components.

C. Maintenance Data: Submit manufacturer's maintenance data including parts lists for each type of duct accessory. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division-1.

1.5 REFERENCES:

A. Codes and Standards:

1. SMACNA Compliance: Comply with applicable portions of SMACNA "HVAC Duct Construction Standards, Metal and Flexible".
2. Industry Standards: Comply with ASHRAE recommendations pertaining to construction of ductwork accessories, except as otherwise indicated.

3. UL Compliance: Construct, test, and label fire dampers in accordance with UL Standard 555 "Fire Dampers and Ceiling Dampers".

4. NFPA Compliance: Comply with applicable provisions of NFPA 90A "Air Conditioning and Ventilating Systems", pertaining to installation of ductwork accessories.

1.6 DELIVERY, STORAGE AND HANDLING:

A. Protection: Protect shop-fabricated and factory-fabricated accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.

B. Storage: Where possible, store accessories inside and protect from weather. Where necessary to store outside, store above grade and enclosed with waterproof wrapping.

PART 2 - PRODUCTS

2.1 MOTORIZED DAMPERS (LOW LEAKAGE):

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Greenheck Fan Corporation. (VCD 43)
   2. Pottorff.
   3. Ruskin Company.(CD50)

B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

C. Frames:
   1. Section:
      a. Hat shaped.
      b. Material:
         1. 6063-T5 Extruded Aluminum
      c. Corners:
         1. Mitered-and-welded.

D. Blades: Multiple.
   1. Maximum blade width:
      a. 6 inches. Airfoil shape
      b. Actioin as indicated on the drawings.
      c. Material:
         1. 6063-T5 Extruded Aluminum.
      d. Jamb Seals:
         1. Flexible metal compression type.
      e. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.
         1. Closed-cell neoprene

E. Blade Axles:
   1. Section:
      a. 1/2 diameter, hex shaped.
      b. Material:
         1. Galvanized steel.
      c. Blade-linkage hardware:
         1. Zinc-plated steel and brass.

2. Ends sealed against blade bearings:
d. Operating Temperature Range: From minus 20 to plus 120 deg F.
e. Make provisions for mountingof damper out of the air stream.

F. Bearings:
1. Type:
a. Molded synthetic.
b. Axles: Dampers in ducts with pressure classes of 3-inch wg or more shall have axles full length of damper blades.

G. Leakage:
1. 5.2 cfm per square foot at 4" w.g. for 48" x 48" size.

H. Pressure Drop:
1. Maximum 0.03" w.g. at 1500 fpm across 24" x 24" damper.

2.2 DUCT HARDWARE:

A. General: Provide duct hardware, typically of one manufacturer, for all items on project, for the following:

1. Test Holes: Provide in ductwork at fan inlet and outlet, and elsewhere as indicated, duct test holes, cover, for instrument tests. Ventlok No. 699 closures shall be provided and installed for each test hole, with sufficient neck length to penetrate the insulation.

B. Manufacturer: Subject to compliance with requirements, provide duct hardware of one of the following:

1. Ventfabrics, Inc.
2. Young Regulator Co.

2.3 FLEXIBLE CONNECTIONS:

A. Extent of Work: Provide flexible connections between ductwork and equipment, such as at fan inlets and discharges, and at other places indicated on the drawings or called for by note or specification.

B. Non-Corrosive Environment or Airstream: For system pressures up to 5" w.c, provide material of heavy waterproof woven glass fabric double coated with neoprene or Hypalon equivalent to "Ventglas" for interior locations and "Ventlon" for exterior locations, fabric not less than 3-1/4" wide clamped between strips of 24 gauge stainless steel or 20 gauge aluminum alloy. Material by Ventfabrics, Inc., Chicago, Ill.

C. Corrosive Environments or Airstream: Provide material of heavy waterproof woven fiberglass fabric coated with Teflon equivalent to "Ventel" by Ventfabrics, Inc., Chicago, Ill.

By nature, the material is slippery and requires rigid clamping in the field installation. Install with the coated side to the corrosive air stream. Clamp the material into a stainless steel edging or hinge with a folded fabric edge. Be careful in securing the clamped fabric to the fan or duct as to not penetrate or disturb any protective coatings or surfaces.

PART 3 – EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which ductwork accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF DUCTWORK ACCESSORIES:

A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.

B. Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.

C. Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

3.3 FIELD QUALITY CONTROL:

A. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leak proof performance.

3.4 ADJUSTING AND CLEANING:

A. Adjusting: Adjust ductwork accessories for proper settings

Label access doors in accordance with Division-23 section "Mechanical Identification".

Cleaning: Clean factory finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION

SECTION 233423
POWER VENTILATORS

PART I - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

B. Division 23 General Mechanical Requirements sections apply to work of this section.

C. See Section 230607 Motors, Drives and Electrical Requirements for Mechanical Work.

1.2 SUMMARY:

A. Extent of power and gravity ventilator work required by this section is indicated on drawings and schedules, and by requirements of this section.

B. Types of power and gravity ventilators specified in this section include the following:

1. Power ventilators.

a. Ceiling Exhaust Fan.
b. Ventilation Fan

C. Refer to Division 23 section "Testing, Adjusting and Balancing" for balancing of power and gravity ventilators; not work of this section.

D. Refer to Division 23 temperature control systems sections for control work required in conjunction with power and gravity ventilators; not work of this section.

E. Refer to Division 16 sections for the following work; not work of this section.

1. Power supply wiring from power source to power connection on ventilators. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.

2. Interlock wiring between ventilators; and between ventilators and field-installed control devices as shown in Division 16.

a. Interlock wiring specified as factory-installed is work of this section.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of power and gravity ventilators, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical data for power and gravity ventilators, including specifications, capacity ratings, dimensions, weights, materials, accessories furnished, and installation instructions.

B. Shop Drawings: Submit assembly-type shop drawings showing unit dimensions, construction details, methods of assembly of components, and field connection details.

C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to power ventilators. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

D. Maintenance Data: Submit maintenance data and parts list for each type of power and gravity ventilator, accessory, and control. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 23.

1.5 REFERENCES:

A. Codes and Standards:

1. AMCA Compliance: Provide power ventilators which have been tested and rated in accordance with AMCA standards, and bear AMCA Certified Rating Seal.

2. UL Compliance: Provide power ventilators which are listed by UL and have UL label affixed.

3. NEMA Compliance: Provide motors and electrical accessories complying with NEMA standards.

PART II - PRODUCTS

2.1 CEILING EXHAUST FAN (CEF-1):

A. Fan shall be ceiling mounted, direct driven, centrifugal exhaust fan.

B. Fan shall be listed by Underwriters Laboratories (UL 705) and bear the AMCA Certified Ratings Seal for Sound and Air Performance.

C. The fan housing shall be minimum 20 gauge galvanized steel and acoustically insulated. Blower and motor assembly shall be mounted to a minimum 14 gauge reinforcing channel and shall be easily removable from the housing. Motor shall be mounted vibration isolators. Unit shall be supplied with integral wiring box and disconnect receptacle shall be standard. Discharge position shall be convertible from right angle to straight through by moving interchangeable panels. The outlet duct collar shall include a reinforced aluminum damper with continuous aluminum hinge rod and brass bushings. To accommodate different ceiling thickness, an adjustable prepunched mounting bracket shall be provided. Gemini 100, 200 & 300 series units shall be provide have a white, non-yellowing, high impact styrene injection molded designer style grill as standard. Gemini 400 through 900 series units shall be provided with a powder painted white steel grille as standard. Unit shall be shipped in ISTA Certified Transit Tested Packaging.

D. Wheel shall be centrifugal forward curved type, constructed of galvanized steel. Wheel shall be balanced in accordance with AMCA Standard 204-05, Balance Quality and Vibration Levels for Fans.

E. Motor shall be open drip proof type with permanently lubricated bearings and include impedance or thermal overload protection and disconnect plug. Motor shall be furnished at the specified voltage.

F. Furnish with adjustable speed controller (rheostat). Furnish with an adjustable time delay switch. Time adjustable from 5 minutes to 60 minutes. Allowing the fan to operate at the timed setting after the wall switch has been turned off.

G. Size and capacity as shown on the drawings.

H. Manufacturer: Subject to compliance with requirements. Provide exhaust fans of one of the following:
1. Cook – GC Series
2. Greenheck
3. Twin City
4. ACME

2.2 VENTILATION FAN (VF-1):

A. Fan shall be a wall mounted, direct driven, propeller exhaust fan.

B. Fan shall be listed by Underwriters Laboratories (UL 705), and bear the AMCA certified ratings seal for sound and air performance.

C. Fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The motor shall be mounted on a 14 Ga. Steel mounting plate and power assembly. The power assembly shall be bolted to a minimum 14 Ga. steel wall panel with continuously welded corners and an integral venturi. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM and static pressure.

D. All steel fan components shall be coated with an electrostatically applied, baked polyester powder coating. Each component shall be subject to a five stage environmentally friendly wash system, followed by a minimum 2 mil thick baked powder finish. Paint must exceed 1,000 hour salt spray under ASTM B117 test method.

E. Propeller shall be cast aluminum airfoil design with cast aluminum hub. The blade pitch shall be factory set and locked using set screws and roll pin. The hub shall be keyed and locked to the shaft utilizing two set screws or a taper lock bushing. Propeller shall be balanced in accordance with AMCA Standard 204-05, *Balance Quality and Vibration Levels for Fans.*

F. Motor shall be Nema design B with class B insulation rated for continuous duty and furnished at the specified voltage, phase and enclosure. Motor shall be suitable for use with VFD and have isolated bearings or shaft grounding.

G. Manufacturer: Subject to compliance with requirements. Provide ventilation fans of one of the following:
1. Cook
2. Greenheck
3. Twin City
4. ACME

PART III - EXECUTION

3.1 INSPECTION:

A. General: Examine areas and conditions under which power and gravity ventilators are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF POWER AND GRAVITY VENTILATORS:

A. General: Except as otherwise indicated or specified, install power ventilators in accordance with manufacturer's installation instructions and recognized industry practices to insure that products serve the intended function.

B. Coordinate ventilator work with work of walls as necessary for proper interfacing.

C. Ductwork: Refer to Division 23 section "Ductwork." Connect ducts to ventilators in accordance with manufacturer's installation instructions.

D. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted.

E. Remove shipping bolts and temporary supports within ventilators. Adjust dampers for free operation.

F. Support exhaust fan from wall complete with appropriate mounting frame. Provide vibration isolation and seismic restraints as specified in Section 230605.

3.3 FIELD QUALITY CONTROL:

A. Testing: After installation ventilators has been completed, test each ventilator to demonstrate proper operation of unit at performance requirements specified. When possible, field correct malfunctioning units, then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected.

3.4 ADJUSTING AND CLEANING:

A. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 233423

SECTION 233713
AIR OUTLETS AND INLETS

PART I - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

1.2 SUMMARY:

A. Extent of air outlets and inlets work is indicated by drawings and schedules, and by requirements of this section.

B. Types of outlets and inlets required for project include the following:

1. Louvers
2. Exhaust Cap

C. Refer to other Division 23 sections for ductwork and duct accessories required in conjunction with air outlets and inlets; not work of this section.

D. Refer to other Division 23 sections for balancing of air outlets and inlets; not work of this section.

E. Refer to other Division sections for louvers, not work of this section.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of air outlets and inlets of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: A firm with at least 3 years of successful installation experience on projects with metal ductwork systems work similar to that required for project.

1. The Installer shall have a publicly registered bonding capacity of sufficient amount to cover this work and all other work in progress by the Contractor.

2. All workmen on the project shall carry state licenses as journeymen or apprentice sheet metal workers with additional certification for welders.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data for air outlets and inlets including the following:

1. Schedule of air outlets and inlets indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.

2. Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details.

3. Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses; throw and drop; and noise criteria ratings. Indicate selections on data.

B. Samples: 3 samples of each type of finish furnished.

C. Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of air outlet and inlet, indicating materials and methods of assembly of components.

D. Maintenance Data: Submit maintenance data, including cleaning instructions for finishes, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of General Conditions.

1.5 REFERENCES:

A. Codes and Standards:

1. ARI Compliance: Test and rate air outlets and inlets in accordance with ARI 650 "Standard for Air Outlets and Inlets".

2. ASHRAE Compliance: Test and rate air outlets and inlets in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets".

3. AMCA Compliance: Test and rate louvers in accordance with AMCA 500 "Test Method for Louvers, Dampers and Shutters".

4. AMCA Seal: Provide louvers bearing AMCA Certified Rating Seal.

5. NFPA Compliance: Install air outlets and inlets in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver air outlets and inlets wrapped in factory-fabricated fiber-board type containers. Identify on outside of container type of outlet or inlet and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.

B. Store air outlets and inlets in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

PART II - PRODUCTS

2.1 LOUVERS

A. Extent of Work: At air openings in the outside wall where indicated on drawings, install AMCA rated drainable stationary extruded aluminum 6" deep weather louvers.

B. Material: Blades shall be on 3-1/2" centers with integral downspouts to drain the water from the louver blades. Stationary louvers shall pass 1000 fpm free area velocity with less than 0.2" static pressure drop and shall carry less than .03 ounces of water per square foot when tested in accordance with AMCA Standard 500. Install stainless steel 1/2” mesh screens on interior face and louver.

1. Louvers shall be equal to Ruskin ELF6375DX American Warming and Ventilating LE-31, Louvers and Dampers, Krueger, Ruskin, Greeheck, Pottorff. Coordinate with the Architectural details for type of flange and structural details for actual wall opening sizes. Anodized aluminum finish.

C. Contractor must coordinate louver size, flange type, and construction with structural and architectural openings to assure fit and appearance. Louvers shall be one piece.

2.1 EXHAUST AIR CAP

A. All aluminum construction, fixed exhaust veins, insect screen, domed weather cap, flanged collar assembly. Finish shall be anodized.

B. Manufacturer: Subject to compliance with requirements, provide exhaust fans from one of the following:

1. Seiho International Inc.

PART III - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which air outlets and inlets are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION:

A. General: Install air outlets and inlets in accordance with manufacturer's written instructions and in accordance with recognized industry practices to ensure that products serve intended function.

B. Coordinate with other work, including ductwork and duct accessories, as necessary to interface installation of air outlets and inlets with other work.

END OF SECTION 233713

SECTION 23 5533
FUEL-FIRED UNIT HEATERS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 1 Specification sections apply to work of this section.

B. All pertinent sections of Section 23 0100 - Mechanical Requirements are a part of the work described in this section.

1.2 SUMMARY:

A. Includes but not limited to:

1. Natural gas fired unit heaters

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of Gas Fired Heating systems with characteristics, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

1. Installer's Qualifications: A firm with at least 3 years of successful installation experience on projects with radiant heating systems.

B. The total heating system shall be design certified by the American Gas Association, and each burner shall be affixed with a nameplate that bears the seal of the American Gas Association.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING:

A. Store radiant heater components in a clean dry place. Protect from weather, dirt, fumes, water, and construction debris, and physical damage.

1.5 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data for fuel fired heating systems showing dimensions, weights, ratings, fan performance, motor electrical characteristics, and finishes of materials, and installation instructions.

B. Shop Drawings: Submit assembly-type shop drawings showing unit dimensions, weight loadings, required clearances, construction details, and field connection details.

1. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to radiant heating systems. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
2. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in maintenance manuals; in accordance with requirements of Division 23.

PART 2 – PRODUCTS

2.1 GAS FIRED UNIT HEATERS (UH-1, 2, & 3):

A. High Efficiency natural gas-fired unit heaters with separated combustion, axial fan, power vented high efficiency.

B. The unit input capacity shall be as listed on the plans. The output capacity shall be a minimum of 93% of the input based on steady-state thermal efficiency as certified by the American Gas Association (A.G.A.)

C. Size and capacity as scheduled on the drawings.

D. Casing: Casing shall be 20 gauge aluminized steel with a baked on enamel finish, aesthetically designed with rounded corners, and fitted to eliminate exposed fasteners. Casing shall also include a hinged bottom panel for easy access to the burner compartment. Horizontal air deflector louvers shall be provided to aid in controlling the discharge air pattern

E. Burner: The burner(s) shall be in-shot type, directly firing each heat exchanger tube individually and is designed for good lighting characteristics without noise of extinction for both natural and propane gas.

F. Heat Exchanger: 18 gauge 409 stainless steel tubes and headers. Each heat exchanger tube shall be individually and directly flame-fired. The heat exchanger tube shall be crimped to allow for thermal expansion and contraction. The flue collector box shall be made of 20 gauge AL29-4C stainless steel.

G. Venting: The unit shall be separated combustion. The venting shall be a power exhausted arrangement with a separate combustion air intake pipe connection to allow for fresh combustion air from outside the conditioned space. The unit shall be tested to insure proper ignition when the unit is subjected to 40 mile per hour wind velocities. The unit shall also include a factory mounted differential pressure switch designed to prevent main burner ignition until positive venting has been proven. Venting shall be Schedule 40 PVC. For Canadian installations, all vent pipe and components must be approved to ULC S636.

H. Controls: Shall be factory wired and tested microprocessor based with the following features and safeties: hot surface ignition system, redundant gas control valves, with on-off knob or switch, multi speed combustion induction fan, combustion fan airflow proving switch, manual reset flame rollout safety switch, limit controls, wiring junction box, control box, solid state fan controls, limit controls, transformer, etc. The unit shall be provided with a single-stage room thermostat with a 50°-90°F temperature set point range. The stat shall also include switching for Heat/Off and Fan On/Auto control.

I. Motor and Propeller Fan: Each unit heater shall have a single motor and propeller. Motor shall be totally enclosed with thermal overload protection (single phase only). Propeller shall be statically balanced and shall be equipped with a safety fan guard.

J. Accessories: The following field installed accessory control devices shall be provided with the unit:
   1. A horizontal concentric vent kit shall be provided to allow the vent outlet and combustion air inlet pipes to penetrate the building wall through one opening.
   2. A condensate pump for high lift applications of up to 22'. Pump shall include indicator lights to show pump status, internal vibration isolation, a check valve, condensate treatment tablet dispenser, and alarm contacts to shut the unit heater down if the pump becomes inoperable.
   3. A condensate pH neutralizing kit to reduce the acidity of condensate. Includes barbed inlet and outlet fittings, mounting brackets and an initial charge of neutralizing aggregate.
   4. A condensate drain kit consisting of one threaded PVC elbow and two specially designed condensate traps to allow the unit to operate and drain properly.

K. Manufacturer
   1. Modine
   2. Reznor
   3. Trane
   4. Sterline

PART 3 - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which gas fired heating systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF GAS FIRED UNIT HEATERS:

A. General: Install gas fired unit heaters as indicated and in accordance with manufacturer's published installation instructions. Mount such that tubing slopes or run level per manufacturers requirements.

B. Provide and install all low voltage (below 120 volt) control wiring and accessories complete, as specified.

C. Power wiring by electrical not work of this division.

D. Extend condensate drain piping from vacuum pump and combustion chamber to an approved drainage fixture through the use of no less than 3/4" copper piping.

E. Extend gas piping to units, provide drop with manual gas shutoff valve, pressure reducing valve, plugged test connection, tee and drip pocket. Locate piping drop so as not to interfere with service of unit. Extend gas piping runout, full size of gas train inlet, from tee to gas train connection, provide union with sufficient clearance for unit removal and service.

3.3 START-UP:

A. Furnace distributors technical service representative shall start up and check out furnace equipment as follows:

1. Verify proper gas orifice sizing.
2. Clock gas meter for rated output.
3. Verify and set gas pressure at unit.
4. Measure and record temperature rise.
5. Check safety controls for proper operation.
6. Check vent and combustion air sizes and performance.

3.4 OPERATION AND MAINTENANCE TRAINING:

A. Provide services of manufacturer's service representative to instruct Owner's personnel in operation and maintenance of gas fired furnaces. Training shall include start-up and shut-down servicing and preventative maintenance schedule and procedures, and troubleshooting procedures plus procedures for obtaining repair parts and technical assistance. Review operating and maintenance data contained in the Operating and Maintenance Manuals section.

1. Schedule training with Owner, provide at least 7-day prior notice to the Architect/Engineer.
2. Vendors for each piece of equipment controls, etc., shall participate along with the contractor(s).

END OF SECTION

SECTION 238126
SPLIT SYSTEM HEAT PUMP

PART 1 GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Furnish and install heat pumps as described in Contract Documents.

B. Related Sections:
   1. Section 230500: General Mechanical Requirements.

1.2 SUBMITTALS

A. Quality Assurance / Control: Equipment check-out sheets.

1.3 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Each unit shall be UL / ULC or ETL labeled.

1.4 WARRANTY

A. Provide five-year warranty on compressors beginning from date of start-up. Record start-up date on warranty certificate for each unit.

PART 2 PRODUCTS

2.1 SPLIT SYSTEM HEAT PUMP (SHP-1 & 2)

A. Heat Pumps:
   1. Indoor Units:
      a. Wall mounted units as scheduled.
      b. Isolate moving parts from cabinets to reduce noise.
      c. Provide with condensate pump
   2. Outdoor Units:
      a. Compressor serving the multi-split system shall be of swing rocker design, provided with multi-ports to match indoor units served with inverter power modulating control.
      b. Fans shall be direct driven and discharge horizontally.
      c. Casings shall be fully weatherproof for outdoor installations.
      d. Microprocessor Controls shall be factory wired with field installed remote pendant station.

e. Refrigerant shall be R-410a.
f. Factory installed refrigerant circuits shall be provided with reversing valves to provide heating function down to 5°F or lower
g. Isolate moving parts from cabinets to reduce noise.
h. Use dry-charged tubing for connection of unit's refrigerant system.

3. Accessories:
   a. Provide all indoor units with wired remote controllers installed in secure housings.
4. In addition to that specified above, provide heat pump split systems with all standard features to match features of those scheduled.
5. Approved Manufacturers:
   a. Daikin Air Conditioning (Americas) Inc, Carrollton, TX www.daikinac.com.
   b. Carrier Corp, Syracuse, NY www.commercial.carrier.com.
   c. Friedrich Air Conditioning Co, Austin, TX www.friedrich.com.
   d. Mitsubishi Electronics America Inc, HVAC Div, Norcross, GA www.mrslim.com.
   e. Sanyo Air Conditioning Products, Chatsworth, CA www.sanyo.com.
   f. LG

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Units shall be started up, checked out, and adjusted by Unit Manufacturer's authorized factory trained service mechanic. Use equipment check-out sheet provided by Manufacturer. Complete and sign all items on sheet.

END OF SECTION

SECTION 23 90 00
AIR FILTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-23, Section 23 05 00 General HVAC Requirements sections apply to work of this section.

1.2 SUMMARY:

A. Extent of air cleaning work required by this section is indicated on drawings and schedules, and by requirements of this section.

B. Types of air cleaning equipment specified in this section include the following:

1. Air Filters.

a. Extended surface self-supporting.

C. Refer to Division-23 duct accessories section for duct access door work required in conjunction with air filters; not work of this section.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of air cleaning equipment of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data including, dimensions, weights, required clearances and access, flow capacity including initial and final pressure drop at rated air flow, efficiency and test method, fire classification, and installation instructions.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawings for filter rack assemblies indicating dimensions, materials, and methods of assembly of components.

C. Maintenance Data: Submit maintenance data and spare parts lists for each type of filter and rack required. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division-23.

1.5 REFERENCES:

A. Codes and Standards:

1. UL Compliance: Comply with UL Standards pertaining to safety performance of air filter units.

2. ASHRAE Compliance: Comply with provisions of ASHRAE Standard 52 for method of testing,

and for recording and calculating air flow rates.

3. ARI Compliance: Comply with provisions of ARI Standard 850 pertaining to test and performance of air filter units.

PART 2 - PRODUCTS

2.1 AIR FILTERS:

A. Manufacturers: Subject to compliance with requirements, replaceable filter media and holding frames shall be a product of one of the following:

1. American Air Filter
2. Continental
3. Farr

B. Holding Frames: Suitable for filters specified. Frame and brace into solid assemblies.

1. May be side access, factory fabricated type.

C. Replaceable pleated media type filters.

1. Pleated, medium efficiency in a cardboard holding frame, 2" or 4" thick as scheduled, 0.32" s.p. maximum initial pressure drop at 500 feet/minute, to change out at 0.50". U.L. Class 2, 25-30% efficiency, 90-95% arrestance per ASHRAE Standard 52-76. Typical selection for 300 feet/min, or less.

2. Equivalent to Farr 30/30.

D. Startup Set:

1. Install a set of filters immediately upon fabrication of any filter bank. Install scheduled set of filters at completion of construction at the time of testing and balancing.

E. Replacement Set:

1. Furnish a second set of filters for each unit to be turned over to Owner as initial replacement stock.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which air filters and filter housings will be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION:

A. General: Comply with installation requirements as specified elsewhere in these specifications pertaining to air filters housing/casings, and associated supporting devices.

B. Install air filters and holding devices of types indicated, and where shown; in accordance with air

filter manufacturer's written instructions and with recognized industry practices; to ensure that filters comply with requirements and serve intended purposes.

C. Locate each filter unit accurately in position indicated, in relation to other work. Position unit with sufficient clearance for normal service and maintenance. Anchor filter holding frames securely to substrate.

D. Coordinate with other work including ductwork and air handling unit work, as necessary to interface installation of filters properly with other work.

E. Install filters in proper position to prevent passage of unfiltered air.

F. Install air filter gage pressure tips upstream and downstream of filters to indicate air pressure drop through air filter. Mount filter gages on outside of filter housing or filter plenum, in accessible position. Adjust and level inclined gages if any, for proper readings.

3.3 FIELD QUALITY CONTROL:

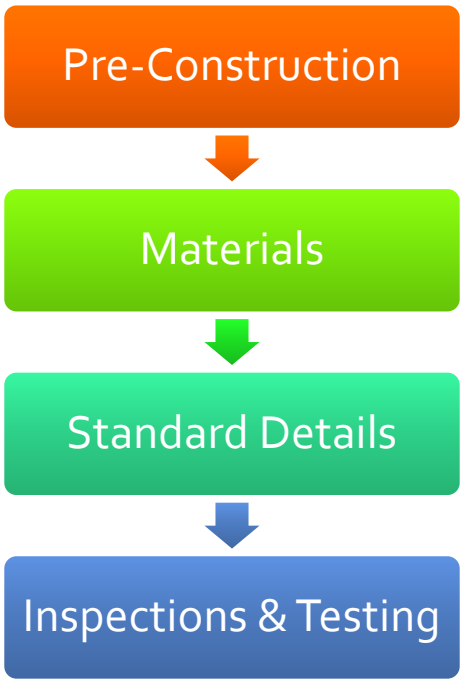
A. Operate installed air filters to demonstrate compliance with requirements. Test for air leakage of unfiltered air while system is operating. Correct malfunctioning units at site, then retest to demonstrate compliance; otherwise remove and replace with new units, and proceed with retesting.

END OF SECTION

GRANGER-HUNTER
IMPROVEMENT DISTRICT

Improving quality of life today – creating a better tomorrow

2024 Material and Construction Specifications For Water and Wastewater Systems



Granger-Hunter Improvement District Engineering Department

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- ADS – Polyethylene Material
- APWA – American Public Works Association
- ASTM – American Society of Testing and Materials
- CC – Center to Center
- CI – Cast Iron
- CORP- Corporation
- CTS – Copper Tube Size
- DI – Ductile Iron
- DIAM – Diameter
- FIP – Female Iron Pipe
- FM (Grease) – Food Grade (Grease)
- GHID – Granger-Hunter Improvement District
- H-20 – Traffic Loading (AASHTO Load Rating)
- ID – Inside Diameter
- MAX – Maximum
- MH – Manhole
- MIL – Thickness (1 MIL =1/1000 of an inch)
- MIN – Minimum
- MIP – Male Iron Pipe
- MJ – Mechanical Joint
- NO- Number
- OC – On Center
- OD- Outside Diameter
- OSHA – Occupational Safety and Health Administration
- PVC – Polyvinyl Chloride
- SDR – Standard Dimension Ratio
- SS – Stainless Steel
- TYP –Typical
- WVC – West Valley City

Pre-Construction

New Construction

Prior to construction of water and wastewater lines, all plans must undergo a review process to determine if the proposed improvements meet GHID standards. The following is a general outline of the process:

- The Owner shall complete the Availability and Plan Review Application (s), pay the fee.
- The Owner shall finalize any easements and/or rights-of-way documents necessary.
- After plan approval, GHID shall issue a Letter of Availability (and sign the plat if applicable).
- It is the Developer's Responsibility to schedule a pre-construction meeting. All applicable fees, signed development agreement (for construction of public infrastructure) License & Permit Bond, Certificate of Insurance and Workers Comp or Workers Comp Waiver must be submitted prior to scheduling pre-construction meeting.

Copies of GHID's Development Agreement, Availability & Plans Review Application, requirements, and connection fees are available on our website at https://www.ghid.org/engineering.html. E-mail final plans to plans@ghid.org. Each plan set must be accompanied by a completed plan submittal checklist. West Valley City's standard plans are available here: https://www.wvc-ut.gov/1592/West-Valley-City-Engineering-Standards.

Modifications/Improvements to Existing Infrastructure

A plan review of improvements of existing infrastructure is required whenever the water, sewer, irrigation, or fire protection systems are being modified. Owners are responsible to contact GHID and fill out an Availability & Plan Review Application. Fees will be assessed on the type of improvements made. Forms are available on GHID's website at https://www.ghid.org/engineering.html

Contractors

The following items will be required before work may commence:

- Submittal of Contractor's License and Permit Bond.
- General Liability Insurance Certificate.
- Workers Compensation and Employer's Liability Certificate, or State of Utah approved waiver.
- Approved set of drawings.
- Arrange for a Pre-Construction meeting with District inspectors by calling 801-968-3551.
- 24-hour notification is required for all inspections. Inspections are available Monday-Thursday. 8:00 AM to 4:00 PM, excluding holidays.

Design Specifications

Water System

- The design of the improvements shall be consistent with West Valley City's Fire Department fire flow requirements.
- All materials that come into contact with drinking water shall be ANSI/NSF 61 Certified.
- All pipe, joints, fittings, valves, and fire hydrants shall conform to AWWA Standards C104-C550 and C900-C950.
- Service laterals shall conform to the Utah Plumbing Code.
- Water mains not connected to hydrants shall be 6-inch minimum diameter. Water mains connected to hydrants shall be 8-inch minimum diameter.
- Water main valves shall be spaced not more than 500 feet in commercial districts and not more than 800 feet or one block in other areas. Water main valves shall be placed at all street and/or water main intersections.
- All dead-end water mains shall be provided with a fire hydrant or blow-off.
- At high points in water mains, air relief valves shall be installed per GHID Specifications.
- Pipe shall be buried at least 4 feet below ground surface.
- The open ends of all pipelines under construction shall be sealed at the end of each day.
- No used materials (valves, fittings, pipe, fire hydrants, etc.....) shall be used.
- Hydrant drains shall not be connected to, or located within, 10 feet of sanitary sewers or storm drains.
- No vaults with valves or blow-offs shall discharge directly to the storm drain or sewer system.
- In PRV Vaults, isolation valves shall be installed on both sides of the PRV.
- Service laterals shall not be connected to fire lines.
- Water meters shall be placed at adjoining property lines centered in the park strip or within one foot back from curb in accordance with District specifications.
- Only two meters per lot (plus either a landscape/back-out meter) are allowed. Landscaping back-out meters must be smaller than the main meter.
- Owner is responsible to submit backflow reports to GHID Water Quality Department within 10 days of initial use and annually thereafter.
- Contractor must sign for service before meters will be installed or provided. https://www.ghid.org/sign-up-for-service for service agreement.
- Abandoned water mains are to be completely removed on reconstruction projects or when the removal does not require excessive disturbance of hard surface improvements as determined by the District. If the water main removal will result in excessive disturbance of hard surface improvements the contractor shall cap and restrain the pipe with a blind flange or equivalent type of plug.

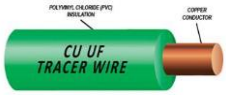
Wastewater System

- The maximum spacing between manholes for all sewer lines shall not exceed 400 feet.
- End all sewer mains with a manhole or cleanout.
- All building connections must have an exterior lateral cleanout within five feet of the building.
- Maximum spacing between cleanouts for all 4-inch cleanouts shall not exceed 60 feet.
- Maximum spacing between cleanouts for all 6-inch cleanouts shall not exceed 100 feet.
- All establishments that discharge fat, oil, grease, or sand shall install a 1,000-gallon minimum interceptor and sampling manhole per District specifications.
- Sampling manholes and grease interceptors shall be placed where they are permanently accessible.
- All wastewater pipelines and laterals must conform to GHID's Typical Conflict Detail.
- All swimming pool drain lines must be limited to 50 GPM.

- Any business requiring a grease interceptor must have its own meter.
- Covered Parking lots and car washes are required to install a sand/water separator.
- Abandoned sewer mains are to be completely removed on reconstruction projects or when the removal does not require excessive disturbance of hard surface improvements the abandoned sewer main shall be filled with flowable fill. In the rare circumstances where removing the abandoned sewer main or placing flowable fill is infeasible, and with approval from the District Engineer, abandoned sewer main may be plugged with a permanent, water-tight concrete (4000 PSI) plug extending into the abandoned pipe at least two feet. All openings in walls of remaining manholes, catch basins, or structures must be plugged as well. This will not be an option for sewer main pipes showing signs of significant deterioration.

Materials

Water Materials

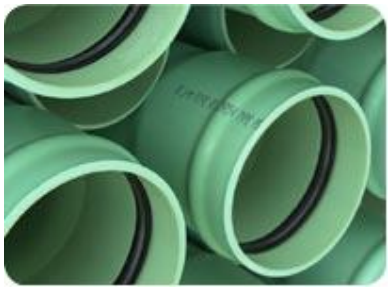
	**Water Mainline Pipe** C-900 SDR 18 PVC Fittings shall be Pressure Class 250 psi Minimum.		**Fire Hydrants** 6" Waterous or Mueller.
	**Water Valves** Gate valve <= 12-inch. AVK, Clow, Mueller or Waterous. Brass valve nuts required.		**Tracer Wire** #14 Insulated Solid Copper Electrical Tracer Wire. Tracer Wire must be continuity tested prior to paving.
	**Mechanical Joint Restraints** Megalug or Romac grip rings or equivalent		**Valve Boxes** Cast Iron adjustable with cover labeled "WATER" D&L M-8045-02 Heavy Weight Valve Box Lid or equivalent
	**Wax Tape** Trenton Wax Tape or Equivalent		**Poly-Ply Wrap** Trenton Poly-Ply Wrap or Equivalent

	**Water Meters** Sensus iPerl & Omni T2-Meters Supplied by the District. ¾"- 2" installed by District, 3" – 10" installed by Contractor Provided by the District.		**Meter Rings and Lids**
	**Meter Box** ADS Plastic		**Ford Coppersetter** See detail for part numbers
	**Stainless Tapping Sleeve** Ford or Romac All Stainless Tapping Sleeve		**Service Line** C.T.S. SDR-9 Poly w/ss stiffeners and compression fittings
	**Corporation Stops** IP x CTS		**Check Valve** Angle Cartridge Dual Check Valve
	**Water Warning Tape** 2" Wide Min. 4mil thick Min. For water and sewer mains		**Snake Pit** CD14BLUTP

	**Sampling Station** Kupferle #88-SS Eclipse With Pedestal		**Brass Saddle** Ford 202BS with brass accessory packs
	**Curb Stamps** W for water lateral, S for sewer lateral		**Bonding Clamp** For Copper to Poly connection for tracer wire
	**Accessory Packs** All accessory packs to be PTFE-Polytetraflouroethylene or SS–Stainless Steel Type 316 Anti-seize required for SS Accessory Packs.		**Repair Coupler** Smith-Blair Full Circle Repair Clamp with PTFE or SS Type 316 nuts and bolts
	**Thrust Restraints** RieberLok Gaskets Or Concrete Thrust Blocks		

	**Typical Large Meter** Meters to be provided by the District
	**Typical Fireline Backflow** Double Check Detector Assembly or Equivalent Required per UPC Section 603.5.14. Meter to be provided by the District.

Wastewater Materials

	**Sewer Pipe** PVC SDR 35		**Nose-on** Inserta Tee or Equal on Existing Mains Wye Fittings on New Mains.
	**Ring and Cover** D&L A1180 or EJ NPR-20-004590-23214 W/Titus TL-125 Twist Lift Security Lock or Equal Labeled as shown		**Manhole** Concrete
	**Grease Interceptor** Concrete 1,000 gallon minimum		**Butyl Sealant** Kent seal or equivalent (for joints in concrete manholes and grease interceptors)

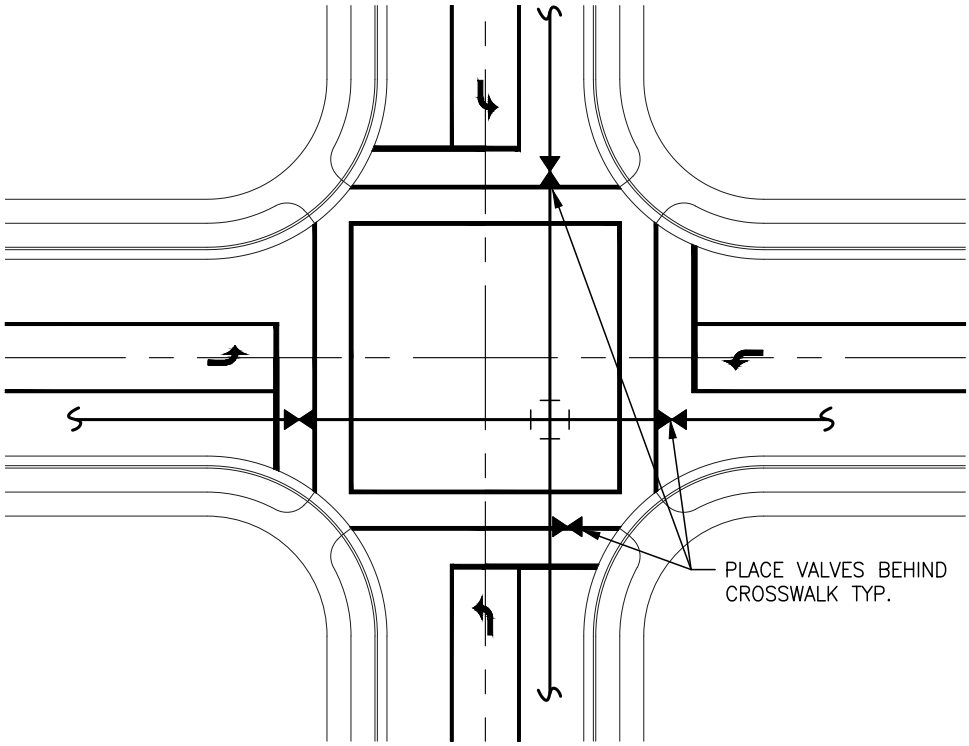
	**WhirlyGIG Manhole Riser Collar System**		**Cretex Pro-Ring**
	**Shielded Fernco Connectors**		**No Hub Cleanout w/ brass plug**
	**Curb Stamps** **S for Sewer or drill and insert a stamped plug**		**Sewer Warning Tape**

Standard Details

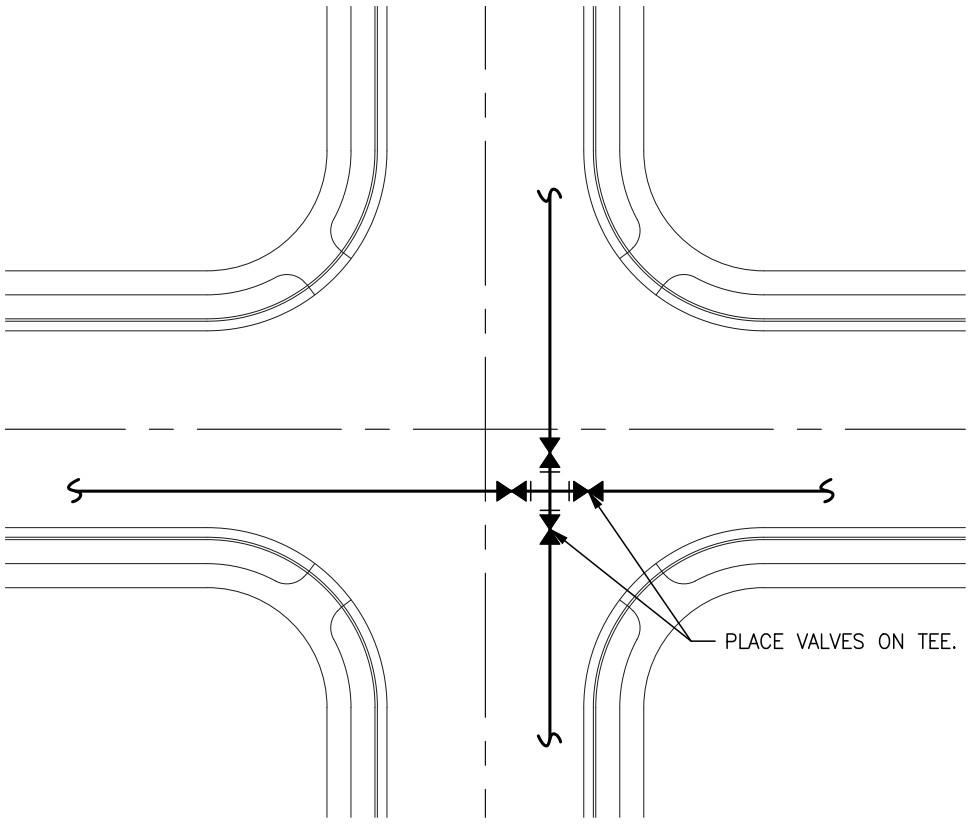
General Notes

1	All construction in the pipe zone shall follow GHID specifications and requirements.
2	The existing water distribution system shall remain in service during construction.
3	It is the contractor's sole responsibility to locate and avoid any/all utilities.
4	All construction above the pipe zone including, but not limited to, replacement of curb, sidewalk, etc to be in accordance with applicable agency (ie. UDOT, West Valley City, APWA 2017 edition) specifications and requirements. Refer to GHID, WVC, APWA and OSHA requirements for trench excavation and safety.
5	All waterline and sewerline construction to be in accordance with GHID Materials and Construction Specifications and APWA Standard Plans and Specifications (2017 edition).
7	Contractor shall restore pavement per applicable agency standards.
8	Bedding and Backfill within Pipe Zone: Waterline Constructed in dry ground – select sand shall be used. Waterline constructed in wet ground and Sewerline – ¾" minus gravel with separation fabric shall be used. Select Sand Bedding and Backfill shall be compacted to a minimum average of 92% density ASTM D-1557. Material shall be compacted in 6-inch layers (uncompacted depth) within the pipe zone area including the haunch areas.

Typical Valve Location Detail



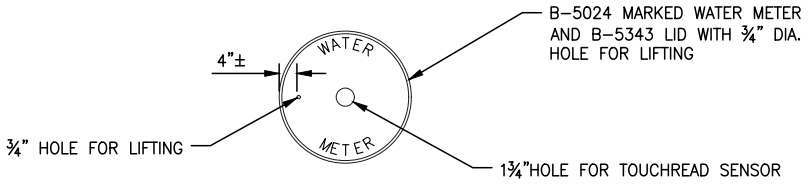
SIGNALIZED INTERSECTIONS

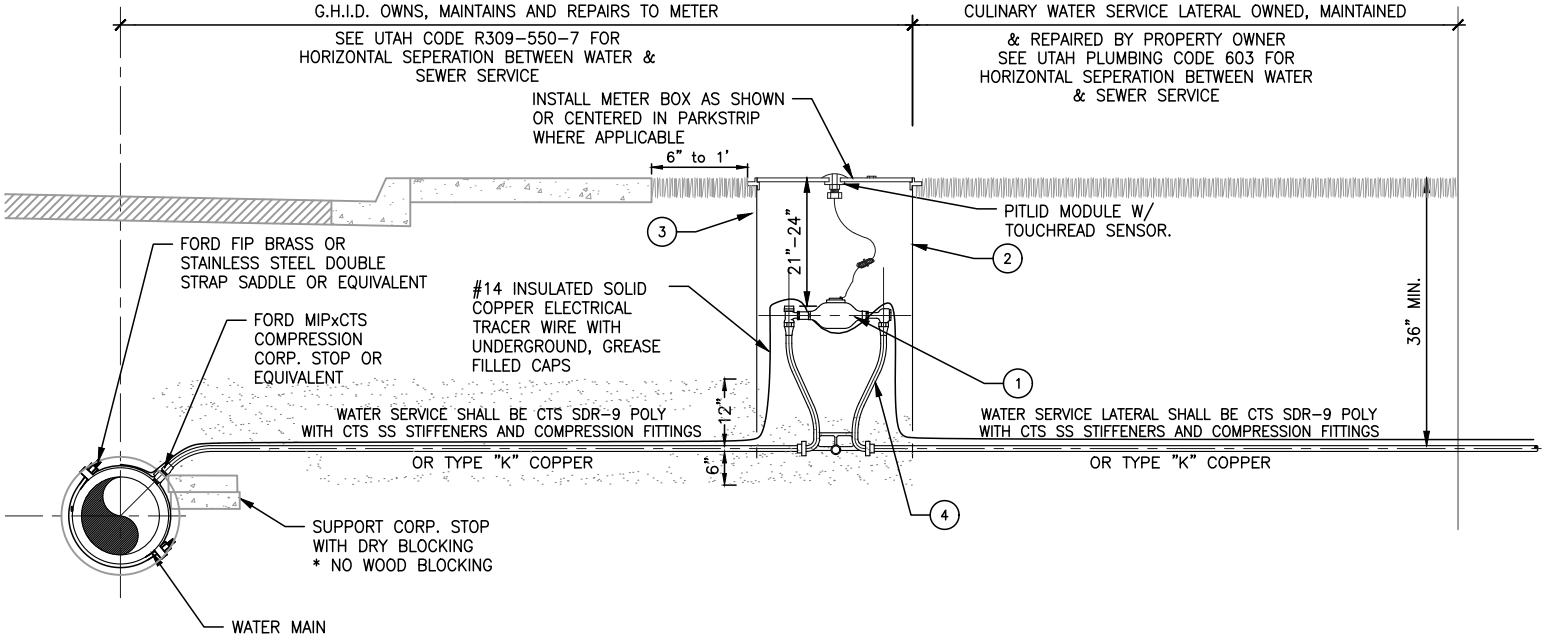


NON-SIGNALIZED INTERSECTIONS

NOTE:
1. SEE PAGE 14 FOR GENERAL NOTES
2. SEE TYPICAL TRENCH SPECIFICTIONS FOR BEDDING AND BACKFILL

Typical Water Service with ¾" - 2" Meter





Water Service Profile

	(1)		(2)	(3)	(4)
METER SIZE	SENSUS METER TYPE		METER BOX SIZE**	LID W/1–3/4" HOLE D&L FOUNDRY *	FORD COPPERSETTERS PART NO. *
3/4"	iPERL 7–1/2"		24" DIA. x 36" DEEP	B–5024	VBHC7218W4433QNL
1"	iPERL		24" DIA. x 36" DEEP	B–5024	VBHC7418W4444QNL
1 1/2"	OMNI		30" DIA. x 36" DEEP	B–5343	VBHH76184466NL
2"	OMNI		30" DIA. x 36" DEEP	B–5343	VBHH77184477NL

* – OR EQUIVALENT
** – OR SIGMA RAVEN EQUIVALENT

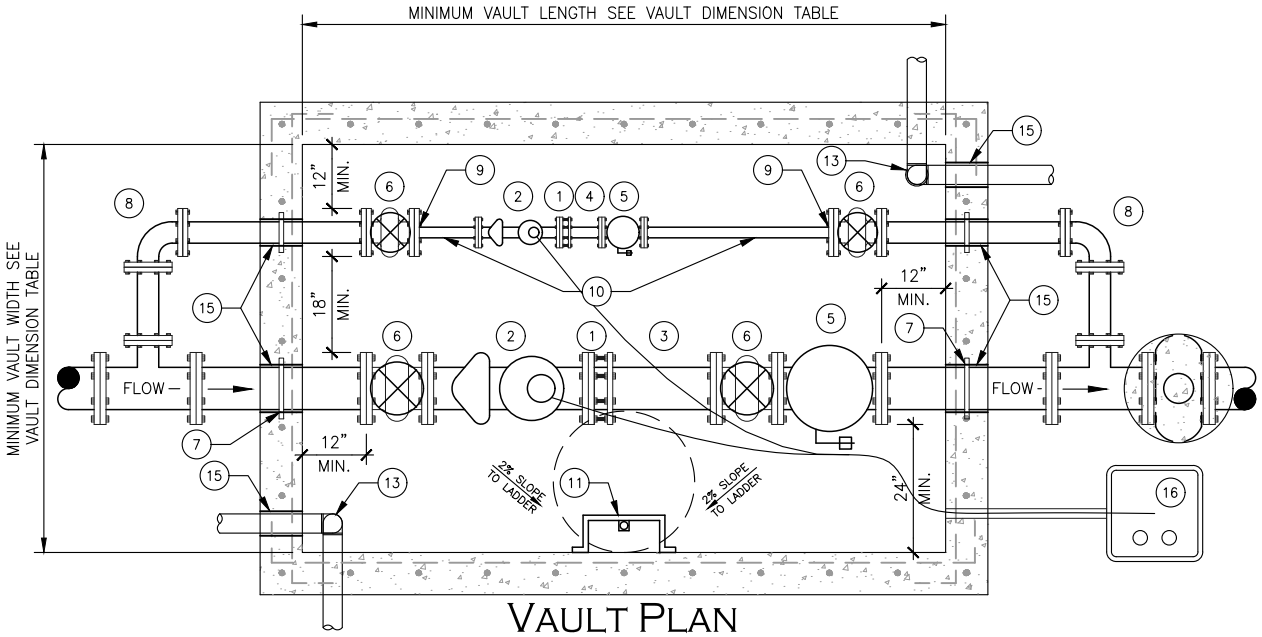
NOTE:
1. SEE PAGE 14 FOR GENERAL NOTES.
2. SEE TYPICAL TRENCH SPECIFICATIONS FOR BEDDING AND BACKFILL
3. MINIMUM TRENCH WIDTH SHALL BE EQUAL TO OUTSIDE PIPE DIAMETER PLUS 1' EACH SIDE OF PIPE.
4. IF DAMAGE IS CAUSED TO WATER MAIN, DUE TO METER INSTALLATION AND/OR OTHER MEANS, CONTRACTOR WILL BE HELD RESPONSIBLE FOR REPAIRS.
5. WATER METER SHALL BE PLACED INLINE WITH WATER SERVICE, SERVICE DEFLECTION NOT TO EXCEED 1'. WATER METER TO BE PLACED PERPENDICULAR TO WATER SERVICE IF WATER SERVICE IS RELOCATED.
6. METER BOX SHALL BE INSTALLED IN PARK STRIP, IF APPLICABLE, OR 6" TO 1' BEHIND SIDEWALK AND SET SUCH THAT THE TOP OF LID IS EQUAL TO THE SIDEWALK ELEVATION (TYPICAL).
7. WRAP ALL FITTINGS WITH WAX TAPE AND POLY–PLY WRAP PER MANUFACTURER'S SPECIFICATIONS.
8. ALL BLOCKING MUST BE REINFORCED BY SECURE GROUND.
9. 3/4"–2" METER SUPPLIED AND INSTALLED BY GHID. HOT TAP, LATERAL, METER PIT AND SETTER TO BE IFURNISHED AND INSTALLED BY OWNER. MATCH EXISTING MATERIALS WHEN DOING REPAIRS.
10. METERS SHALL NOT BE PLACED IN DRIVEWAY. IF METER NEEDS TO BE MOVED MORE THAN 2' IN EITHER DIRECTION IT SHALL BE MOVED AT THE MAIN AND OLD LATERAL ABANDONED AT THE MAIN.
11. WATER SERVICE TO BE MARKED WITH W AT CURB
12. GRANGER–HUNTER IMPROVEMENT DISTRICT DOES NOT ALLOW COPPER SETTERS WITH A BYPASS.
13. JUMPERS ARE NOT ALLOWED AND WILL BE ASSESSED A TAMPER FEE.
14. 3/4" THROUGH 2" METERS: TAPPING SADDLE, CORP. STOP AND LATERAL MUST MATCH METER SIZE.

Typical Large Meter Vault 1 of 2

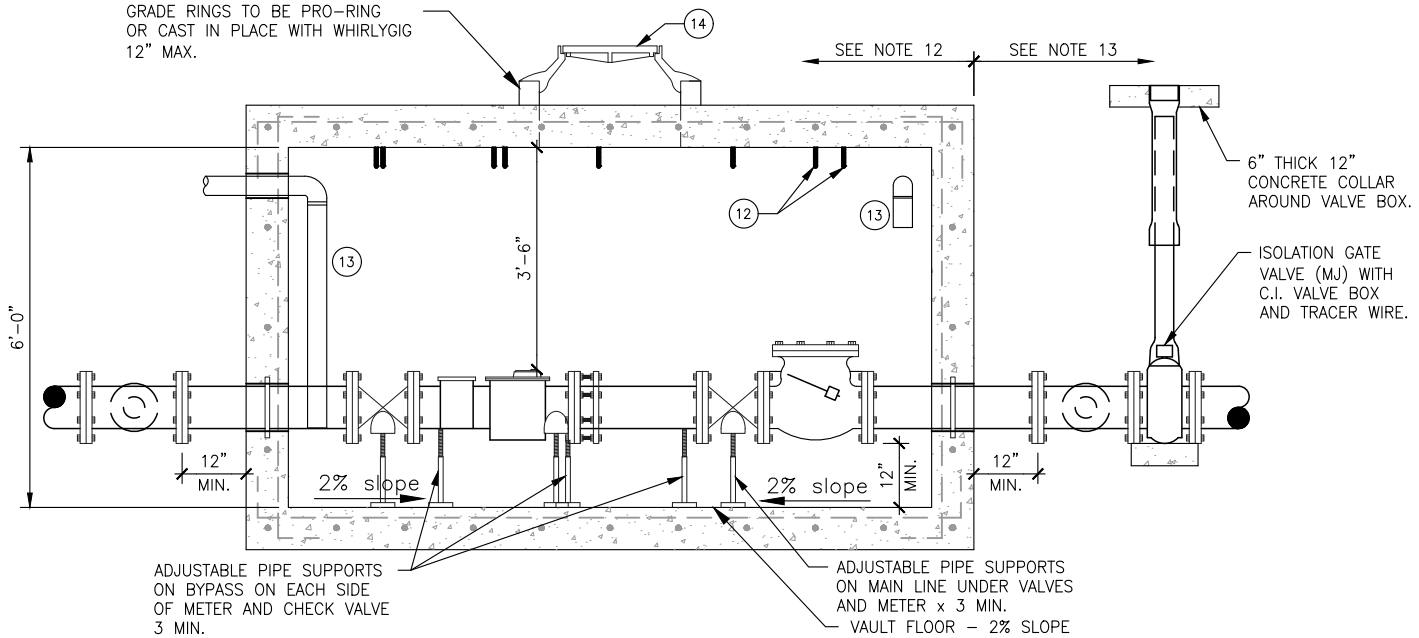
1. FLANGED COUPLING ADAPTER
2. SENSUS OMNI METER
3. FLANGED x PLAIN END PIECE. CUT TO FIT. LENGTH = 3 x PIPE DIA.
4. FLANGED x PLAIN END PIECE. CUT TO FIT. MINIMUM LENGTH 16"
5. SWING CHECK VALVE
6. GATE VALVE SEE VAULT DIMENSION TABLE FOR BYPASS VALVE SIZE
7. PIPE RESTRAINT CAST INTO WALL. ALTERNATIVES AT DISCRETION OF ENGINEER.
8. 90° BEND SEE VAULT DIMENSION TABLE FOR SIZE
9. BLIND FLANGE W/2" TAPPED HOLE SEE VAULT DIMENSION TABLE FOR SIZE
10. 2" COPPER OR BRASS ONLY
11. STAINLESS STEEL LADDER WITH EXTENSION, HALLIDAY MODEL L6B WITH L6E LADDER EXTENSION OR EQUAL
12. (8) 3/4" DIA. S.S. LIFTING EYES (TYPE 316) OVER ALL METERS AND VALVES
13. AIR VENT PIPING
14. 30" VAULT OPENING EJ 2600 SERIES 4-1/8" TALL COMPOSITE MANHOLE ASSEMBLY W/COMMLOCK LATCHES MARKED GHID WATER
15. SEAL ALL INTRUSIONS WITH NON-SHRINK GROUT
16. 12"x12" IRRIGATION BOX W/1 3/4" HOLE FOR TOUCHREAD SENSOR. PLACE BOX IN LANDSCAPING DRILL (2) 2" HOLES IN VAULT TO RUN WIRE THROUGH. RUN 1 1/2" CONDUIT FROM VAULT TO SENSOR BOX. CONDUIT TO BE SEALED WITH SPRAY FOAM BY GHID AFTER SENSOR IS INSTALLED

VAULT DIMENSION TABLE				
METER SIZE	MIN. LENGTH	MIN. WIDTH	*MIN. WIDTH	BYPASS FITTINGS
3"	6'-0"	6'-6"	5'-0"	3"
4"	7'-6"	6'-6"	5'-0"	4"
6"	9'-0"	7'-0"	5'-0"	4"
8"	11'-0"	7'-6"	6'-0"	4"
10"	13'-0"	7'-6"	6"-0"	4"

*MINIMUM WIDTH LANDSCAPE METER W/O BYPASS

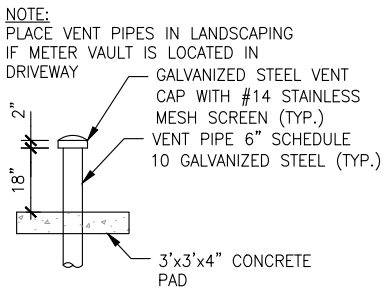


VAULT PLAN



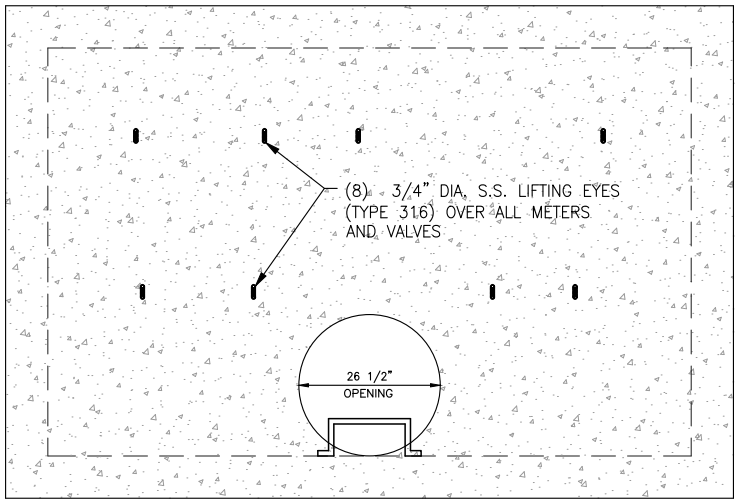
VAULT PROFILE

Typical Large Meter Vault 2 of 2



VENT DETAIL

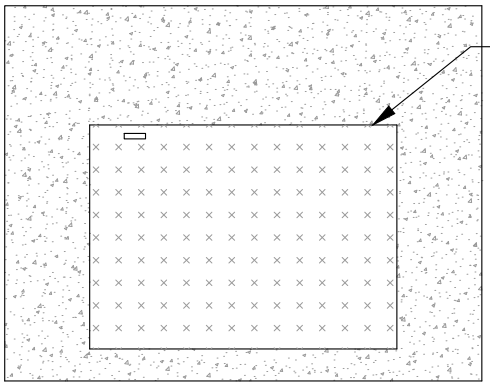
NOTE:
1. SEE PAGE 14 FOR GENERAL NOTES.
2. METER TO BE PROVIDED BY GHID.
3. ALL MANHOLES SHALL HAVE A 6" THICK CONCRETE COLLAR PER A.P.W.A. PLAN 362.
4. VAULT BACKFILL SHALL BE COMPACTED TO 95% MINIMUM ASTM D-1557.
5. IF DAMAGE IS CAUSED TO WATER MAIN, DUE TO VAULT INSTALLATION AND/OR OTHER MEANS, CONTRACTOR WILL BE HELD RESPONSIBLE FOR REPAIRS.
6. NO MORE THAN ONE GRADE RING (1' MAX.) ALLOWED PER LID AND COLLAR.
7. ALL FLANGED x PLAIN END SPOOLS TO BE PRE-CAST INTO VAULT WALLS BY VAULT MANUFACTURER.
8. WRAP ALL EXTERNAL DUCTILE IRON PIPE & FITTINGS WITH WAX TAPE AND POLY-PLY WRAP PER MANUFACTURER'S SPECIFICATIONS.
9. VAULT SHALL BE SUITABLE FOR H-20 LOADINGS.
10. BYPASS SHALL BE 2".
11. GHID OWNS, MAINTAINS, AND REPAIRS CULINARY WATER SERVICE TO THE BACK OF THE METER VAULT.
12. CULINARY WATER SERVICE OWNED, MAINTAINED AND REPAIRED BY PROPERTY OWNER.
13. VAULT TO BE ENGINEERED AND STAMPED BY A PROFESSIONAL ENGINEER LICENSED IN THE STATE OF UTAH. STAMPED DRAWINGS TO BE PROVIDED TO THE DISTRICT.
14. BEDDING FOR VAULT TO BE 1" MINUS GRAVEL 12" THICK.
15. PIPE ASSEMBLY TO BE PREPARED PAINTED PRE ASSEMBLED & CAST INTO BOX. DI PIPES AND FITTINGS INSIDE VAULT TO BE PAINTED WITH EPOXY PAINT SW4086 SAFETY BLUE OR EQUIVALENT.
16. 10" AND LARGER METERS REQUIRE AN ADDITIONAL ADJUSTABLE PIPE SUPPORT ON THE SPOOL PIECE ON THE MAIN LINE.
17. 3" METERS: INSTALL 4" TAPPING SADDLE, 4 INCH GATE VALVE AND 4x3 REDUCER. TAP AND LATERAL TO BE 3" MAX.
    4" AND LARGER METERS: TAPPING SADDLE, GATE VALVE AND LATERAL MUST MATCH METER SIZE.
18. GHID SHALL NOT BE RESPONSIBLE FOR REPLACING CONCRETE, TREES OR STRUCTURES PLACED WITHIN 5' OF METER VAULT.
19. ALL VAULT FITTINGS TO BE DUCTILE IRON.
20. VALVES INSIDE VAULT SHALL HAVE HAND WHEELS
21. FOR 3" METERS VAULTS VALVE ON CUSTOMER SIDE SHALL BE 4" MINIMUM INCREASER TO BE PLACED ON CUSTOMER SIDE OF TEE.



ROOF PLAN

Typical Double Check Detector Assembly

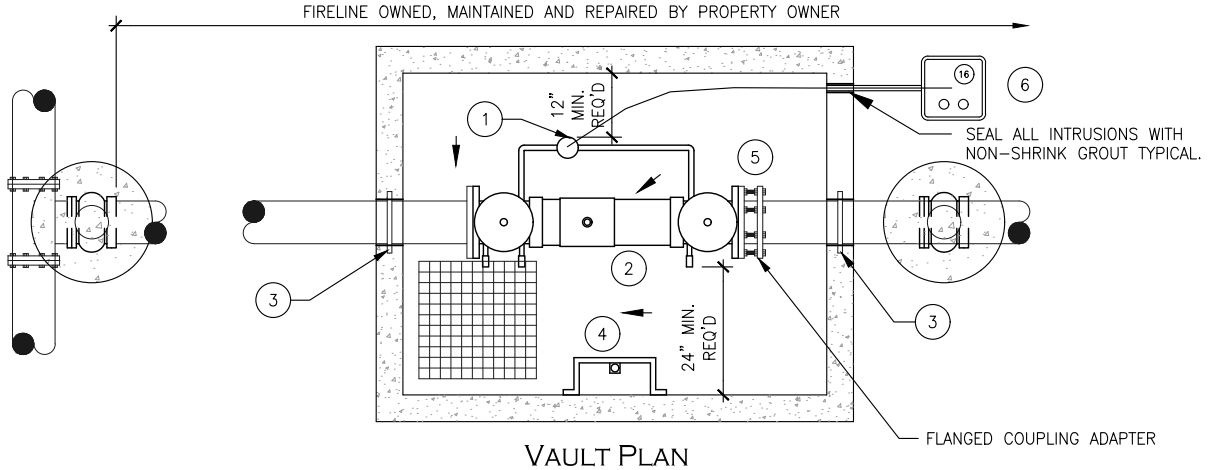
1. 3/4" METER PROVIDED, OWNED, MAINTAINED AND REPAIRED BY DISTRICT
2. DOUBLE CHECK DETECTOR ASSEMBLY PROVIDED, OWNED, MAINTAINED AND REPAIRED BY OWNER
3. MEGA LUG CAST INTO WALL OR EPOXY COATED GALVANIZED STEEL PLATE BOLTED ON OUTSIDE OF BOX W/MEGA LUG. REQ'D
4. ALUMINUM LADDER WITH EXTENSION, HALLIDAY MODEL L1B WITH L1E OR EQUAL RECOMMENDED, NOT REQUIRED
5. FLANGED COUPLING ADAPTER REQ'D
6. 12"x12" IRRIGATION BOX W/1 3/4" HOLE FOR TOUCHREAD SENSOR. PLACE BOX IN LANDSCAPING DRILL (2) 2" HOLES IN VAULT TO RUN WIRE THROUGH. RUN 1 1/2" CONDUIT FROM VAULT TO SENSOR BOX. CONDUIT TO BE SEALED WITH SPRAY FOAM BY GHID AFTER SENSOR IS INSTALLED.
7. SUMP RECOMMENDED IN AREAS WITH HIGH GROUND WATER.



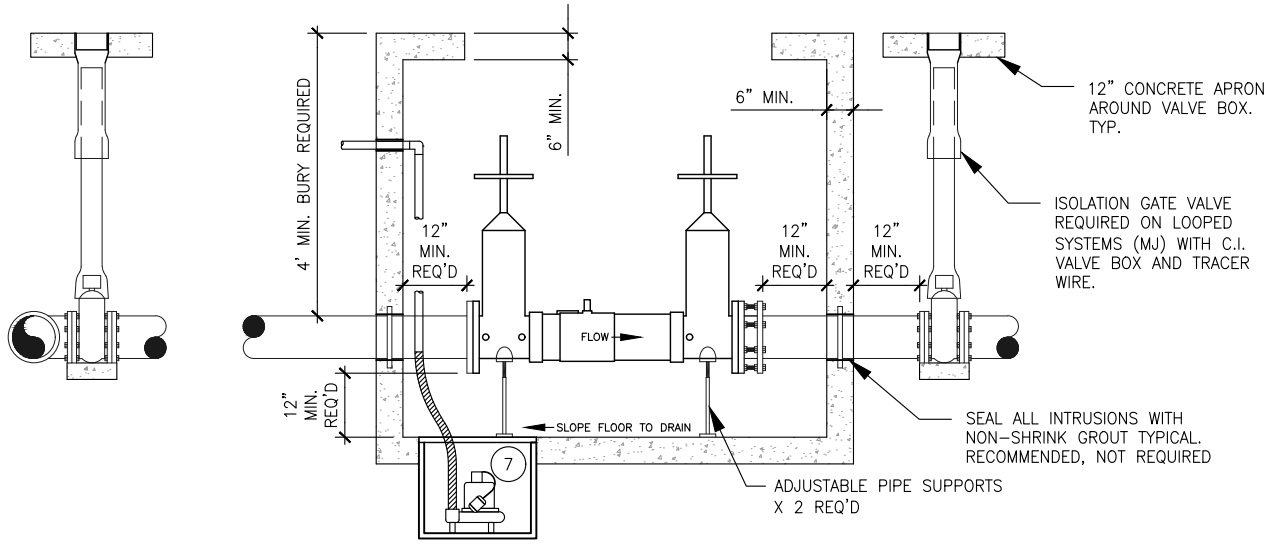
VAULT DIMENSION TABLE		
BACKFLOW SIZE	MIN. LENGTH	MIN. WIDTH
6"	78"	54"
8"	96"	58"
10"	98"	58"
12"	100"	58"

DIMENSIONS BASED ON WILKINS MODEL 350DA

ROOF PLAN



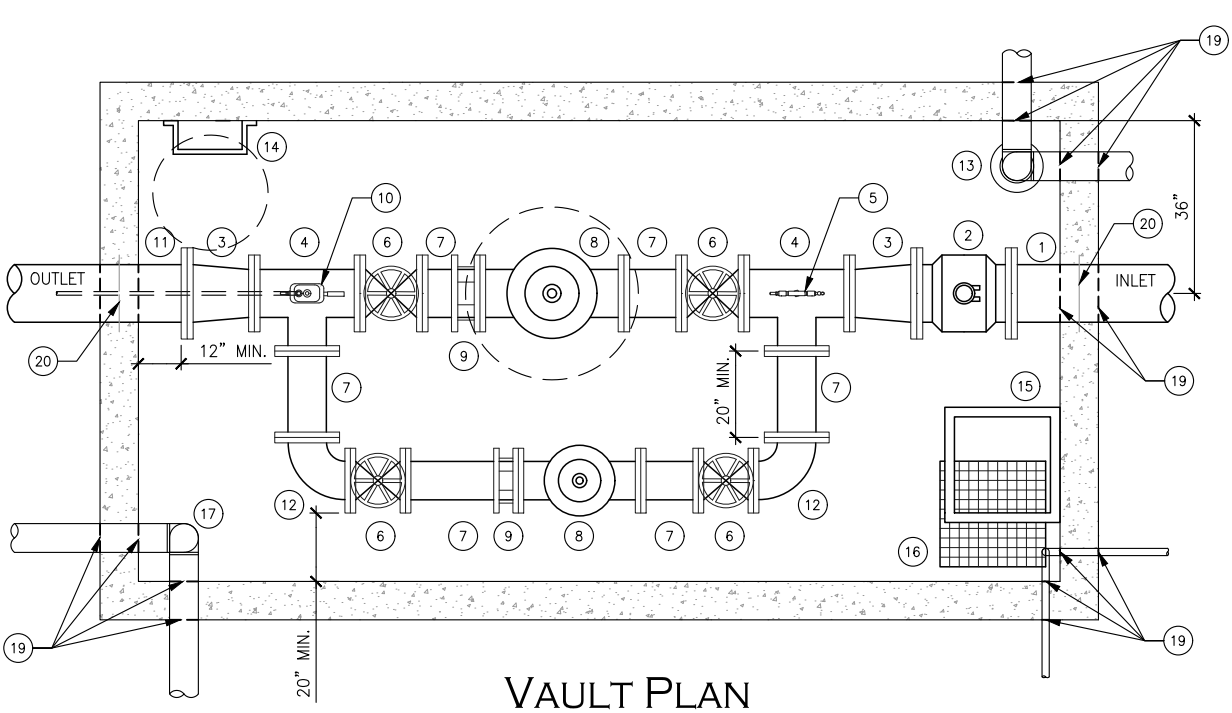
VAULT PLAN



VAULT PROFILE

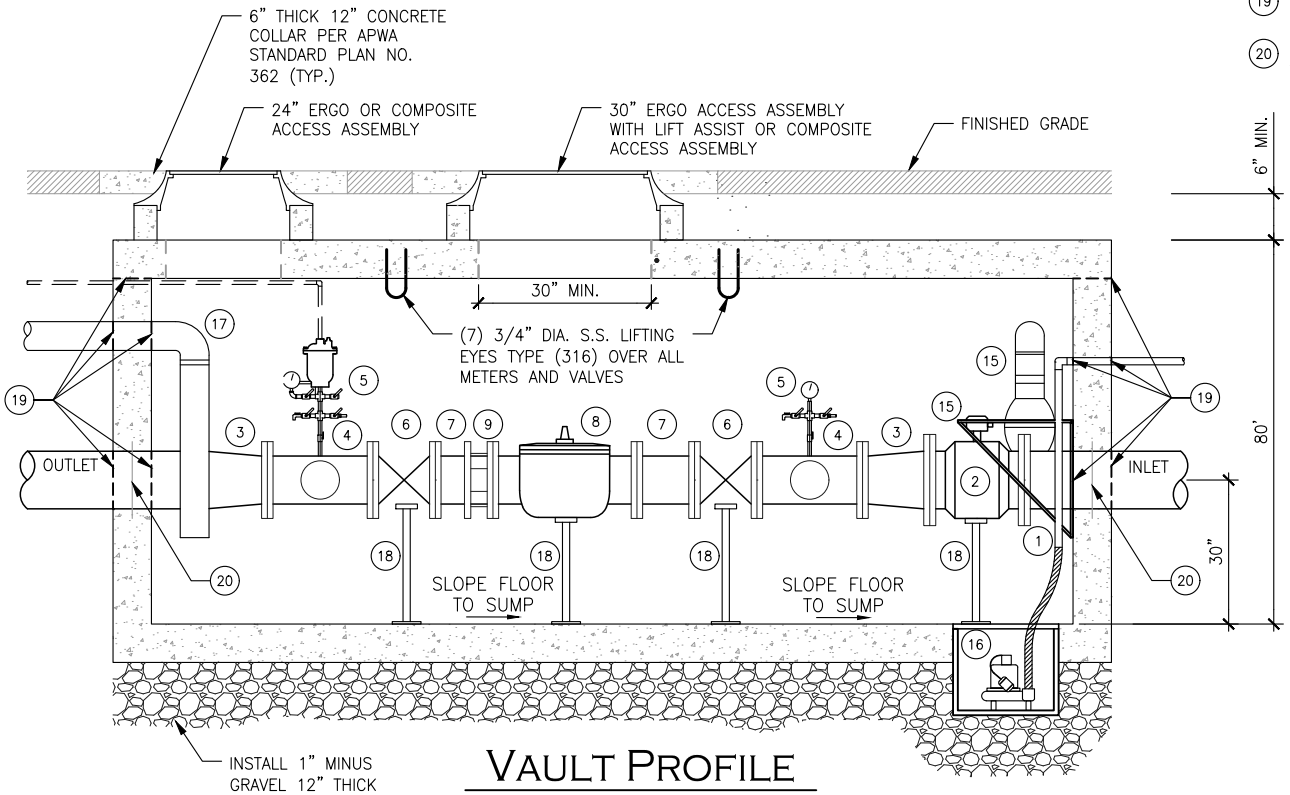
NOTES:
1. SEE PAGE 14 FOR GENERAL NOTES.
2. VAULT AND PIPE BEDDING SHALL BE COMPACTED TO 95% MINIMUM ASTM D-1557.
3. ALL FLANGED x PLAIN END SPOOLS TO BE PRE-CAST INTO VAULT WALLS BY VAULT MANUFACTURER.
4. OWNER SHALL AVOID PLACING VAULT IN TRAFFIC AREAS IF POSSIBLE.
5. **VAULTS IN TRAFFIC AREAS SHALL BE SUITABLE FOR H-20 LOADINGS.**
6. **VAULT TO BE ENGINEERED BY LICENSED STRUCTURAL ENGINEER, DRAWINGS TO BE PROVIDED TO GHID.**
7. WRAP ALL EXTERNAL DUCTILE IRON PIPE & FITTINGS WITH WAX TAPE AND POLY-PLY WRAP PER MANUFACTURER'S SPECIFICATIONS.
7. GHID OWNS, THE MAINLINE VALVE AND THE METER EVERYTHING ELSE TO BE OWNED, MAINTAINED AND REPAIRED BY PROPERTY OWNER.
8. BEDDING FOR VAULT TO BE 1" MINUS GRAVEL 12" THICK.
9. PIPE ASSEMBLY TO BE PREPARED PAINTED PRE ASSEMBLED & CAST INTO BOX. DI PIPES AND FITTINGS INSIDE VAULT TO BE PAINTED WITH EPOXY PAINT SW4086 SAFETY BLUE OR EQUIVALENT , RECOMENDED, NOT REQUIRED
10. BACKFLOW ASSEMBLY MAY ALSO BE PLACED IN A HEATED ABOVE GROUND ENCLOSURE.
11. IF OWNER OPTS TO USE A MANHOLE INSTEAD OF A HATCH, VAULT LID MAY NEED TO BE REMOVED TO REPLACE BACKFLOW ASSEMBLY.
12. BACKFLOW MAY FAIL TESTS IF IT IS SUBMERGED.

Typical Pressure Reducing Valve



VAULT PLAN

1. INLET PIPE
2. METER
3. REDUCER
4. TEE
5. GAUGE TREE
6. GATE VALVE
7. SPOOL
8. PRESSURE REDUCING VALVE
9. DRESSER COUPLING
10. GUAGE TREE
11. OUTLET PIPE
12. 90° BEND
13. VENTILATOR
14. STAINLESS STEEL LADDER WITH EXTENSION. HALLIDAY MODEL L6B WITH L6E LADDER EXTENSION OR EQUAL.
15. DEHUMIDIFIER AND BRACKETS
16. SUMP AND PUMP
17. AIR PIPING
18. ADJUSTABLE PIPE SUPPORTS UNDER VALVES AND METER X 7 MIN.
19. SEAL ALL INTRUSIONS WITH NON-SHRINK GROUT
20. PIPE RESTRAINT CAST INTO WALL. ALTERNATIVES AT DISCRETION OF ENGINEER

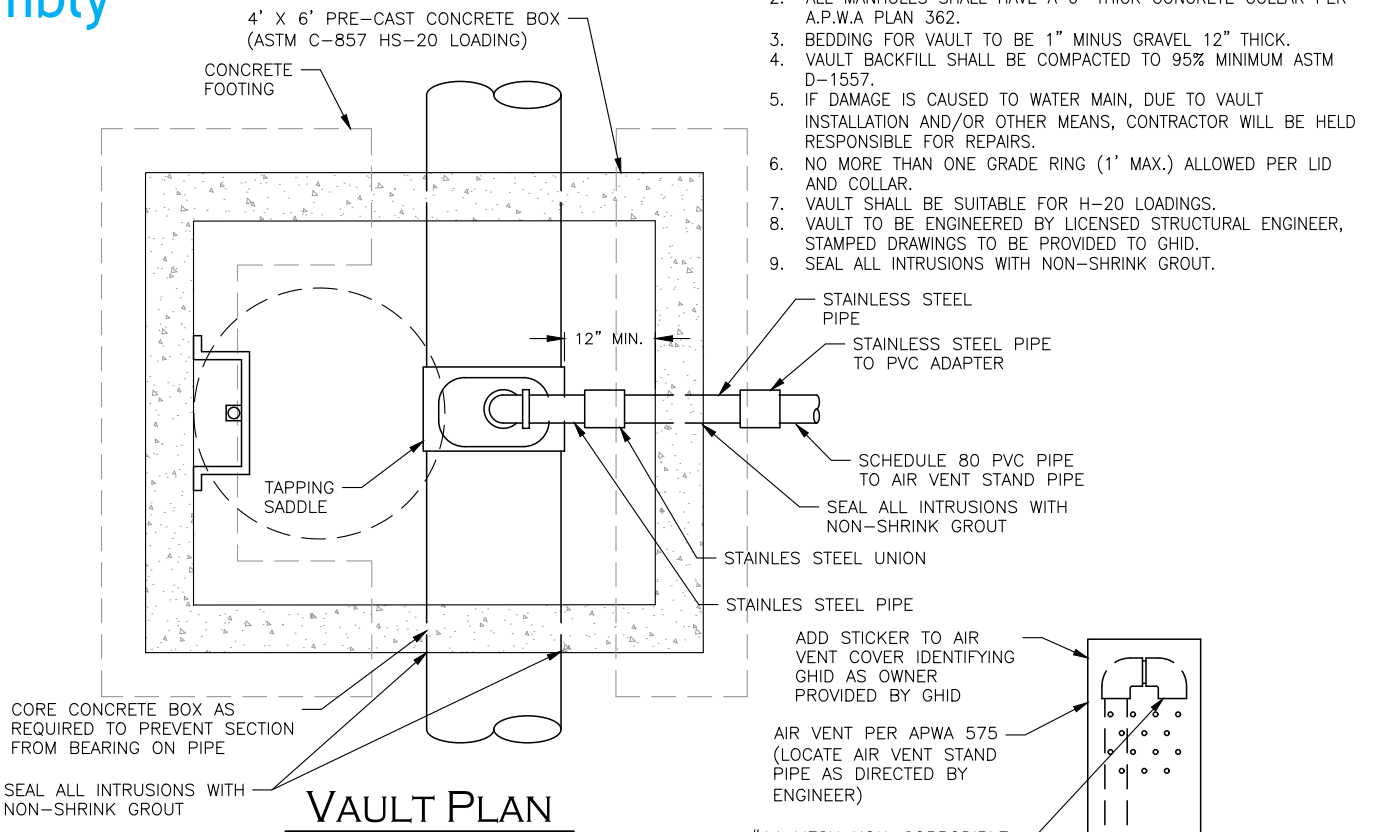


VAULT PROFILE

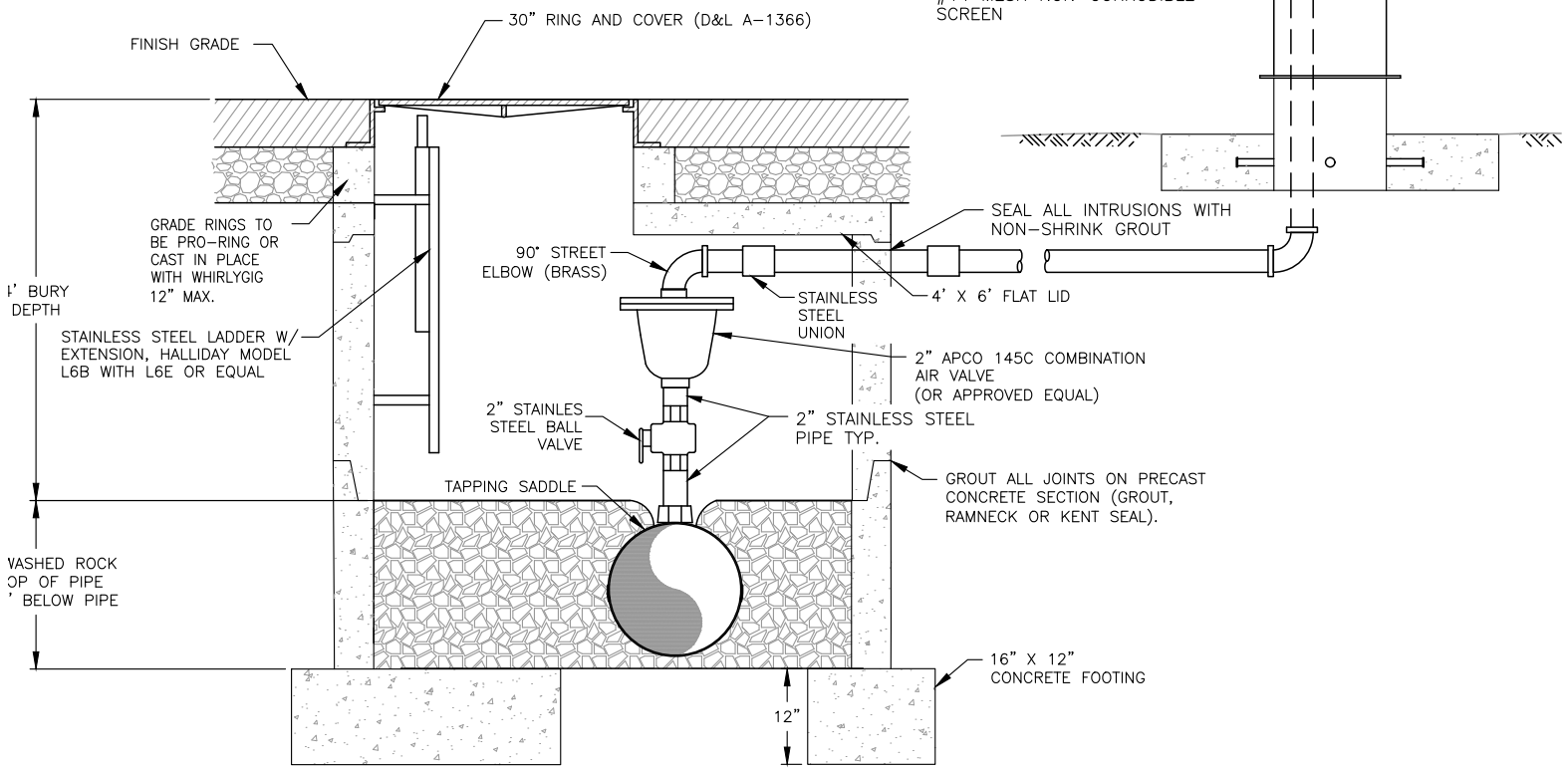
NOTE:
1. PIPE ASSEMBLY TO BE PREPARED, PAINTED, PRE ASSEMBLED, & CAST INTO BOX. DI PIPES AND FITTINGS INSIDE VAULT TO BE PAINTED WITH EPOXY PAINT SW4086 SAFETY BLUE OR EQUIVALENT
2. WRAP ALL EXTERNAL DUCTILE IRON PIPE & FITTINGS WITH WAX TAPE AND POLY-PLY WRAP PER MANUFACTURER'S SPECIFICATIONS.

Typical Air/Vacuum Release Assembly

NOTE:
1. SEE PAGE 14 FOR GENERAL NOTES.
2. ALL MANHOLES SHALL HAVE A 6" THICK CONCRETE COLLAR PER A.P.W.A PLAN 362.
3. BEDDING FOR VAULT TO BE 1" MINUS GRAVEL 12" THICK.
4. VAULT BACKFILL SHALL BE COMPACTED TO 95% MINIMUM ASTM D-1557.
5. IF DAMAGE IS CAUSED TO WATER MAIN, DUE TO VAULT INSTALLATION AND/OR OTHER MEANS, CONTRACTOR WILL BE HELD RESPONSIBLE FOR REPAIRS.
6. NO MORE THAN ONE GRADE RING (1' MAX.) ALLOWED PER LID AND COLLAR.
7. VAULT SHALL BE SUITABLE FOR H-20 LOADINGS.
8. VAULT TO BE ENGINEERED BY LICENSED STRUCTURAL ENGINEER, STAMPED DRAWINGS TO BE PROVIDED TO GHID.
9. SEAL ALL INTRUSIONS WITH NON-SHRINK GROUT.

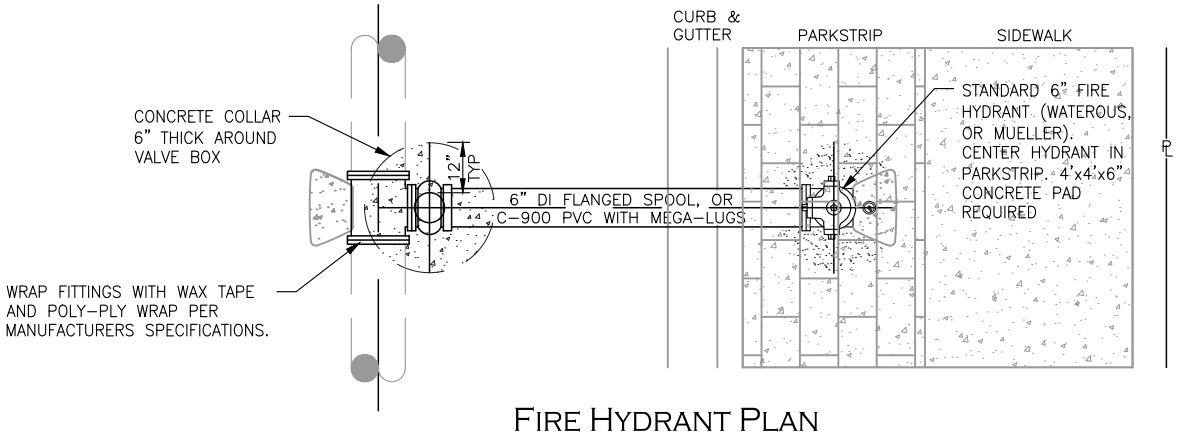


VAULT PLAN

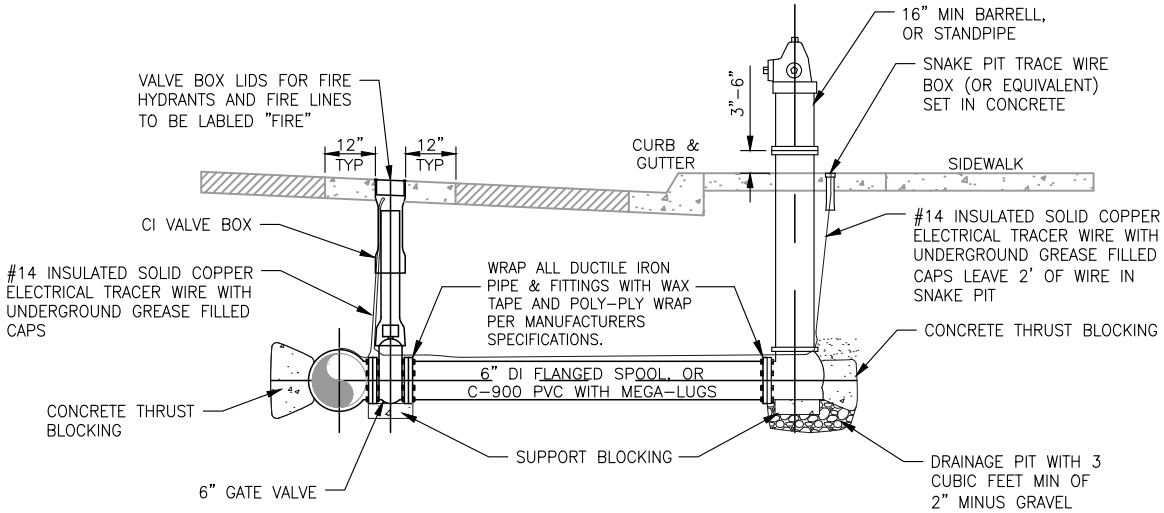


VAULT PROFILE

Typical Fire Hydrant



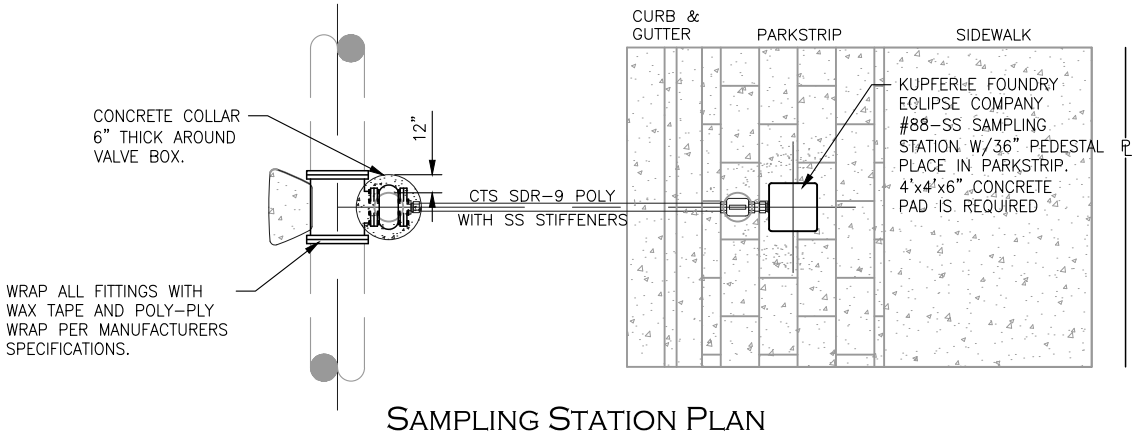
FIRE HYDRANT PLAN



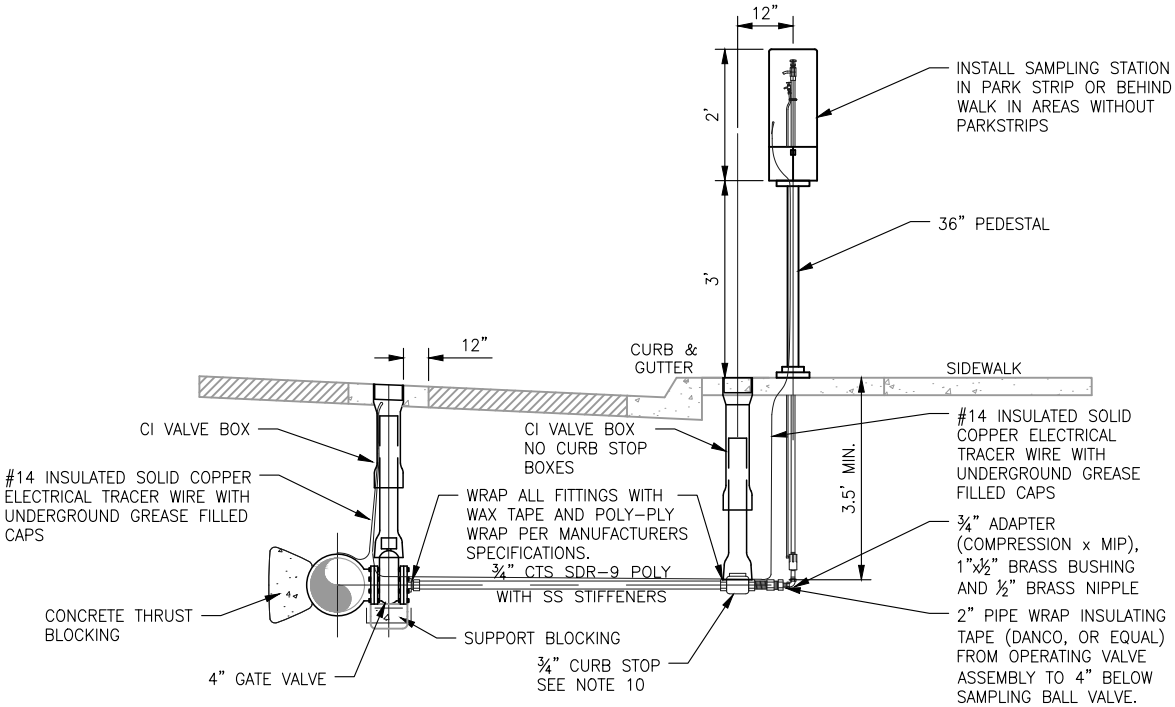
FIRE HYDRANT PROFILE

NOTE:
1. SEE PAGE 14 FOR GENERAL NOTES
2. SEE TYPICAL TRENCH SPECIFICATIONS FOR BEDDING AND BACKFILL
3. MINIMUM TRENCH WIDTH SHALL BE EQUAL TO OUTSIDE PIPE DIAMETER PLUS 1' EACH SIDE OF PIPE. SEE TYPICAL TRENCH SPECIFICATIONS.
4. IF DAMAGE IS CAUSED TO WATER MAIN, DUE TO FIRE HYDRANT INSTALLATION AND/OR OTHER MEANS, CONTRACTOR WILL BE HELD RESPONSIBLE FOR REPAIRS.
5. FIRE HYDRANT SHALL BE SET SUCH THAT THE BARREL, OR STANDPIPE, FLANGE IS 3" TO 6" ABOVE FINISH GRADE.
6. WRAP ALL DUCTILE IRON PIPE & FITTINGS WITH WAX TAPE AND POLY-PLY WRAP PER MANUFACTURER'S SPECIFICATIONS.
7. DRAINAGE PIT MUST HAVE 3 CUBIC FEET (MINIMUM) OF 3/4" MINUS GRAVEL.
8. ALL THRUST BLOCKING MUST BE REINFORCED BY A UNDISTURBED GROUND. SEE TYPICAL THRUST BLOCKING DETAIL.

Typical Sampling Station



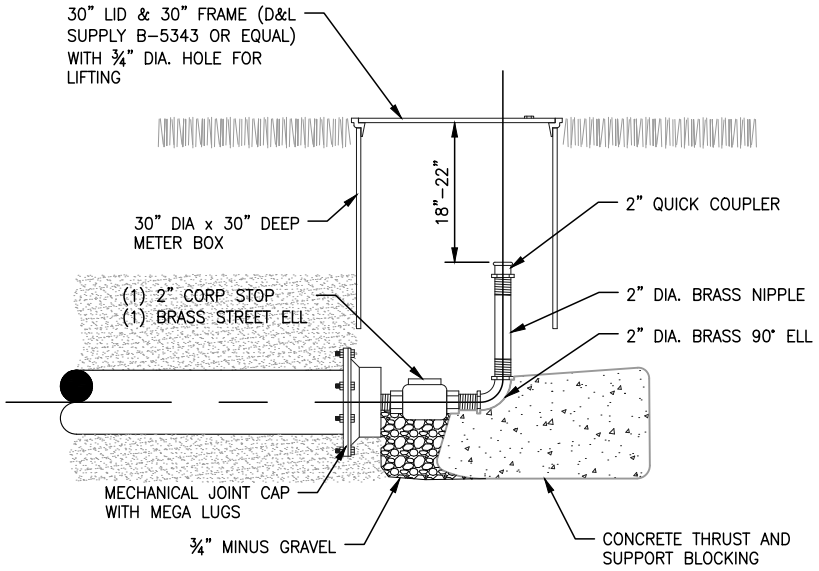
SAMPLING STATION PLAN



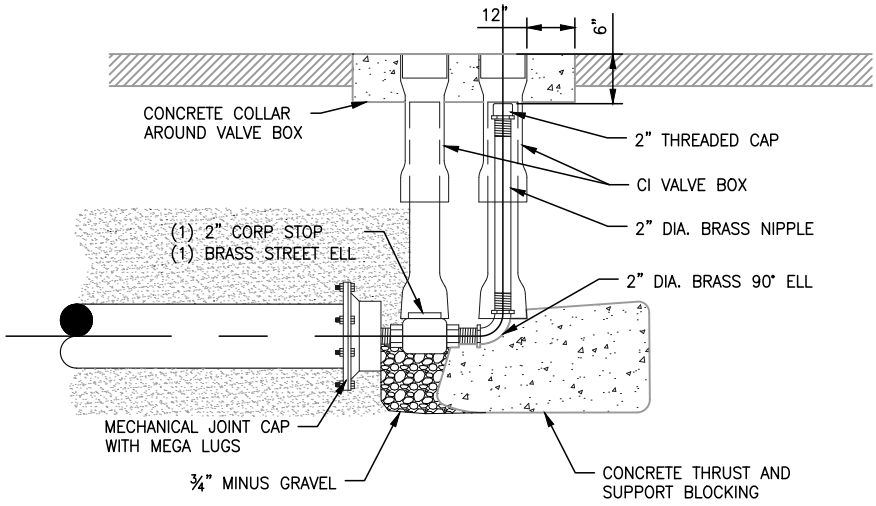
SAMPLING STATION PROFILE

NOTE:
1. SEE PAGE 14 FOR GENERAL NOTES
2. SEE TYPICAL TRENCH SPECIFICATIONS FOR BEDDING AND BACKFILL.
3. IF DAMAGE IS CAUSED TO MAIN LINE, DUE TO SAMPLING STATION INSTALLATION AND/OR OTHER MEANS, CONTRACTOR WILL BE HELD RESPONSIBLE FOR REPAIRS.
4. TYPE OF PIPE SHALL BE CTS POLYETHYLENE WITH COMPRESSION FITTINGS, SS STIFFENERS, AND #14 INSULATED SOLID COPPER ELECTRICAL TRACER WIRE WITH UNDERGROUND GREASE FILLED CAPS.
5. SAMPLING STATION FINISH GRADE SHALL BE SET ACCORDING TO MANUFACTURER SPECIFICATIONS.
6. WRAP ALL FITTINGS WITH WAX TAPE AND POLY-PLY WRAP PER MANUFACTURER'S SPECIFICATIONS.
7. 2" PIPE WRAP INSULATING TAPE (DANCO, OR EQUAL) FROM OPERATING VALVE ASSEMBLY TO 4" BELOW SAMPLING BALL VALVE.
8. ALL THRUST BLOCKING SHALL BE REINFORCED BY A UNDISTURBED GROUND. SEE TYPICAL THRUST BLOCKING DETAIL.
9. SAMPLING STATION SHALL BE INSTALLED IN PARK STRIP, IF APPLICABLE, OR 6" TO 1' BEHIND SIDEWALK.
10. CURB STOP REQUIRED ON ALL STREETS THAT WOULD TYPICALLY BE STRIPED.

Typical 2" Blow-Off



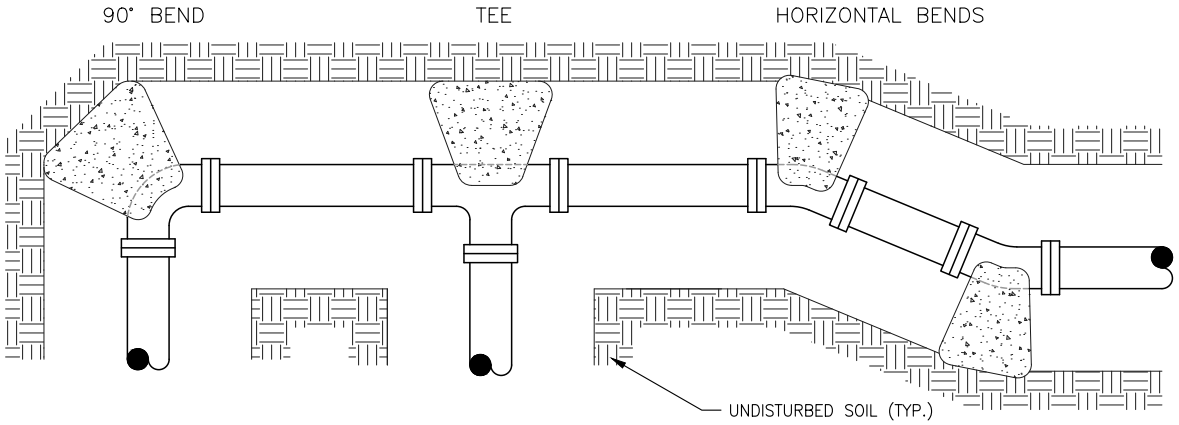
BLOW OFF IN LANDSCAPING

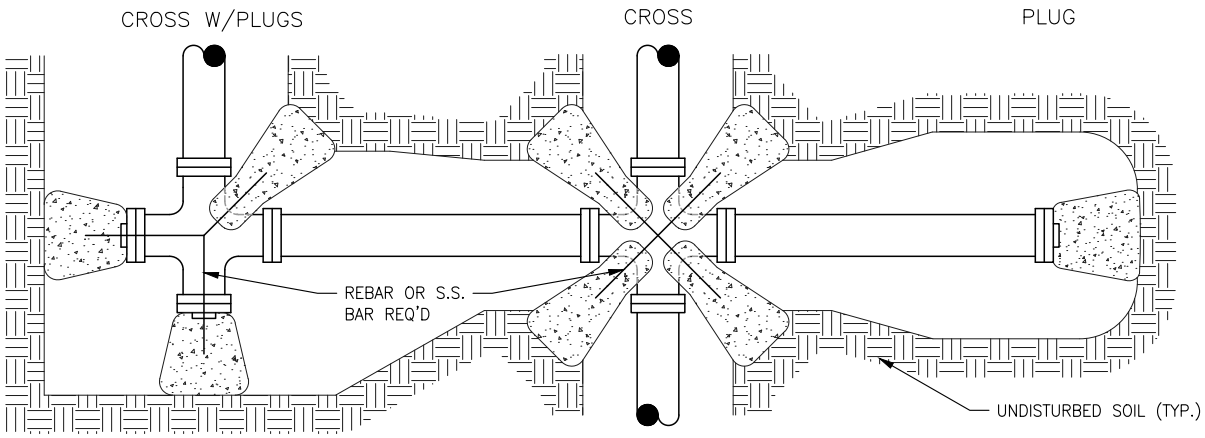


BLOW OFF IN ROADWAY

NOTE:
1. SEE PAGE 14 FOR GENERAL NOTES
2. BLOW OFF PIPE SHALL BE 2" SDR 9 POLY OR COPPER WITH ALL BRASS FITTINGS. GALVANIZED PIPE WILL NOT BE PERMITTED.
3. BLOW-OFF ASSEMBLY SHALL BE INSTALLED AS SHOWN OR OTHERWISE APPROVED BY GHID.
4. WRAP ALL FITTINGS WITH WAX TAPE AND POLY-PLY WRAP PER MANUFACTURER'S SPECIFICATIONS.
5. ALL BLOCKING MUST BE REINFORCED BY UNDISTURBED GROUND. SEE TYPICAL THRUST BLOCKING DETAIL.

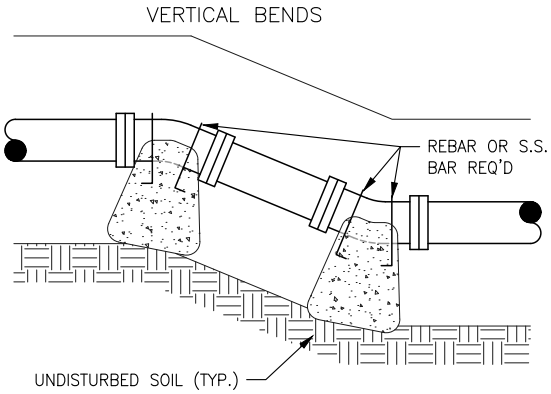
Typical Thrust Blocking Detail

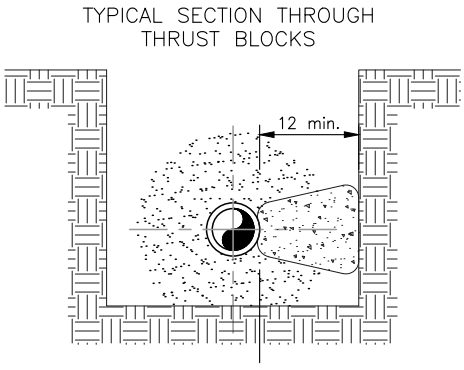




SIZE OF PIPE	MINIMUM BEARING AREA IN SQ. FT.				
	TEES, VALVES DEAD ENDS	90° BENDS	45° BENDS	22 1/2° BENDS	11 1/4° BENDS
4"	2	3	2	2	2
6"	4	5.5	3	2.5	2
8"	6.5	9.5	5	2.75	2.5
12"	14	20	11	5.5	3
14"	19	26.5	14.5	7.5	4
16"	24	34	18.5	9.5	6
20"	27	52	28.5	14.5	9
24"	53	74	41	21	12
30"	81	114	62	32	16

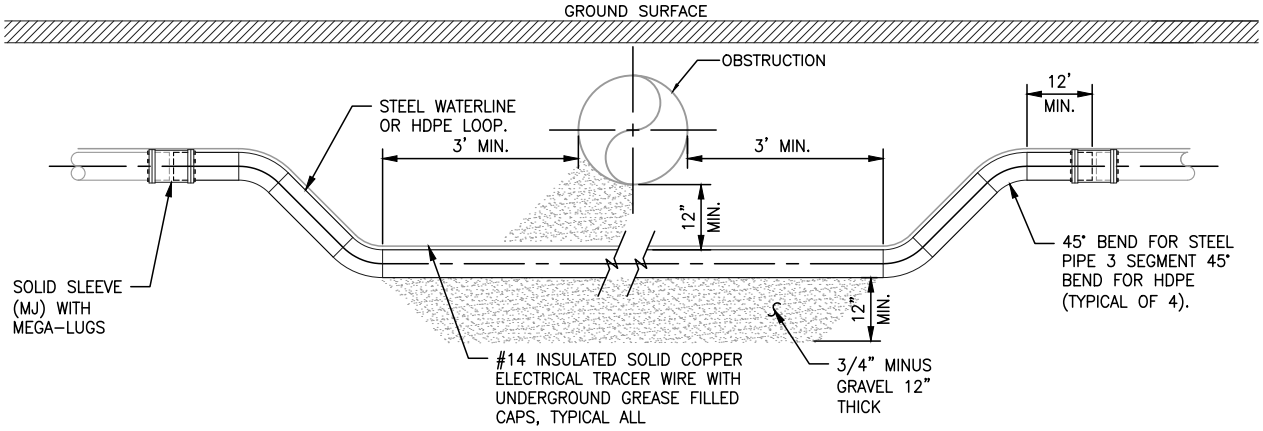
PER APWA PLAN 561





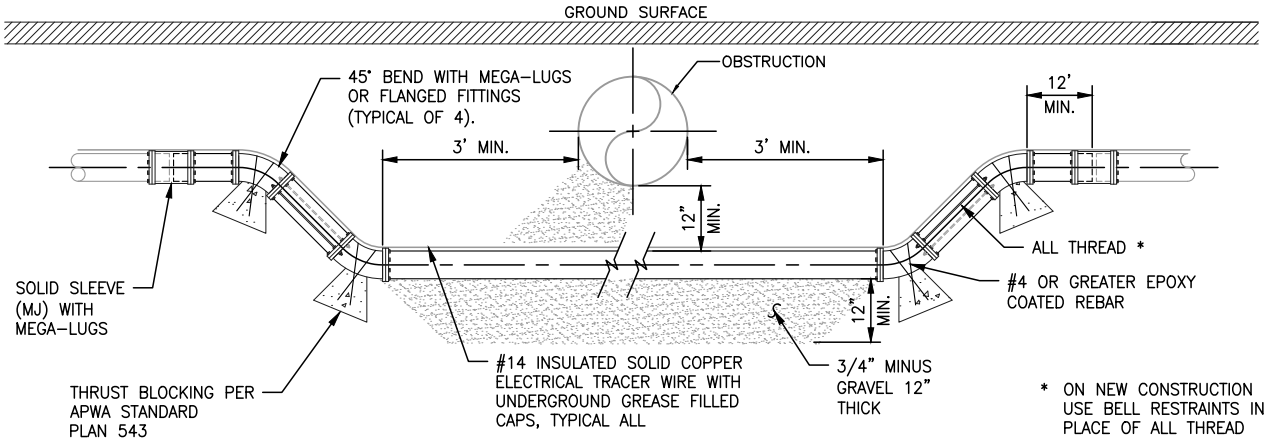
NOTE:
1. ALL REBAR MUST BE #4 (MINIMUM) AND EPOXY COATED
2. 3/8" (MINIMUM) STAINLESS STEEL BAR IS ACCEPTED IN PLACE OF REBAR.
3 ALL THRUST BLOCK BEARING FACES SHALL BE POURED AGAINST UNDISTURBED SOIL, OR AN APPROVED COMPACTED BACKFILL
4. CONCRETE USED FOR THRUST BLOCKING SHALL BE CLASS 6.0–B–3000.
5. ALL THRUST BLOCK SIDES SHALL BE FORMED

Typical Waterline Loops



PRE-FABRICATED LOOP

GHID STANDARD LOOP

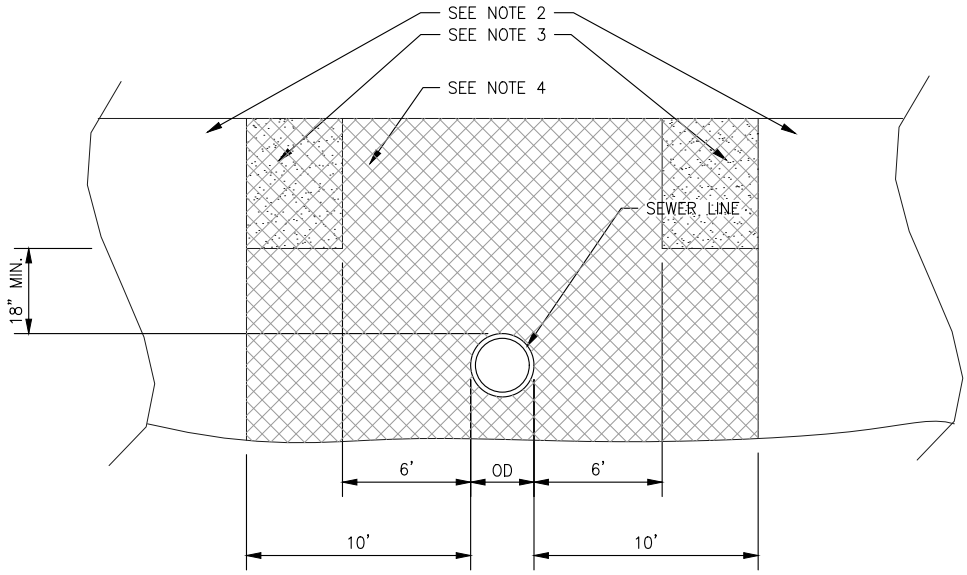


FIELD FABRICATED WATERLINE LOOP

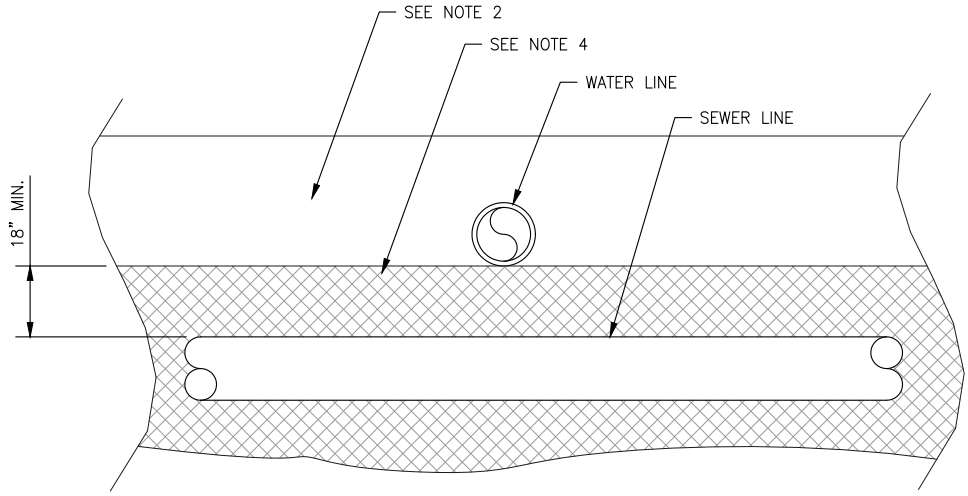
MAY BE USED AT DISCRETION OF DISTRICT ENGINEER

NOTE:
1. SEE PAGE 14 FOR GENERAL NOTES.
2. SEE TYPICAL TRENCH SPECIFICATIONS FOR BEDDING AND BACKFILL.
3. MINIMUM TRENCH WIDTH SHALL BE EQUAL TO OUTSIDE PIPE DIAMETER PLUS 1' EACH SIDE OF PIPE. SEE TYPICAL TRENCH SPECIFICATIONS.
4. IF DAMAGE IS CAUSED TO WATER MAIN CONTRACTOR WILL BE HELD RESPONSIBLE FOR REPAIRS.
5. PRE-FAB WATERLINE PIPE AND FITTINGS SHALL BE BUTT WELDED A53 GRADE B SCH. 80 STEEL FOR PIPES LESS THAN 12" DIAMETER AND SCH. 40 FOR PIPE GREATER THAN 12" DIAMETER, OR HDPE DR-9 UNLESS OTHERWISE SPECIFIED BY GHID. ALL PIPE SHALL HAVE #14 INSULATED SOLID COPPER ELECTRICAL TRACER WIRE WITH UNDERGROUND GREASE FILLED CAPS.
6. REFER TO AWWA C210 FOR EPOXY COATING OR AWWA C214 FOR TAPE COATING DETAILS
7. WRAP ALL FITTINGS WITH WAX TAPE AND POLY-PLY WRAP PER MANUFACTURER'S SPECIFICATIONS. SEE TYPICAL THRUST BLOCKING DETAILS
8. ALL THRUST BLOCKING MUST BE REINFORCED BY UNDISTURBED GROUND.
9. FOR CANAL OR RIVER CROSSINGS, A MINIMUM OF 2' OF VERTICAL SEPARATION IS REQUIRED. FOR CROSSINGS GREATER THAN 15', RESTRAINED JOINTS SHALL BE USED UNDER THE WATERWAY AND FLEXIBLE RESTRAINED JOINTS USED AT BOTH EDGES, ISOLATING VALVES SHALL BE PROVIDED AT BOTH ENDS OF CROSSING, A SAMPLE TAP SHALL BE INSTALLED OUTSIDE THE FLOOD AREA TO ENABLE TESTING OF THE SECTION, AND PRESSURE TESTING MUST BE COMPLETED ON THE SECTION PRIOR TO PLACING IT INTO SERVICE.
10. FOR HDPE LOOPS MATCH INTERNAL DIAMETERS TO HOST PIPE.

Typical Conflict Resolution



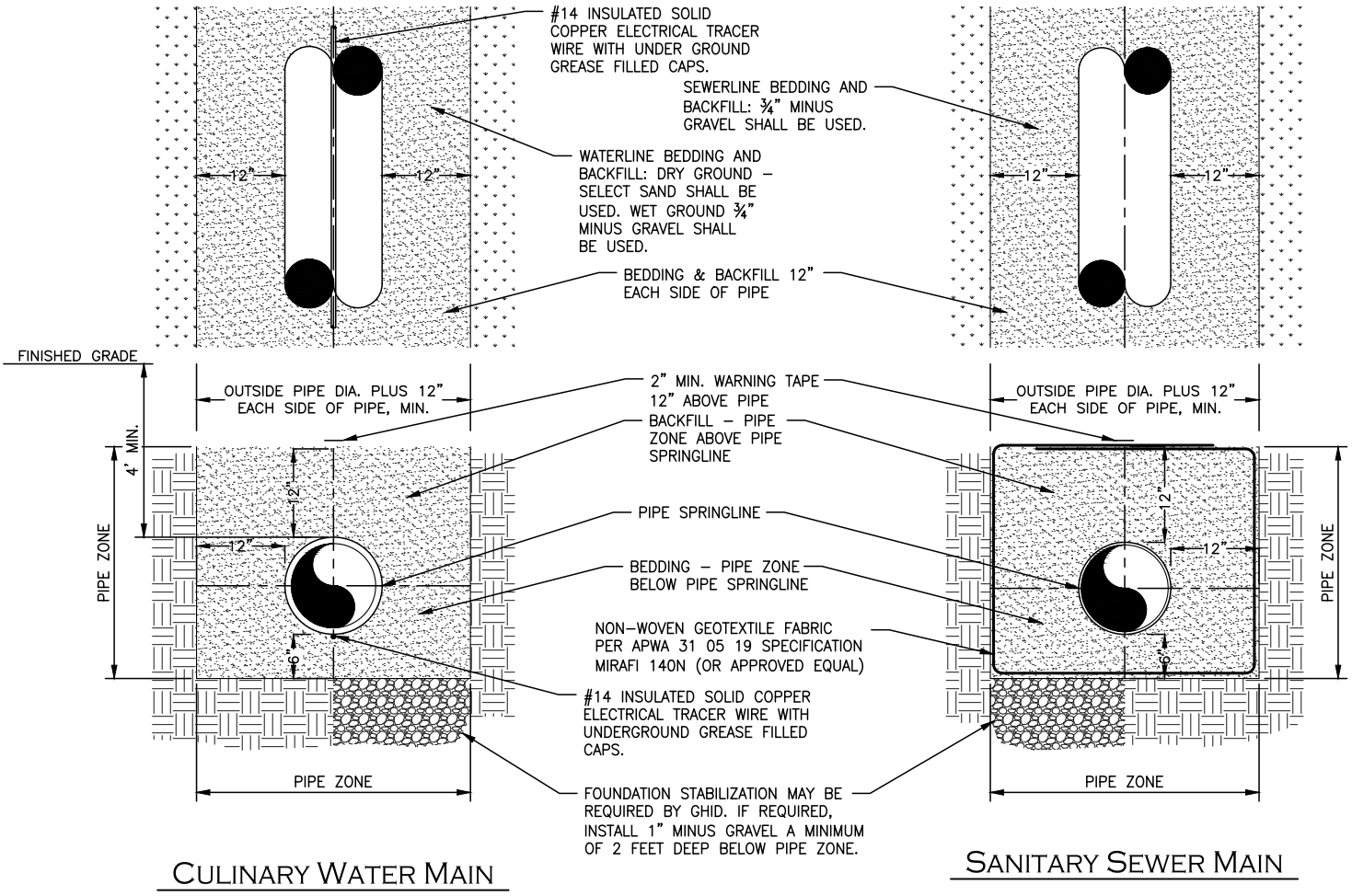
PARALLEL PIPES



CROSSING PIPES

NOTE:
1. SEE PAGE 14 FOR GENERAL NOTES.
2. MEETS BASIC SEPARATION STANDARDS.
3. MUST APPLY FOR A VARIANCE PER R309-550-7
4. MUST APPLY FOR EXCEPTION PER R309-105-6(2)(b)
5. WATER MAINS AND SEWER LINES SHALL NOT BE INSTALLED IN THE SAME TRENCH.
6. IF SEWER IS FORCE MAIN, SEWER SHALL BE ENCASED IN A CONTINUOUS SLEEVE WITHIN 10' OF WATERLINE
7. IF WATER MAIN IS OVER FORCE MAIN, WATER MAIN WILL BE RATED FOR 200 PSI MINIMUM.

Typical Trench Specifications

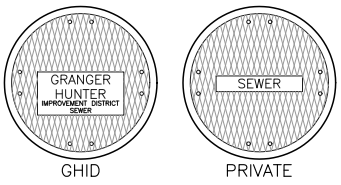


NOTE:
1. SEE PAGE 14 FOR GENERAL NOTES.
2. CONTRACTOR SHALL RESTORE PAVEMENT PER APPLICABLE AGENCY STANDARDS.
3. BEDDING AND BACKFILL IS REQUIRED 6" UNDER, 12" ON SIDES AND 12" OVER WATERLINE, SEWERLINE, FITTINGS, SERVICES, AND METERS.
4. BEDDING AND BACKFILL WITHIN PIPE ZONE: WATERLINE CONSTRUCTED IN DRY GROUND – SELECT SAND SHALL BE USED. WATERLINE CONSTRUCTED IN WET GROUND AND SEWERLINE – ¾" MINUS GRAVEL WITH SEPARATION FABRIC SHALL BE USED. SELECT SAND BEDDING AND BACKFILL SHALL BE COMPACTED TO A MINIMUM AVERAGE OF 92% DENSITY ASTM D–1557. MATERIAL SHALL BE COMPACTED IN 6" LAYERS (UNCOMPACTED DEPTH) WITHIN THE PIPE ZONE AREA INCLUDING THE HAUNCH AREAS.
5. MINIMUM TRENCH WIDTH SHALL BE EQUAL TO OUTSIDE PIPE DIAMETER PLUS 1' EACH SIDE OF PIPE.
6. IF DAMAGE IS CAUSED TO WATER AND/OR SEWER MAIN CONTRACTOR WILL BE HELD RESPONSIBLE FOR REPAIRS.
7. WRAP ALL EXTERNAL DUCTILE IRON PIPE & FITTINGS WITH WAX TAPE AND POLY–PLY WRAP PER MANUFACTURER'S SPECIFICATIONS.
8. ALL BLOCKING MUST BE REINFORCED BY UNDISTURBED GROUND. SEE TYPICAL THRUST BLOCK DETAILS.
9. SUBMISSION OF QUALITY CONTROL COMPACTION TEST RESULT DATA FOR TRENCH BACKFILL MAY BE REQUESTED, BY THE DISTRICT, AT ANY TIME. CONTRACTOR IS TO PROVIDE RESULTS OF TESTS IMMEDIATELY UPON REQUEST.
10. FOR ALL NON–METALLIC CULINARY WATERLINES AND PRESSURE SEWERLINES INSTALL #14 INSULATED SOLID COPPER ELECTRICAL TRACER WIRE. TRACER WIRE TO BE CONTINUITY CHECKED PRIOR TO PAVING.

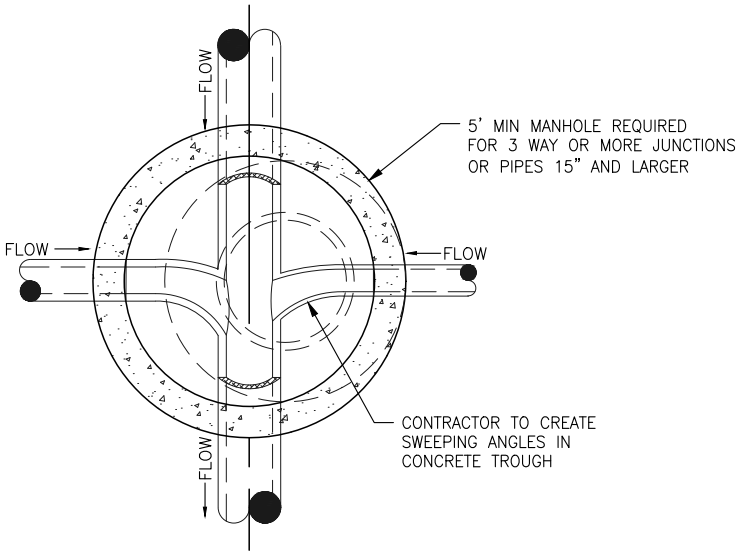
Select Sand Gradation	
US Sieve Size	% Passing By Weight
3/8"	100
#4	80–95
#40	15–35
#100	10–20
#200	5–11

*PI<=6

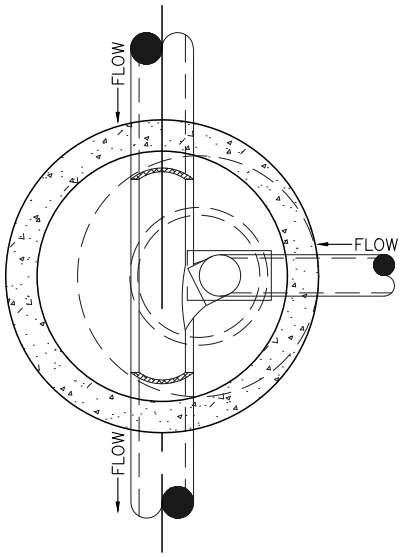
Typical Sanitary Sewer Manhole



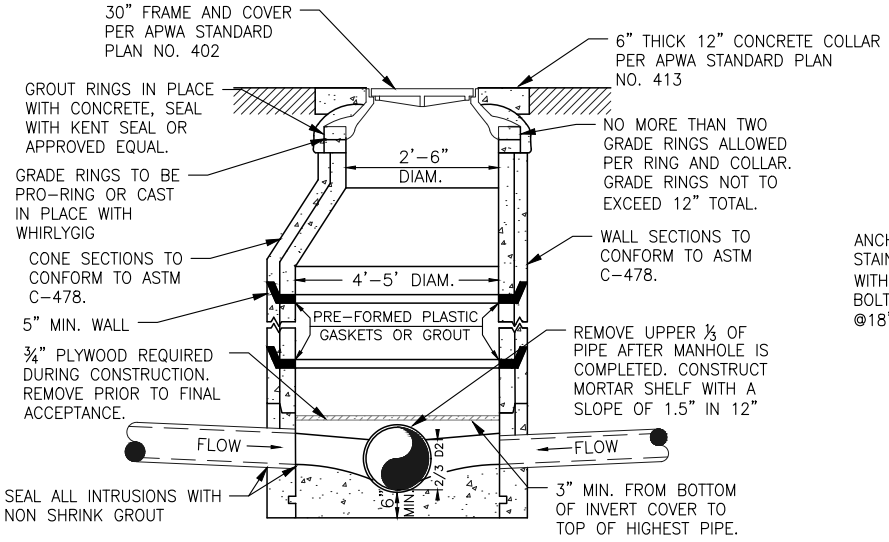
MANHOLE COVERS



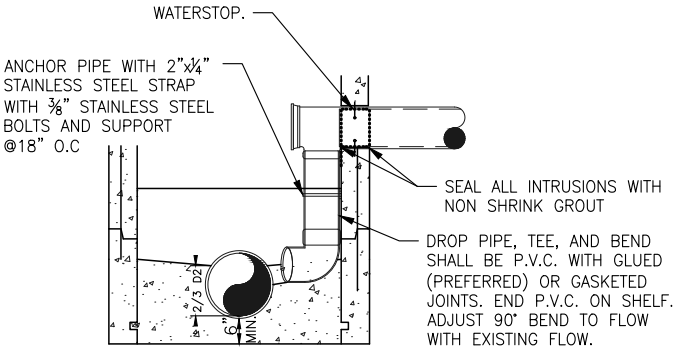
STANDARD MANHOLE PLAN



DROP MANHOLE PLAN



STANDARD MANHOLE SECTION

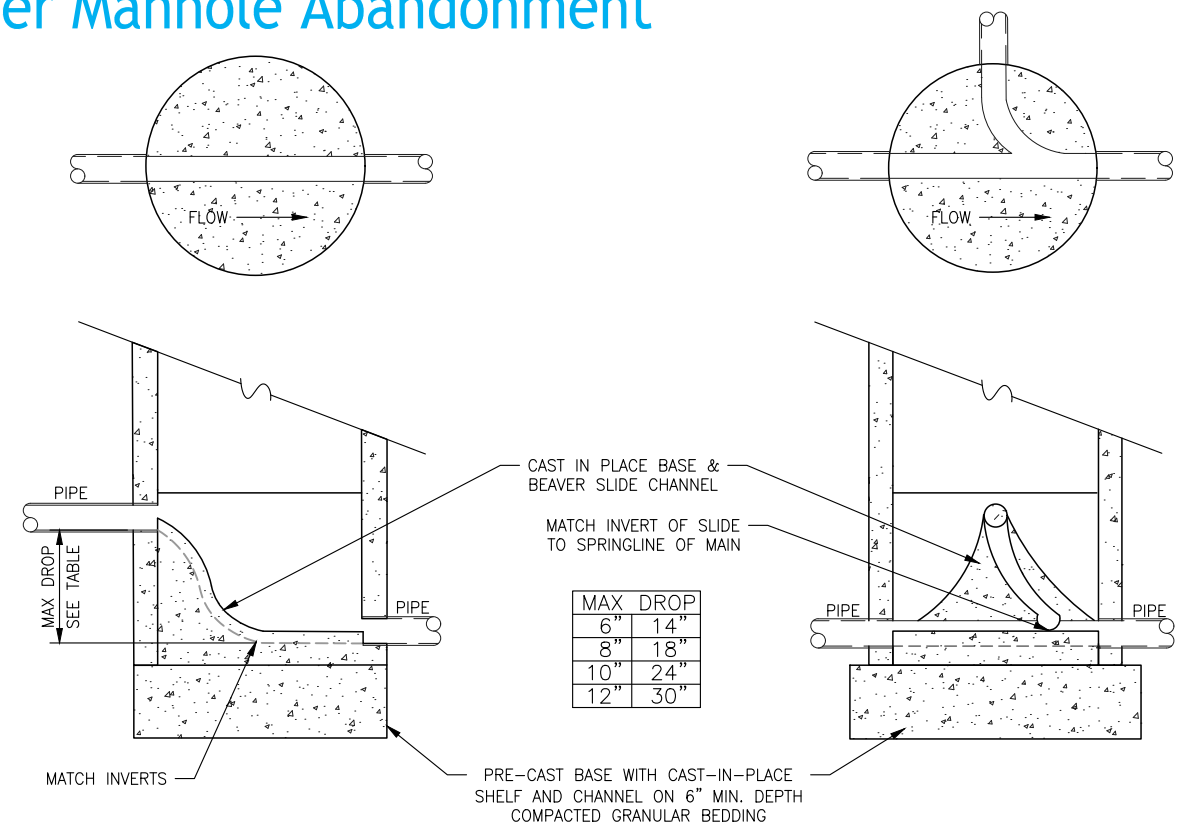


DROP MANHOLE SECTION

NOTE:
1. SEE PAGE 14 FOR GENERAL NOTES.
2. MANHOLES MUST BE ACCESSIBLE AND MUST NOT BE PLACED IN PARKING SPACES.
3. POUR MANHOLE BASE AFTER PIPES ARE IN PLACE. IF PRE-FORMED BASE IS USED AS ALTERNATIVE TO POURED BASE, FOUNDATION OF 1" MINUS GRAVEL 1.5' DEEP UNDER BASE IS REQUIRED.
4. MANHOLE BACKFILL SHALL BE COMPACTED TO 95% MINIMUM ASTM D-1557 3/4" MINUS GRAVEL BACKFILL IS REQUIRED 12" ON SIDES OF MANHOLE TO TOP OF PIPE ZONE.
5. ALL MANHOLES SHALL HAVE A CONCRETE COLLAR PER A.P.W.A. STANDARD PLAN 413.
6. IF DAMAGE IS CAUSED TO SEWER MAIN DUE TO MANHOLE INSTALLATION AND/OR OTHER MEANS, CONTRACTOR WILL BE HELD RESPONSIBLE FOR REPAIRS.
7. GRANGER-HUNTER MANHOLE COVERS AVAILABLE AT D&L SUPPLY AND NEENAH FOUNDARY.
8. MAINTAIN SLOPE THROUGH TROUGH OF MANHOLE.

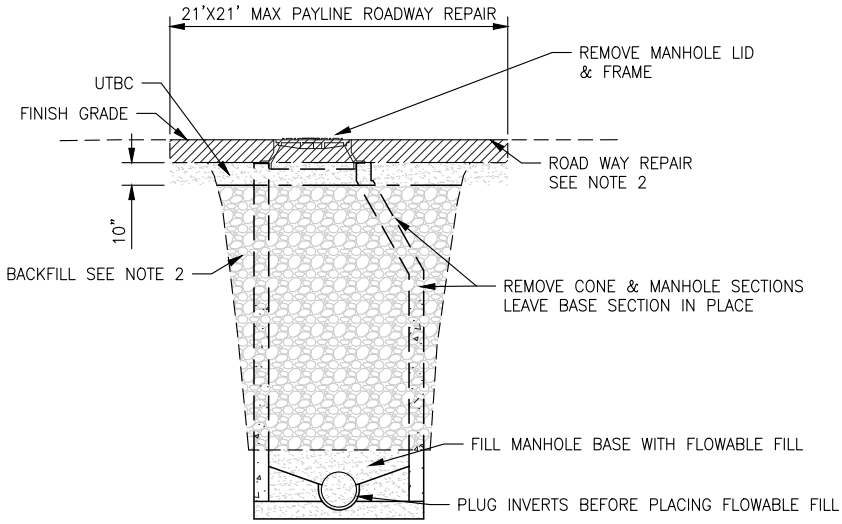
MINIMUM SEWER SLOPES	
PIPE SIZE	SLOPE
4"	2%
6"	1%
8"	0.5%
10"+	0.2%

Typical Beaver Slide & Sewer Manhole Abandonment



MAX	DROP
6"	14"
8"	18"
10"	24"
12"	30"

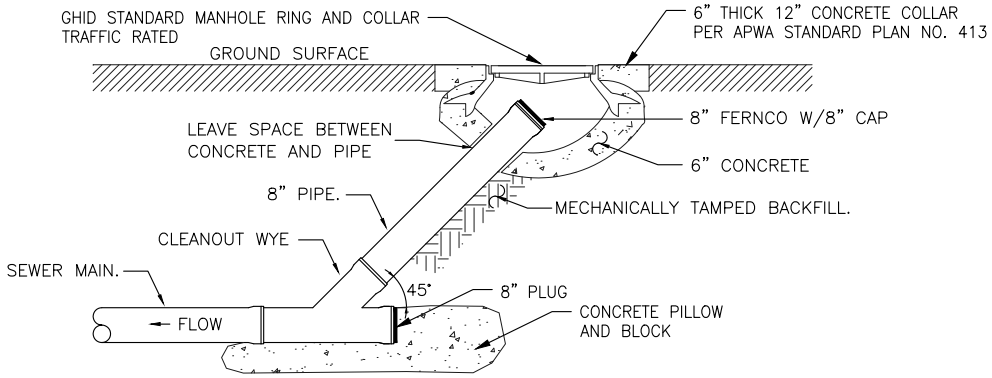
Beaver Slide Detail



Sewer Manhole Abandonment

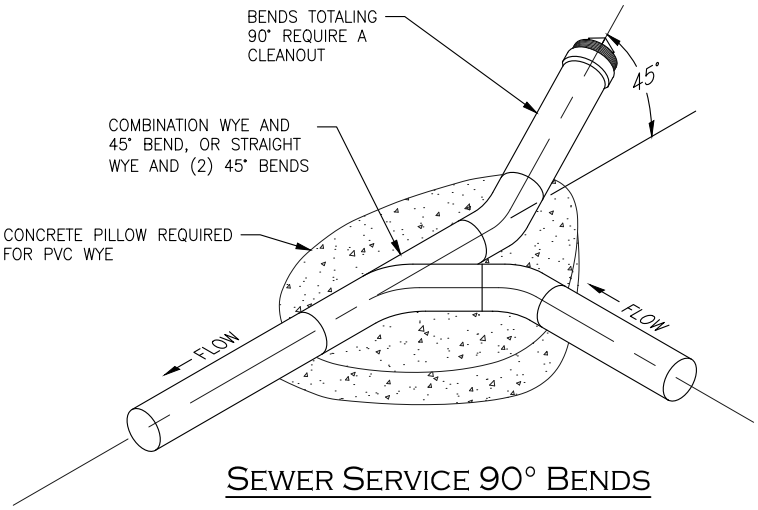
NOTE:
1. SEE PAGE 14 FOR GENERAL NOTES.
2. BACKFILL AND ROADWAY REPAIR TO MEET REQUIREMENTS APPLICABLE AGENCY ENGINEERING STANDARDS.
3. SEE DROP MANHOLE DETAIL FOR DROPS LARGER THAN MAXIMUM DROP.

Typical Mainline Sanitary Sewer Cleanouts



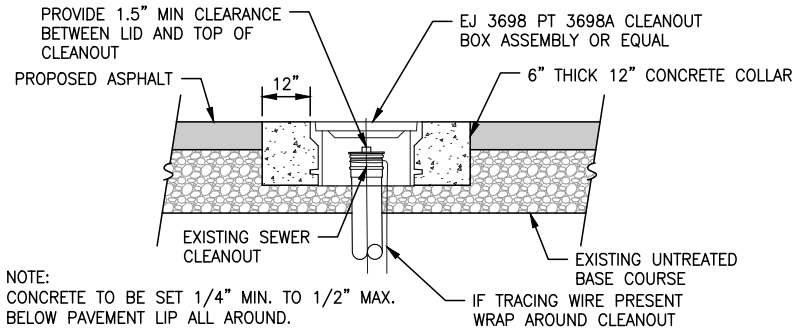
STANDARD 8" AND LARGER CLEANOUT PROFILE

Typical Sanitary Sewer Service 90° Bends



SEWER SERVICE 90° BENDS

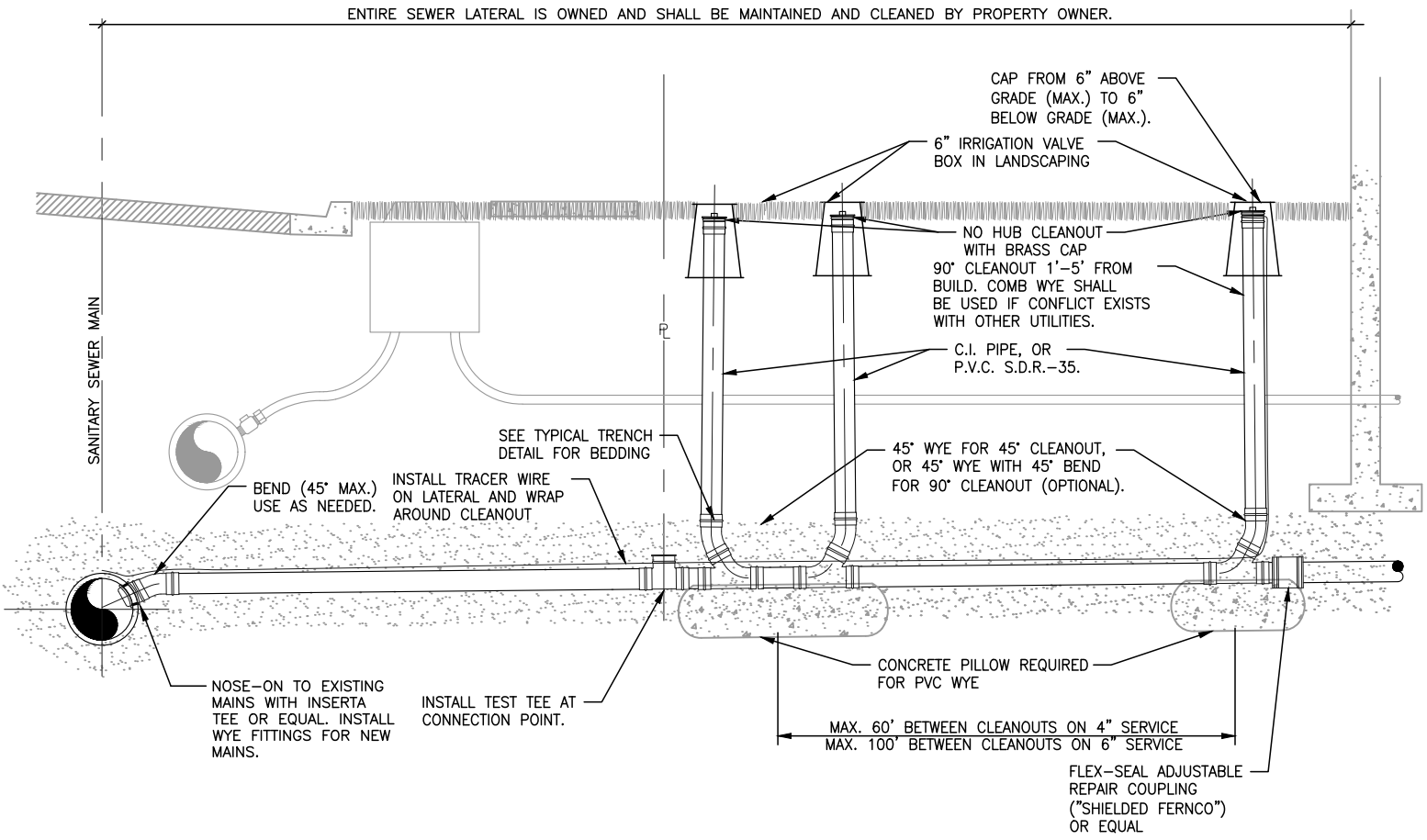
Cleanout Lids in Paved Areas



CLEANOUT LIDS IN PAVED AREAS

NOTE:
1. SEE PAGE 14 FOR GENERAL NOTES.
2. SEE TYPICAL SECTIONS FOR BEDDING AND BACKFILL.
3. CONTRACTOR IS TO SAW CUT ALL TRENCHES AND PROVIDE A SMOOTH CLEAN EDGE FOR PAVING.
4. IF DAMAGE IS CAUSED TO SEWER MAIN, DUE TO MANHOLE INSTALLATION AND/OR OTHER MEANS, CONTRACTOR WILL BE HELD RESPONSIBLE FOR REPAIRS.

Typical Sewer Service

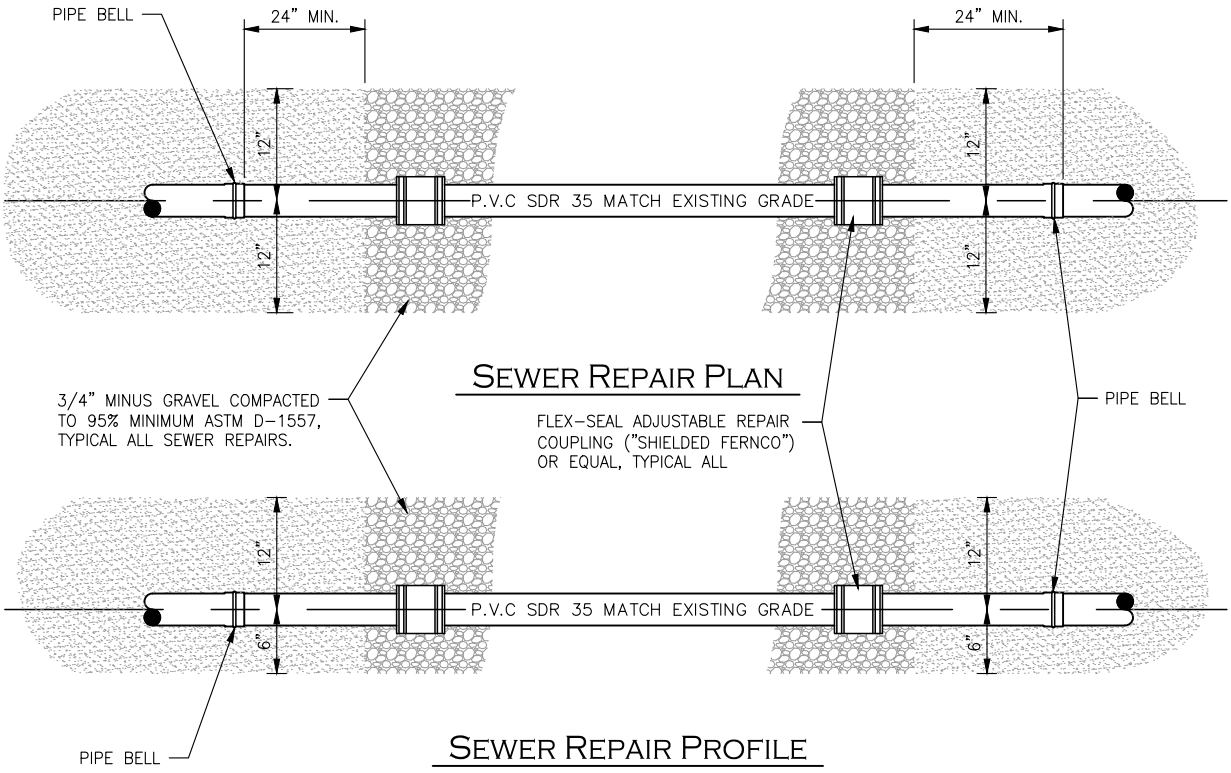


SEWER SERVICE PROFILE

NOTE:

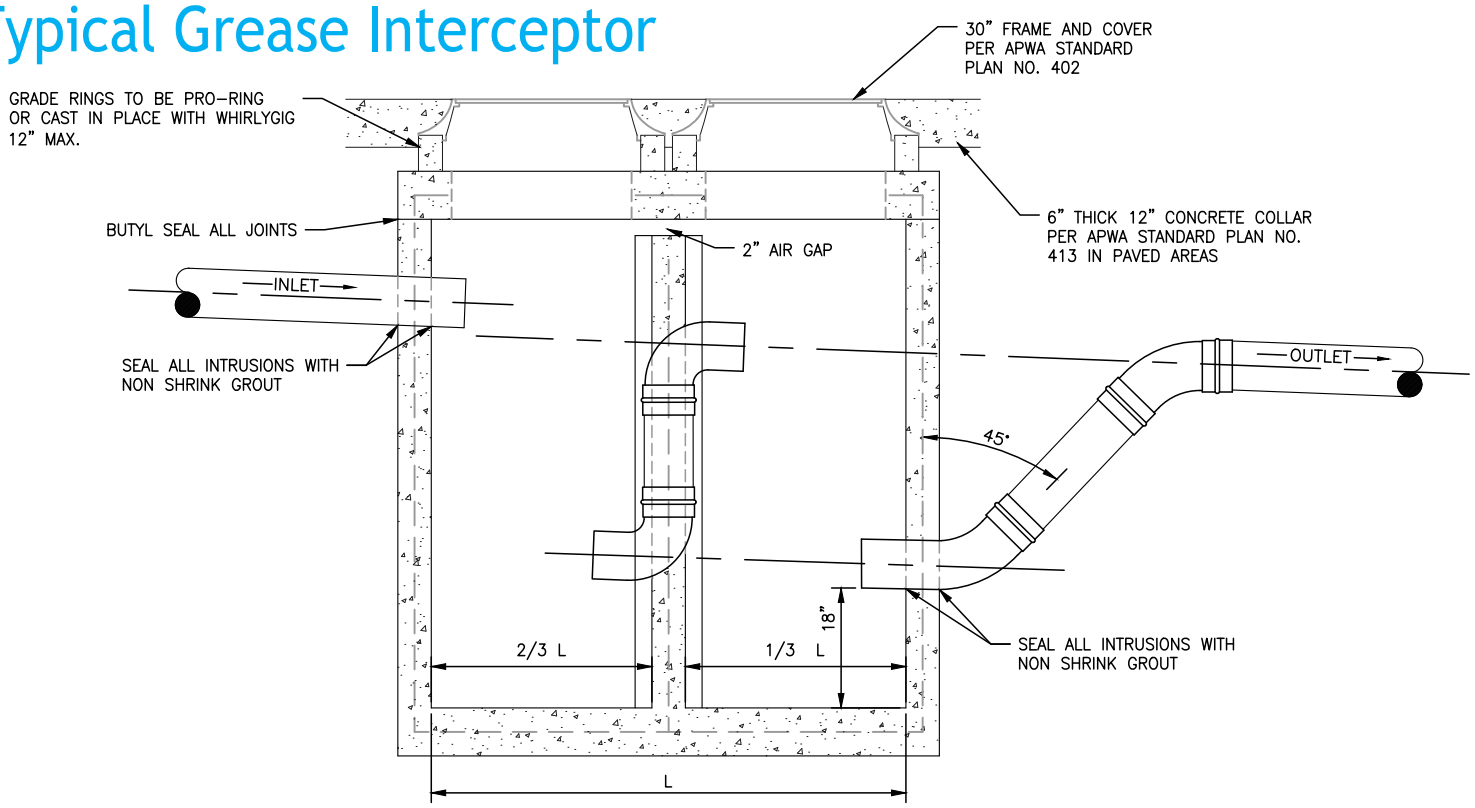
1. SEE PAGE 14 FOR GENERAL NOTES
2. SEE TYPICAL SECTIONS FOR BEDDING AND BACKFILL.
3. MINIMUM TRENCH WIDTH SHALL BE EQUAL TO OUTSIDE PIPE DIAMETER PLUS 1' EACH SIDE OF PIPE. SEE TYPICAL TRENCH SPECIFICATIONS
4. IF DAMAGE IS CAUSED TO WATER AND/OR SEWER MAIN, DUE TO WATERLINE/SEWERLINE INSTALLATION AND/OR OTHER MEANS, CONTRACTOR WILL BE HELD RESPONSIBLE FOR REPAIRS.
5. SEWER LATERAL PIPE SHALL BE PVC SDR-35.
6. BETWEEN TWO DIFFERENT MATERIALS, SUCH AS CLAY TO P.V.C., USE FLEX SEAL ADJUSTABLE REPAIR COUPLING (SHIELDED FERNCO), OR EQUAL (NO-HUB BANDS ARE NOT ALLOWED).
7. BENDS TOTALING 90° SHALL BE BACKED BY A CLEANOUT, SEE TYPICAL SANITARY SEWER SERVICE 90° BEND DETAIL.
8. ALL SEWER LATERAL PLUGS SHALL BE SLIP IN SOLID PLASTIC PLUGS (BRANDT PLUGS ARE NOT ALLOWED).
9. A SEWER TEST TEE SHALL BE INSTALLED AT EACH CONNECTION POINT.
10. SEWER MAIN SHALL BE CORE DRILLED (OTHER CUTTING, CHIPPING AND/OR PUNCHING METHODS ARE NOT ALLOWED).
11. SEWER NOSE-ON SHALL BE ABOVE THE SEWER MAIN SPRING LINE.
12. SEE TYPICAL WATER SERVICE DETAIL FOR WATER AND SEWER SEPARATION.
13. SEWER SERVICE TO BE MARKED WITH S AT CURB
14. INSTALL BACKWATER VALVE PER IPC CODE 714 REQUIREMENTS

Typical Sewer Repair

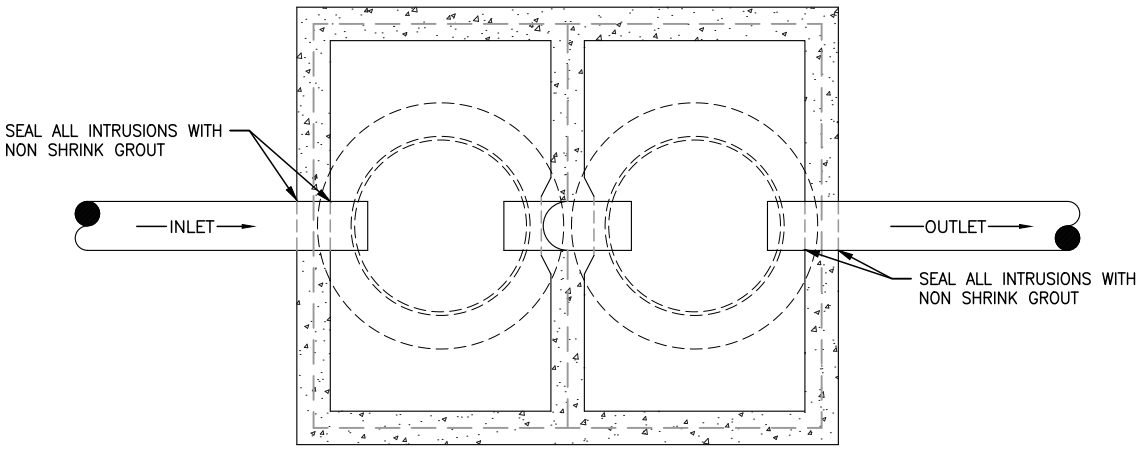


NOTE:
1. SEE PAGE 14 FOR GENERAL NOTES.
2. SEE TYPICAL TRENCH SPECIFICATIONS FOR BEDDING AND BACKFILL.
3. IF DAMAGE IS CAUSED TO SEWER MAIN, DUE TO NOSE-ON AND/OR OTHER MEANS, CONTRACTOR WILLBE HELD RESPONSIBLE FOR REPAIRS.
4. SEWER SHALL BE VIDEO INSPECTED BEFORE AND AFTER REPAIR AND VIDEO PROVIDED TO GHID IN DIGITAL FORMAT.
5. IF EXCAVATION IS WITHIN 2 FEET OF A BELL CONTRACTOR TO REMOVE BELL AND EXTEND REPAIR TO CUT.

Typical Grease Interceptor



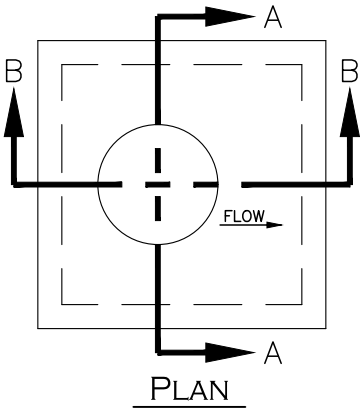
SECTION



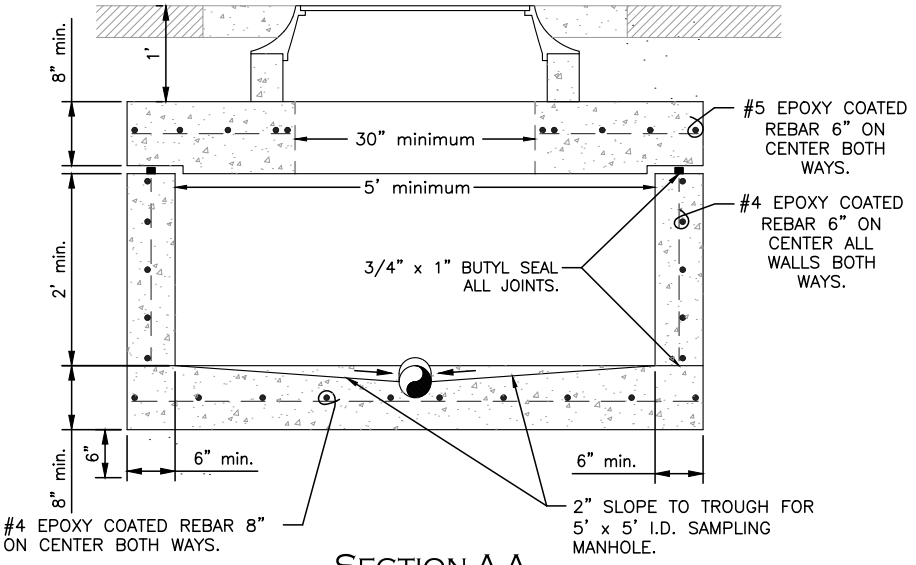
PLAN

NOTES:
1. SEE PAGE 14 FOR GENERAL NOTES.
2. 1,000 GALLON MINIMUM OUTDOOR GREASE INTERCEPTOR. THIS INTERCEPTOR IS NOT A REPLACEMENT FOR AN APPROPRIATELY SIZED AND LOCATED INDOOR GREASE INTERCEPTOR. INDOOR GREASE INTERCEPTORS SHALL COMPLY WITH ALL CURRENT W.V.C. AND I.P.C. REQUIREMENTS AND SPECIFICATIONS AND BE PLUMBING AND DRAINAGE INSTITUTE CERTIFIED.
3. COVER SHALL BE FLUSH WITH FINISH GRADE.
4. NO MORE THAN ONE GRADE RING (1' MAX.) ALLOWED PER RING AND COVER. IF MORE RISE IS REQUIRED, A SHELL SECTION WITH CENTER WALL SHALL BE INSTALLED.
5. SANITARY SEWER (S.S.) SHALL NOT RUN THROUGH THE SAMPLING MANHOLE AND/OR GREASE INTERCEPTOR. S.S. SHALL BE CONNECTED TO THE SEWER LATERAL DOWNSTREAM FROM THE SAMPLING MANHOLE.
6. FOUNDATION OF 1" MINUS GRAVEL 1.5' DEEP UNDER VAULT IS REQUIRED.
7. MANHOLE BACKFILL SHALL BE COMPACTED TO 95% MINIMUM ASTM D-1557. 3/4" MINUS GRAVEL BACKFILL IS REQUIRED 12" ON SIDES OF VAULT TO THE TOP OF THE PIPE ZONE.
8. BETWEEN TWO DIFFERENT MATERIALS, SUCH AS CLAY TO P.V.C., USE FLEX SEAL ADJUSTABLE REPAIR COUPLINGS ("SHIELDED FERNCO") OR EQUAL (NO-HUB BANDS ARE NOT ALLOWED).
9. FOR INSPECTION, FILL GREASE INTERCEPTOR WITH WATER ABOVE INLET AND OUTLET WATER TIGHT GROUT JOINTS.
10. PIPE SHALL BE P.V.C. SDR 35.
11. GREASE INTERCEPTOR SHALL BE SUITABLE FOR H-20 LOADINGS.
12. GREASE INTERCEPTOR SHALL BE VENTED THROUGH BUILDING PLUMBING.
13. GREASE TRAP AND SAMPLING MANHOLE MUST BE ACCESSIBLE AND MUST NOT BE PLACED IN PARKING STALLS.

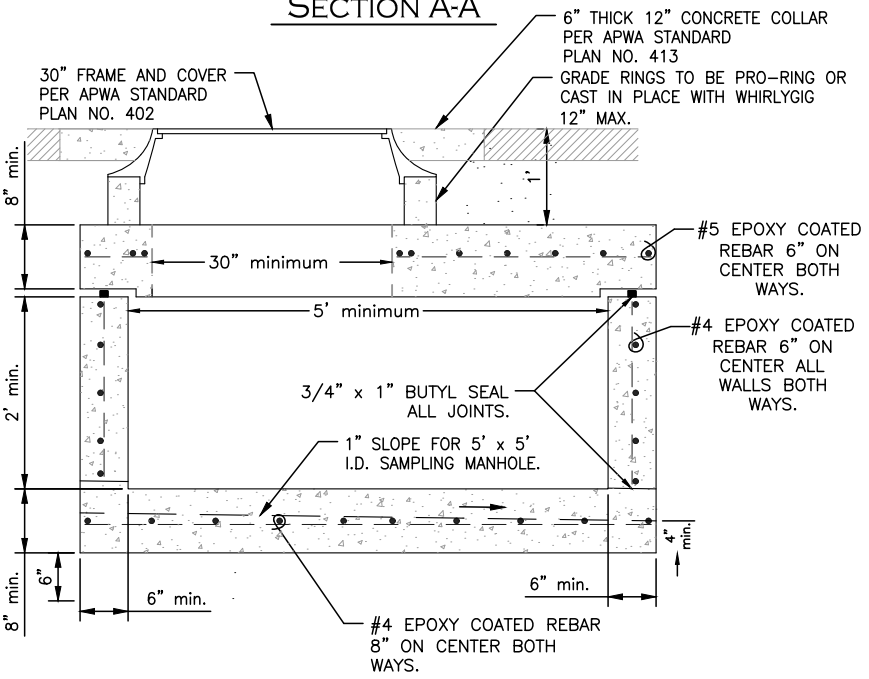
Typical Sampling Manhole



PLAN



SECTION A-A



SECTION B-B

NOTE:
1. SEE PAGE 14 FOR GENERAL NOTES.
2. THE EXISTING SEWER COLLECTION SYSTEM SHALL REMAIN IN SERVICE DURING CONSTRUCTION.
3. FOUNDATION OF 1" MINUS GRAVEL 1.5' DEEP UNDER BASE IS REQUIRED.
4. MANHOLE BACKFILL SHALL BE COMPACTED TO 95% MINIMU ASTM D-1557. 3/4" MINUS GRAVEL BACKFILL IS REQUIRED 12" ON SIDES OF MANHOLE TO THE TOP OF THE PIPE ZONE.
5. TYPE OF PIPE SHALL BE P.V.C. SDR-35.
6. BETWEEN TWO DIFFERENT MATERIALS, SUCH AS CLAY TO P.V.C., USE FERNCO COUPLERS OR EQUAL (NO-HUB BANDS ARE NOT ALLOWED).
7. BENDS TOTALING 90° MUST BE BACKED BY A CLEANOUT.
8. SEWER LATERALS MAY RUN UNDER DRIVE APPROACH, PERMITTING TOP OF CLEANOUT IS NOT UNDER CONCRETE.
9. ALL LATERAL PLUGS SHALL BE SLIP IN SOLID PLASTIC PLUGS (BRANDT PLUGS ARE NOT ALLOWED).
10. IF DAMAGE IS CAUSED TO SEWER MAIN, DUE TO M.H. INSTALLATION AND/OR OTHER MEANS, CONTRACTOR WILL BE HELD RESPONSIBLE FOR REPAIRS.
11. SANITARY SEWER SHALL NOT RUN THROUGH THE SAMPLING MANHOLE AND/OR GREASE TRAP. SANITARY SEWER SHALL BE CONNECTED TO THE SEWER LATERAL DOWNSTREAM FROM THE SAMPLING MANHOLE.
12. SAMPLING MANHOLE SHALL BE SUITABLE FOR H-20 LOADINGS.
13. GREASE TRAP AND SAMPLING MANHOLE MUST BE ACCESSIBLE AND MUST NOT BE PLACED IN PARKING STALLS.

Inspections & Testing

Pre-Inspection Requirements

Work may commence when the following items are completed:

- GHID has been provided with the contractor's License and Permit Bond, General Liability Insurance Certificate, Workers Compensation and Employer's Liability Certificate or State Of Utah approved waiver.
    - **Original** $5,000.00 License and Permit Bond required.
    - General Liability Insurance Certificate. Original, PDF, and faxed copies are acceptable.
        - $500,000.00 Minimum coverage for work being performed within private property
        - $1,000,000.00 Minimum coverage for work being performed within a public right of way.
        - Granger Hunter Improvement District (GHID) shall be named as the Certificate Holder and Additional Insured.
    - Workers Compensation or a State of Utah approved waiver. Original, PDF, and faxed copies are acceptable. Alternatively, this coverage may be shown on the General Liability Insurance Certificate. Original, PDF, and faxed copies are acceptable.
- The project has a "GHID Final Approval" stamped on the drawing with a date and signature from an approved GHID representative.
- All applicable connection and/or inspection fees are paid in full.
- A preconstruction meeting has taken place with the Developer, the Contractor who will be installing the utilities, and one or more GHID Representatives. **(Note: It is the Developer/Contractors responsibility to schedule a preconstruction meeting.)**

Inspection Requirements

- Developer/Contractor must give GHID a minimum of 24 hours' notice prior to all inspections. When scheduling inspections please note that:
    - GHID's inspection hours are from 8:00 AM to 4:00 PM Monday – Thursday, excluding all holidays.
    - Inspections shall be scheduled by calling GHID's office at 801-968-3551.
    - No inspections will be scheduled from voice mail messages. If necessary please leave a message to call you back.
    - Additional inspection fees may be assessed if a GHID representative is dispatched, and the job is not inspection ready. Provide at least 24 hours' notice for cancellations to avoid additional fees.
- All work completed that has not been inspected will be required to be uncovered and inspected prior to any final acceptance given for the project. Please note that:
    - Projects that have not been given a final acceptance letter will not be allowed to connect to GHID's water and sewer Utilities, and/or,
    - Projects that are connected to GHID's Utilities will be considered to be in default, and the connection will be terminated until final acceptance is given.
- In the event a stop work order is issued, the Developer/Contractor shall stop work and comply with all requirements set forth by GHID inspectors.

- Owner is responsible to submit backflow reports to GHID Water Quality Department within 10 days of initial use and annually thereafter.
- Contractors must sign up for service before meters are installed or provided. https://www.ghid.org/sign-up-for-service for service agreement. The District will set meters less than 3-inches or provide meters 3-inches and greater. Contractor to coordinate pickup of meter and coordinate installation of the MXU.
- Prior to Final Acceptance of the project, the applicant must submit a digital copy of field verified As-Built Plans in PDF and DWG format spatially referenced to NAD 1983 State Plane Utah Central FIPS 4302 (feet) and tied to the nearest existing Salt Lake County benchmark monument. Digital As-Built Plans shall have separate layers for culinary waterlines, culinary water services, fire lines, fire hydrants, valves, sanitary sewer lines, sanitary sewer manholes, sanitary sewer laterals, sanitary sewer clean-outs, and pretreatment infrastructure. As-Built Plans can be submitted to plans@ghid.org.

Water Shutdown Requirements

Water shutdowns may commence when all of the following items are completed:

- Developer/Contractor has satisfied all pre-inspection requirements (see pre-inspection requirements for details).
- Developer/Contractor has given Granger Hunter Improvement District (GHID) a minimum of 10 business days' notice prior to any scheduled water shutdown.
    - If any problems arise with the scheduled water shutdown, GHID shall notify the contractor within the 10 business day time frame.
    - Proper notice and approval must be given for all water shutdowns (private and public).
    - All water shutdowns shall be scheduled on a Tuesday, Wednesday, or Thursday between the hours of 8:00 Am to 4:00 Pm. Any deviance from these dates and times will constitute an after-hours shutdown and may require additional notification time for approvals.
- GHID has approved the proposed water shutdown:
    - Developer/Contractor shall give all affected parties (i.e. residences, businesses, etc.) a minimum of 48 hours written notice prior to the scheduled shutdown.
    - It is the Developer/Contractor's responsibility to meet all reasonable needs required by all affected parties (i.e. residences, businesses, etc.) prior to the scheduled water shutdown.
    - Only approved GHID personnel shall open or close all public water valves

Disinfection & Testing

Disinfection and testing of water mainlines shall conform to AWWA C600, C651 and APWA 33 13 00 Specifications (current version) in addition to the following requirements and exceptions:

- Contractors are not to operate public mainline valves. Private valves may be opened and closed by the Contractor, but shall be coordinated with GHID staff. GHID staff will be responsible for opening and closing all public mainline valves.
- Once the line has been filled and chlorinated, the line must remain static for a minimum of 24 hours to allow the disinfection process to occur.
- Care must be taken when disposing of chlorinated water. Contractor shall be required to neutralize the chlorinated water before discharging.
- After flushing is completed, GHID staff will take a chlorine residual test. If amounts do not meet GHID standards, additional flushing will be required.

- Bacteriological samples shall be obtained by GHID staff. Frequency of samples shall be a minimum of 1 sample per 1,000 feet of pipeline. If sample(s) are positive, the Contractor shall repeat chlorination and flushing steps and shall be responsible for all retesting costs.
- Pressure testing is required by the Contractor on all water lines. A hydrostatic pressure of 200 psi must be maintained for two hours. All components for the pressure test must be supplied by the Contractor.

Sewer Testing

Sewer mainline testing shall conform to the **APWA 33 31 00** Specification (current version) in addition to the following requirements and exceptions:

- Contractors are required to provide a means of protecting GHID's Sewer System prior to and during construction. This can include: Test balls, and false bottoms in addition to any other reasonable means as requested by the inspector.

Prior to performing any testing it is recommended that the sewer line is cleaned and vacuumed.

- Deflection testing

  Mandrel testing. Mandrel shall be 95% of the diameter of the pipe that is being tested. If there are any sections of the pipe being tested that fail for any reason it is the responsibility of the contractor to make those repairs. After completion of any such repairs the section of pipe must be retested.
- Video Inspection

  CCTV Inspection of all sewer mains is required. This is a way of visually inspecting the quality of workmanship, in addition to any locating irregularities. This also allows GHID to record the position in which the sewer laterals connect into the Sewer main. Provide Pre and Post Video Inspections for all Sewer Liners.
- Air Test

  All contractors shall provide air test on 8" mains for 12 minutes at 5 psi and 10-12" mains for 25 minutes at 5 psi. The maximum permissible drop is 0.5 psi in that duration. A visual water test on 6" or smaller for 2 hours is permissible. Any pipe larger than 12", the inspector will determine the best testing method per ASTM F1417.

Abandonments

Permanent Water Abandonment

- Mainline – To be abandoned per District Engineer's instructions and WVC standards.
- Lateral – To be abandoned at main. Corp stop to be shut off and 1' minimum physical disconnection and WVC standards.

Permanent Sewer Abandonment

- Mainline - To be abandoned per District Engineer's instructions.
- Lateral – To be abandoned at main. CIPP with pre and post inspection video or physical disconnect and cap at the main with concrete. Brandt plugs not accepted.

Temporary Water and Sewer Disconnect

- To be capped at a point that is clear of future construction and marked with a 2x4.

All abandoned lines and manholes to be inspected prior to being buried.

NOTE: It is the contractor's sole responsibility to comply with all State of Utah, Salt Lake County, West Valley City, and GHID requirements and specifications. For GHID requirements and specifications please go to our website (www.ghid.org) or call or email the Engineering Department (801-968-3551) (plans@ghid.org) or visit our office (2888 South 3600 West).

Engineering Office Hours

Monday – Thursday 6:30 AM to 6:00 PM

Inspection Hours

Monday – Thursday 8:00 AM to 4:00 PM

Engineering Contact

Phone Number: (801)968-3551

Email: Plans@ghid.org

WEST VALLEY CITY
Unity Pride Progress

COMMUNITY AND ECONOMIC DEVELOPMENT DEPARTMENT
Building Inspection Division

STATEMENT OF SPECIAL INSPECTIONS
PROJECT ADDRESS SPECIAL INSPECTION AGENCY (attach individual special inspector qualifications) BUILDING OWNER ARCHITECT STRUCTURAL ENGINEER Jessie Shocklee, P.E.

1. Special inspections and structural testing shall be provided by an independent agency employed by the Owner for the items identified in this section and in other areas of the approved construction plans and specifications, unless waived by the Building Official (see IBC Chapter 17).
2. The names and credentials of the Special Inspectors to be used shall be submitted to the Building Official for approval.
3. Duties of the Special Inspector:

a. The Special Inspector shall review all work listed below for conformance with the approved construction plans and specifications and the 2018 IBC.

b. The Special Inspector shall furnish special inspection reports to the EOR, Contractor, Owner and Building Official
on a weekly basis, or more frequently as required by the Building Official. All items not in compliance shall be brought to the immediate attention of the Contractor for correction, and if uncorrected, to the EOR and the Building Official.

c. Once corrections have been made by the Contractor, the Special Inspector shall submit a final signed report to the Building Official stating that the work requiring special inspection was, to the best of the Special Inspector's knowledge, in conformance with the approved construction plans and specifications as well as the applicable workmanship provisions of the 2018 IBC.

4. Duties and responsibilities of the Contractor:

a. The Contractor shall submit a written statement of responsibility to the Owner and the Building Official prior to the commencement of work. In accordance with IBC 1704.4, the statement of responsibility shall contain acknowledgement of the special inspection requirements contained within this "Statement of Special Inspections".
b. The Contractor shall notify the responsible Special Inspector that work is ready for inspection at least one working day (24 hours minimum) before such inspection is required.

c. All work requiring special inspection shall remain accessible and exposed until it has been observed by the Special Inspector.

5. Please see the "Special Inspection Schedule" for the types, extents and frequency of specific items requiring special inspections and structural tests as part of this project.

SPECIAL INSPECTION SCHEDULE			
Areas requiring special inspection:	Frequency		Comments:
	Continuous	Periodic	
FABRICATORS (IBC 1704.2.5)			
		✓	If fabricator is approved, on-site inspection is not required but a certificate of completion must be provided to the B.O. (IBC 1704.2.5.1)
SOILS (IBC 1705.6)			
Verify adequate materials below footings	✓		Prior to placement of concrete.
Excavation extend to proper depth and materials	✓		Prior to placement of compacted fill or concrete.
Classification and testing of fill materials	✓		Check classification and gradations at each lift, but not less than once for each 10,000ft² of surface area.
Verify proper fill materials, lift thicknesses and in-place densities	✓		
Verify properly prepared site and subgrade	✓		Prior to placement of concrete.
CONCRETE CONSTRUCTION (IBC 1705.3)			
Reinforcing steel placement		✓	Verify size, clearances, splices and proper ties.
Embedded bolts or plates		✓	
Verify required design mix		✓	Verify mix design meets strength and exposure requirements listed on approved plans.
Concrete placement/sampling	✓		Includes sampling for air, slump, strength and temperature techniques
Inspect formwork		✓	Verify shape, location and member dimensions.
Post-installed anchors		✓	In accordance with approved ICC-ES Report. Periodic inspections allowed if stated in ES Report.
WOOD FRAMED or COLD-FORMED STEEL CONSTRUCTION (IBC 1705.12.1 OR .2)			
Components of wind- and seismic-force resisting systems.		✓	Verify proper screw attachment, bolting and anchoring of shear walls, braces and hold-downs having a fastener spacing ≤ 4"o.c.
OTHER THAN STRUCTURAL STEEL (IBC 1705.2.2)			
Steel Roof & Floor Deck:			
Material verification of steel deck		✓	Identification markings per applicable ASTM standard
Roof and deck welds		✓	Verify that welds conform to AWS D1.3.
Welding of Reinforcing Steel:		✓	
Verification of weldability (except A706 bar)		✓	Verify material is able to conform to AWS D1.4.

SPECIAL INSPECTION SCHEDULE (continued)			
Areas requiring special inspection:	Frequency		Comments:
	Continuous	Periodic	
STRUCTURAL STEEL CONSTRUCTION (IBC 1705.2, 1705.11.**2**, 1705.12.**1**)			
Prior to Welding (Table N5.4-1, AISC 360-10):			
Verify welding procedures		✓	
Material identification		✓	Verify type and grade of material.
Welder identification		✓	Verify there is a system in place to identify the welder who has welded a joint or member.
Fit-up groove welds		✓	Verify joint preparation, dimensions, cleanliness, tacking and backing.
Access holes		✓	Verify configuration and finish.
Fit-up fillet welds		✓	Verify alignment, gaps at root, cleanliness of steel surfaces, tack weld quality and location.
During Welding (Table N5.4-2, AISC 360-10):			
Use of qualified inspectors		✓	Verify that welders are appropriately qualified.
Control and handling of welding consumables		✓	Verify packaging and exposure control.
Cracked tack welds		✓	Verify welding is not over a cracked tack weld.
Environmental conditions		✓	Verify wind speed is within limits as well as precipitation and temperature.
WPS followed		✓	Verify items such as welding equipment settings, travel speed, welding materials, shielding gas type/flow rate, preheat applied, interpass temperature maintained, and proper position.
Welding techniques		✓	Verify interpass and final cleaning, each pass is within profile limitations, and quality of each pass.
After Welding (Table N5.4-3, AISC 360-10):			
Welds cleaned		✓	Verify that welds have been properly cleaned.
Size, length and location of welds		✓	
Welds meet visual acceptance criteria		✓	
Arc strikes		✓	
k-area		✓	
Backing & welding tabs removed		✓	
Repair activities		✓	
Document acceptance/rejection of weld		✓	
Nondestructive Testing (Table N5.5, AISC 360-10):			
~~SFRM – Sprayed Fire Resistive Material~~			~~Bonding and thickness~~

SPECIAL INSPECTION SCHEDULE (continued)			
Areas requiring special inspection:	Frequency		Comments:
	Continuous	Periodic	
~~CJP welds (Risk Cat. II)~~			Ultrasonic testing shall be performed on 10% of CJP groove welds in butt, T- and corner joints subject to transversely applied tension ~~loading in materials 5/16-inch thick or greater. Testing rate must be increased if > 5% of welds have unacceptable defects.~~
Access holes (flange > 2")			
~~Welded joints subject to fatigue~~			
Other Steel Inspections (Table N5.7, AISC 360-10; Tables J8-1 and J10-1, AISC 341-10)			
Structural steel details		✓	All fabricated steel and their connections shall be inspected to verify compliance with the details shown in the approved plans.
Anchor rods/embeds supporting structural steel		✓	Shall be on the premises during the placement of anchor rods/embedments. Verify diameter, grade, type, and length of element and the extent or depth of embedment prior to placement of concrete.
Reduced beam sections (RBS)			~~Verify contour and finish as well as dimensional tolerances (see Table J8-1 of AISC 341).~~
Protected zones			~~Verify that no holes or unapproved attachments are made within the protected zone (see Table J8-1 of AISC 341).~~
MASONRY CONSTRUCTION (IBC 1705.4)			
Minimum Testing (Table 1.19.2, TMS-402/ACI 530-11):			
Verification of Slump Flow and Visual Stability Index (VSI) for self-consolidating grout.		✓	Compressive strength tests per ASTM C 1019 for slump flow and ASTM C 1611 for VSI.
Verification of f'm.		✓	Determine compressive strength per "unit strength" or "prism test" as specified in Article 1.4.B of ACI 530.1 prior to construction.
Prior to Construction (Article 1.15, TMS-602/ACI 530.1-11):			
Review material certificates, mix designs, test results and construction procedures		✓	Verify materials conform to approved construction documents. Mix design, test results, material certificates, and construction procedures should be submitted for review. Mortar mix designs shall conform to ASTM C 270 while grout shall conform to ASTM C 476. Material certificates shall be provided for the following: reinforcement; anchors, ties, fasteners, and metal accessories; masonry units; mortar and grout materials. Review cold-weather or hot-weather construction procedures.
As Construction Begins (Table 1.19.2, TMS-402/ACI 530-11):			
Proportions of site-prepared mortar		✓	Verify that mortar is type and color specified on approved plans, it conforms to ASTM C 270, and is mixed per Article 2.6.A of ACI 530.1.
Construction of mortar joints		✓	Verify mortar joints meet Article 3.3.B of ACI 530.1.
Location of reinforcement, connectors and anchorages.		✓	Verify reinforcement is placed in accordance with Article 3.4 of 530.1.

SPECIAL INSPECTION SCHEDULE (continued)			
Areas requiring special inspection:	Frequency		Comments:
	Continuous	Periodic	
Prior to Grouting (Table 1.19.2, TMS-402/ACI 530-11):			
Grout space	✓		Verify grout space is free of mortar droppings, debris, loose aggregate, and other deleterious materials and that cleanouts are provided per Article 3.2.D and 3.2.F of ACI 530.1.
Grade, type and size of reinforcement, anchor bolts and anchorages.		✓	Verify reinforcement, joint reinforcement, anchor bolts and veneer anchors comply with approved plans and Section 1.6 of ACI 530.
Placement of reinforcement, connectors and anchorages.		✓	Verify reinforcement, joint reinforcement, anchor bolts and veneer anchors are installed per approved plans and Articles 3.2.E, 3.4, and 3.6.A of ACI 530.1.
Proportions of site-prepared grout.	✓		Verify grout proportions meet ASTM C 476 and a slump between 8-11 inches. Self-consolidated grout shall not be proportioned onsite.
Construction of mortar joints		✓	Verify mortar joints placed in accordance with Article 3.3.B of ACI 530.1.
During Construction (Table 1.19.2, TMS-402/ACI 530-11):			
Size and location of structural elements		✓	Verify locations of structural elements per approved plans and confirm tolerances meet Article 3.3.F of ACI 530.1.
Type, size and location of anchors, frames, etc.		✓	Verify correct anchorages and connections are provided per approved plans and Sections 1.16.4.3 and 1.17.1 of ACI 530.
Placement of grout.	✓		
Preparation, construction and protection of masonry during cold weather (<40°F) or hot weather (>90°F).	✓		Verify cold-weather construction complies with Article 1.8.C of ACI 530.1 and hot weather construction per Article 1.8.D of ACI 530.1.
Observation of grout specimens, mortar specimens, and/or prisms.		✓	Confirm specimens/prisms are performed as required by Article 1.4 of ACI 530.1.

WEST VALLEY CITY

WEST VALLEY CITY
2020 ENGINEERING STANDARDS
VOLUME I

GENERAL STANDARDS AND SPECIFICATIONS

APPLICABLE FOR WORK IN THE PUBLIC RIGHT-OF-WAY AND ON PUBLIC INFRASTRUCTURE AND APPURTENANCES

WEST VALLEY CITY - PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION
ADOPTED BY WEST VALLEY CITY COUNCIL August 25, 2020

WEST VALLEY CITY, UTAH

RESOLUTION NO. 20-135

A RESOLUTION ADOPTING REVISIONS TO THE WEST VALLEY CITY ENGINEERING STANDARDS.

WHEREAS, the West Valley City Engineering Standards set forth certain regulations and requirements applicable to development and construction within the City; and

WHEREAS, the City's Engineering Division has prepared revisions and updates to said Engineering Standards; and

WHEREAS, the revised Engineering Standards are attached hereto as Exhibit A;

WHEREAS, the City Council of West Valley City, Utah, does hereby determine that it is in the best interests of the health, safety, and welfare of the citizens of West Valley City to adopt the revised Engineering Standards;

NOW, THEREFORE, BE IT RESOLVED, by the City Council of West Valley City, Utah, that the West Valley City Engineering Standards attached hereto as Exhibit A shall replace the existing Engineering Standards, are hereby adopted as binding City regulations, and said Engineering Standards shall have the full force of law.

PASSED, APPROVED and MADE EFFECTIVE this 25th day of August, 2020.

WEST VALLEY CITY

MAYOR

ATTEST:

CITY RECORDER

Table of Contents

Part 1: Introduction - West Valley City Engineering Standards

1.1 Volume I – General Standards and Specifications

These Engineering Standards are intended to provide a foundation for design and construction and to ensure quality and uniform construction of public infrastructure in West Valley City.

All public improvements constructed in the city right-of-way are required to comply with these standards. Some engineering standards are also applicable to private development site design, and all new development and redevelopment projects are required to adhere to these standards. Design exceptions to specific standards will be considered and must be approved by the City Engineer.

1.2 Volume II – Minimum Sampling and Testing Requirements

West Valley City has adopted minimum sampling & testing requirements which are intended to ensure quality and uniform construction of public infrastructure in West Valley City. This document shall be used to determine the frequency of verification sampling and testing on all public improvements constructed within the city right-of-way. Test results will be used to determine acceptance or rejection of material placed. Exceptions to specific sampling and testing requirements must be approved by the City Engineer.

1.3 Modifications

Sections that have been modified from the previous version are noted with a solid vertical line to the right of the paragraph.

Part 2: Standard Specifications and Standard Drawings

West Valley City uses the APWA Standard Specifications. APWA standard specifications and drawings are available for purchase from the Utah Chapter of the American Public Works Association (APWA), via the Utah Chapter website.

http://utah.apwa.net

2.1 APWA Manual of Standard Specifications –2017 Edition

APWA amendments are not automatically adopted.

2.1.1.1 West Valley City Special Provisions

The following sections of the APWA Standard Specifications have been modified by West Valley City. These Special Provisions replace or supplement the APWA Standard Specifications and are available for download on the Engineering Division webpage.

Section 01 45 00-M – Quality Control
Section 26 56 19-M – Roadway Lighting
Section 31 05 13-M – Common Fill
Section 31 23 23-M – Backfilling for Structures
Section 32 12 05-M – Bituminous Concrete
Section 32 12 13.13-M – Tack Coat
Section 32 12 16.13-M – Plant Mix Asphalt Paving
Section 32 16 14-S – Curb Cut Assembly
Section 32 16 24-S – Stamped Concrete
Section 33 05 20-M – Backfilling Trenches
Section 33 41 00-M – Storm Drainage Systems

2.2 APWA Manual of Standard Drawings – 2017 Edition

The drawings listed in the section below are adopted as standard drawings. Other plans in the APWA Manual of Standard Drawings may be used if proposed under specific circumstances.

2.2.1 APWA Adopted Standard Drawings:

Plan 205 – Type A Curb and Gutter
Plan 211 – Waterway
Plan 215 – Dip Driveway Approach
Plan 221 – Flare Driveway Approach – Type A
Plan 222 – Saw-cut Driveway Approach
Plan 231 – Sidewalk
Plan 251 – Asphalt Concrete Pavement Tie-In
Plan 302 – 30" Frame and Cover
Plan 308 – 35-1/2" Grate and Frame
Plan 315 – Catch Basin
Plan 381 – Trench Backfill
Plan 382 – Pipe Zone Backfill
Plan 802 – Defective Concrete – For application in areas with existing infrastructure adjacent to new development.

2.3 West Valley City Standard Drawings

The following standard drawings are available for download on the Engineering Division webpage.

WVC 213 – Waterway Transition Structure
WVC 232.1 – Patterned Concrete Park Strip
WVC 239 – Pedestrian Access Ramp Rolled Curb Transition
WVC 255 – Asphalt Concrete T-Patch
WVC 316 – Modified Storm Drain Combo Box
WVC 331 - Cleanout Box
WVC 762.1 – Asphalt Speed Table
WVC 762.2 – Concrete Speed Table
WVC 731 – Streetlight Junction Box Detail
WVC LP-01 – 40W LED Residential (10-9-2019)
WVC LP-02 – 40W LED Arterial Less than 80' ROW (10-9-2019)
WVC LP-03 – 80W LED Arterial Over 80' ROW (10-9-2019)
WVC LP-03A – Fairbourne Streetlight (10-9-2019)
WVC LP-04 – 80W LED 3500 South Double (10-9-2019)
WVC LP-05 – Sidewalk – Lake Park Pole LED (10-9-2019)
WVC LP-06 – Lake Park Median (10-9-2019)
WVC LP-07 – Industrial Standard (10-9-2019)

Part 3: Roadway Design

3.1 General Roadway Design Elements

3.1.1 Horizontal Alignment

1. Make horizontal alignments as direct as possible and consistent with topography.
2. Horizontal curves must meet AASHTO standards. Avoid minimum horizontal curve radii.
3. Avoid sharp curves at the end of long tangents.
4. Avoid short lengths on curves on small deflection angles of horizontal alignment.
5. Avoid compound circular curves with large difference in radii.
6. Avoid the use of "broken-back curves" (two curves in the same direction on either side of a short tangent or large radius curve).
7. Avoid the use of direct reverse curves. Use a tangent length between the curves.

3.1.2 Vertical Alignment

Vertical curves should be used to enable gradual changes between tangent grades. Crest and Sag Vertical Curves shall be governed by *K values* as shown in the latest edition of *AASHTO - A Policy on Geometric Design of Highways and Streets*. A K value of 167 shall not be exceeded on vertical curves that create a high point or low point for drainage purposes.

Design Speed	Maximum Algebraic Difference without Vertical Curve
Less than or equal to 30 mph	2.0%
Greater than 30 mph	1.0%

3.1.3 Longitudinal Street Grades

Longitudinal grades of streets without curb and gutter shall not be less than 0.5%.

Longitudinal grades of streets with curb and gutter is preferred to have a minimum of 0.5%, but no grade shall be less than 0.3%.

Maximum Grades: Longitudinal grades of streets shall not be greater than 5%. Any exception to this standard must be approved in writing by the City Engineer. No roadway will be approved with a longitudinal grade of 12% or greater.

3.1.4 Cross Slope

Street cross slope on new construction shall be 2%. When widening the shoulder on existing pavement maintain cross slope between 1% and 4%. It may be necessary to remove additional pavement to meet cross slope requirements.

3.1.5 Sight Stopping Distance

Sight distance requirements are as defined by the latest edition of *AASHTO - A Policy on Geometric Design of Highways and Streets*.

3.1.6 Design Speed

Local streets: 25 mph (lower design speeds may be considered on local urban streets with approval of the City Engineer)

Collector Streets: 40 mph

Arterial Streets: 45 mph

Any exception to this standard must be approved in writing by the City Engineer.

3.1.7 Intersection Design

Intersections should be designed with as much sight distance as possible, conforming to AASHTO design standards.

Roads may not intersect with an angle greater than 5° from perpendicular.

Intersection grades should be as flat as possible while still maintaining drainage.

Maximum grade for curb radii shall be 5%, with exceptions being approved by the City Engineer.

3.1.7.1 Intersection Spacing

Intersecting roads must be spaced according to the table below. Exceptions to this standard must be approved by the City Engineer.

Intersecting Road Spacing Measured from Centerline to Centerline	
Intersected Street Classification	**Min. Centerline Offset**
Minor Street/Minor Collector	150-feet
Collector	250-feet
Arterial	500-feet

3.1.7.1 Back of Curb Radius of Curb Returns

Back of curb curve radii for various intersecting street right-of-way widths are as shown in the following table (in feet).

Right-of-Way Width (ft)		Right-of-Way Width (ft)				
		54	**60**	**66**	**80**	**106**
Right-of-Way Width (ft)	**106**	30	30	35	45	45
	80	25	25	35	40	
	66	25	25	30		
	60	25	25			
	54	25				

A larger radius than is shown in the table may be required in areas of higher truck turning volume, where a turning template indicates necessity.

3.1.8 Driveway Construction and Access Management

Driveway access to properties shall be per West Valley City Code 7-9-107 – Parking Lot Access.

Provisions for residential double Driveways – West Valley City Code 7-9-114

3.1.9 Dead End Roadways

Dead end roadways shall conform to West Valley City Code 7-13-705.

The maximum number of units for a single access street shall not exceed 30-single unit dwellings, or 100-multiple unit dwellings.

3.1.9.1 Cul-de-Sac Design:

Roadways must be terminated with a cul-de-sac, per West Valley City Code 7-13-705.

Cul-de-Sacs must be designed according to the following criteria:

Residential Streets:

Radius at the Right-of-Way: 52 feet
Radius at Top Back of Curb: 42 feet
Radius at the Lip of Gutter: 39.5 feet

Commercial or Industrial Streets (66’ ROW or Greater)

Radius at the Right-of-Way: 60 feet
Radius at Top Back of Curb: 50 feet
Radius at the Lip of Gutter: 47.5 feet

A larger radius may be required in areas of anticipated high-volume use or as determined by the City Engineer.

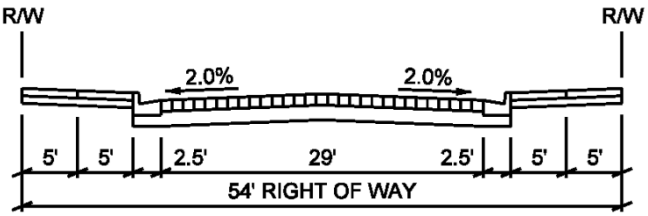
3.1.9.1.1 Maximum cul-de-sac length

The maximum length of a cul-de-sac is 750-feet, as measured along the centerline from the right-of-way line of the connecting street to the point of curvature on the radius entering the cul-de-sac.

3.2 Typical Section Elements

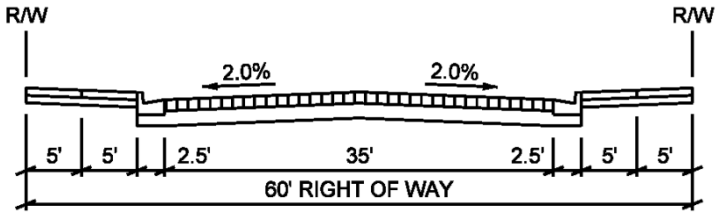
3.2.1 Subdivision Street Sections

3.2.1.1 54 foot ROW - Minor Street – 29 feet of pavement

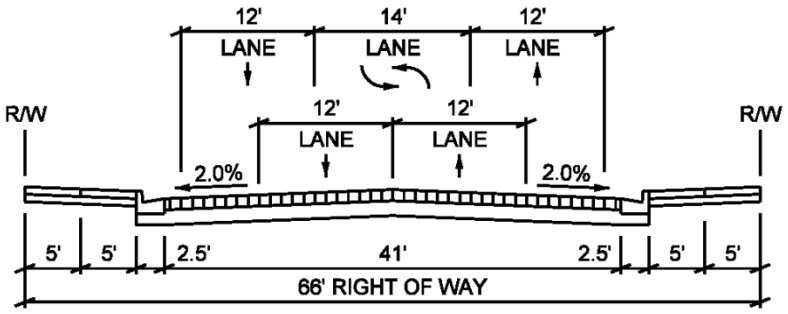


A 44 foot right-of-way road section without park strip may be allowed in certain infill development circumstances, with approval of the City Engineer.

3.2.1.2 60 foot ROW - Minor Collector Street Section – 35 feet of pavement

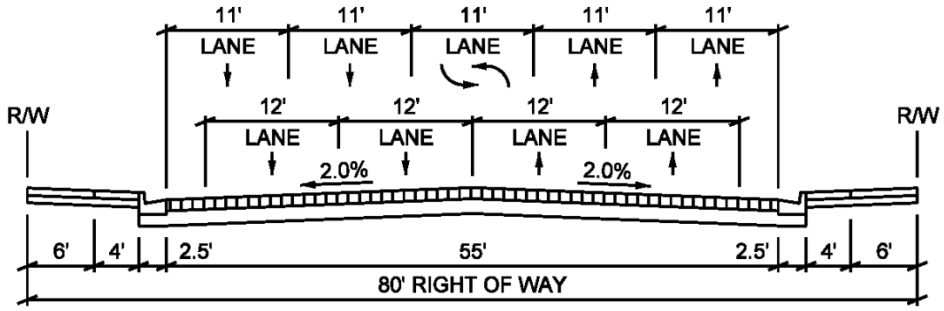


3.2.1.3 66 foot ROW - Collector Section – 41 feet of pavement



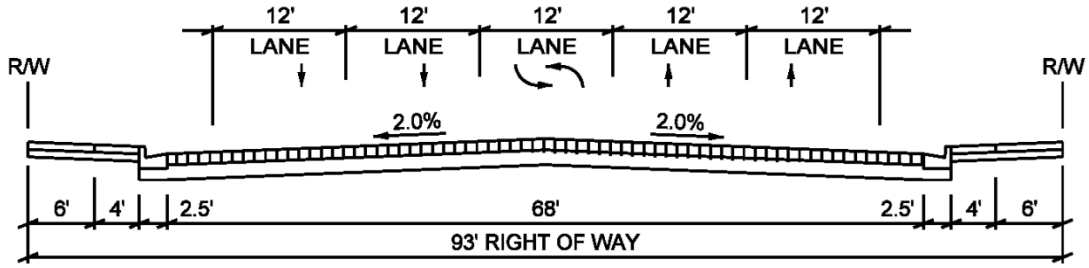
3.2.1.4 80 foot ROW - Minor Arterial Section – 55 feet of pavement

For use on existing 80-foot rights of way.

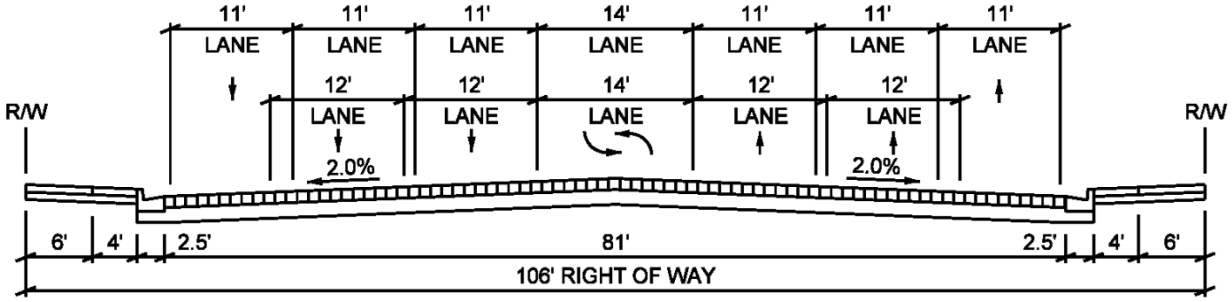


3.2.1.5 93 foot ROW – Minor Arterial Section 68 feet of pavement

For use on new minor arterial roadways.



3.2.1.6 106 foot ROW - Major Arterial Section – 81 feet of pavement



3.2.2 Bike Lanes

Streets on the City Bike Plan – Class 2 Bike Lanes – Add a minimum of 8 feet of total pavement width (to allow for one 4-foot bike lane on each side of the street). The Bike Plan is part of the West Valley City General Plan; *Vision West 2035*, under the Transportation Chapter, and can be found on the City's Website.

http://www.wvc-ut.gov/450/General-Plan

3.2.3 Curb and Gutter, Sidewalk

Curb and Gutter is required on all streets. Curb and Gutter to be per APWA Plan 205, Type A (30-inch). Other types of curb and gutter may be considered in unique instances but must be approved by the City Engineer.

Sidewalks on arterial streets shall not be less than 6-feet in width. (West Valley City Code 7-19-805, (5), b.)

Pedestrian Access Ramps are required at all intersections and mid-block crosswalks. Any exceptions must be approved by the City Engineer. WVC has adopted the Utah Department of Transportation (UDOT) standards for pedestrian access ramps. The UDOT Standard Drawings shall be used to design and construct all pedestrian access ramps within WVC. Each ramp will be evaluated utilizing the "UDOT Pedestrian Access Evaluation Form C170" to ensure ADA requirements are met. Each pedestrian ramp is required to pass this evaluation prior to acceptance by WVC.

In residential areas, sidewalks through the drive approach must be 6-inches thick, as shown on APWA Plan 215, and 221. Sidewalks in subdivisions with a park strip are to be constructed per APWA 231, 4-inches thick. In residential subdivisions where the locations of drive approaches are not known at the time of the sidewalk construction, the developer may choose either to construct all sidewalk 6-inches thick, or to remove 4-inch thick sidewalk through the driveway and replace with 6-inch thick sidewalk. Sidewalk is to be 8-inches thick through the driveway in commercial or industrial areas.

In areas where walls are required in double frontage lots or other scenarios, patterned colored concrete will be required in the park strip. See Section 6.9.3 for requirements.

In general, sidewalk should be placed with a 2% cross slope draining toward the street. The elevation of the sidewalk is determined by projecting up 2% through the park strip from the top back of curb elevation. If a cross slope through the park strip greater than 2% is necessary, a design exception must be given.

3.3 Pavement Design

3.3.1 Rigid Pavement

3.3.1.1 Minimum Rigid Pavement Section

Portland Cement Concrete Pavement (PCCP) designs should be prepared by a geotechnical engineer and approved by the City Engineer.

Pavement designs will include load transfer bars at each joint aligned with the wheel path.

3.3.2 Flexible Pavement

3.3.2.1 Minimum Pavement Section

As part of the subdivision approval process, a soils report is required to be prepared by a Professional Engineer, specializing in geotechnical engineering and soil mechanics. The soils report must include pavement section recommendations using generally accepted engineering practices and methods. The soils report must include a CBR value for existing subgrade soils under proposed pavements. Absence of CBR data will require all roads be built to the standard below for *Collector or Greater*, with *Very Poor* Subgrade Class, regardless of street classification.

The minimum pavement sections are shown in the table below.

		Street Classification (as defined in West Valley City Code 7-13-705)		
Subgrade Class	**Pavement Section**	**Minor Street**	**Minor Collector**	**Collector or Greater (66' ROW +)**
Very Poor (CBR<3)	Asphalt Pavement	3.5-inches	4-inches	6-inches
	Untreated Base Course – Grade 1, or 1-1/2	8-inches	8-inches	10-inches
	Granular Borrow	10-inches	10-inches	12-inches
	Non-woven Geotextile Fabric Required	Yes	Yes	Yes
Poor (CBR 3-9)	Asphalt Pavement	3-inches	3.5-inches	6-inches
	Untreated Base Course – Grade 1, or 1-1/2	12-inches	12-inches	14-inches
	Granular Borrow	0	0	0
	Non-woven Geotextile Fabric Required	No	No	No
Medium CBR>9	Asphalt Pavement	3-inches	3.5-inches	6-inches
	Untreated Base Course – Grade 1, or 1-1/2	8-inches	8-inches	10-inches
	Granular Borrow	0	0	0
	Non-woven Geotextile Fabric Required	No	No	No

3.3.2.2 Seal Coat After Warranty Period

A seal coat treatment per APWA 32 01 13.52 or 32 01 13.68 is required to be placed on asphalt pavements on development projects at the end of the warranty period and final release of the bond.

3.4 Traffic Issues

3.4.1 Traffic Impact Studies

A traffic impact study may be required by the City and must be prepared by a registered Professional Engineer. The traffic study shall include an analysis of on-site circulation, capacities of existing streets, number of additional trips which will be generated, origin/destination studies and peak home traffic generation and movements. West Valley City Code 7-14-106.

3.4.2 Traffic Calming in Residential Neighborhoods

New residential developments must evaluate with the Public Works Department the need for neighborhood traffic calming devices to be installed with the subdivision roadway improvements.

Traffic calming speed tables may be required on residential roadways (66' ROW or less) that exceed 750 feet in length. Developer's engineer to recommend locations of traffic calming devices.

3.5 Roadway Lighting

Per West Valley City Code 7-13-803, streetlights are required to be installed in all new developments.

3.5.1 Streetlight Standards

3.5.1.1 General

The Developer shall incur all costs for and provide trenching in which subsurface electrical lines may be installed to power the street lighting system as shown on the development plans or subdivision plats. Trenching shall be to the depth, width and standards specified by West Valley City.

Components of the street lighting system shall follow the West Valley City special provisions and standard drawings.

The Developer shall purchase the streetlight assemblies and shall provide materials, equipment and labor necessary to install a complete and operable street lighting system as shown on the development plat.

See Streetlight Assembly Drawings in West Valley City Standard Drawings.

The Developer shall schedule a preconstruction meeting with West Valley City Transportation Division, (801-955-3726), prior to any part of construction of the streetlight system for review of the extent of the project and responsibilities of both parties. Failure to comply will result in rejection and delay of project.

3.5.1.2 Streetlight Placement

Streetlights shall be placed on alternating sides of the street at 200 feet maximum for roads of less than 60 feet of right-of-way and at 150 feet maximum for roads of greater than or equal to 60 feet of right-of-way.

Streetlights shall be placed at each road intersection and at the end of each cul-de-sac.

Sidewalk lights shall be located behind the sidewalk and spaced as defined in Title 7.

The developer shall show streetlight locations on all residential, commercial, and industrial development plans or plats. Streetlights should be placed at the intersection of lot line boundaries to avoid unnecessary obstruction along the property frontage. The Transportation Engineer may require additional or fewer

streetlights at his discretion. Additional streetlights may be required in locations where safety hazards or special traffic needs exist.

3.5.1.3 Required Notes on Streetlight Plan

1. All street lighting work shall be performed in accordance with the West Valley City Street Lighting Standards and the APWA Standard Plans and Specifications.

2. Electrical contractor shall contact West Valley City at 801-955-3726 prior to commencement of construction.

3. Contractor shall be responsible to inspect poles and fixtures upon delivery to the job site and to protect the same from damage until installation is complete and lighting system is accepted by West Valley City.

4. Contractor shall be responsible to coordinate construction of lighting system with Rocky Mountain Power and West Valley City. Confirm final location of Rocky Mountain Power transformers or secondary boxes before starting construction.

5. All Light poles, fixtures, junction boxes, transformers or secondary boxes, underground conduit and wiring shall be placed only within the public street right-of-way and/or designated public utility easement. All underground work shall be completed and inspected prior to construction of permanent roadway, sidewalk, and curb and gutter.

6. All aspects of street lighting installation shall be inspected by West Valley City. Call West Valley City Transportation Division at 801-955-3726 to schedule inspections at least 24 hours in advance. Two (2) inspections will be required. One (1) pole and underground installation, and one (1) Final inspection after system installation is completed.

7. Anticipate 12 weeks for delivery of streetlight assemblies from manufacturer.

3.5.1.4 Streetlight ID Number

West Valley City Engineering Division will assign Streetlight Identification Numbers to be shown on the street lighting plans after the light location has been established.

3.5.2 Street Lighting Standard Drawings

Refer to Standard Drawing section in this document for streetlight standard drawings.

3.5.3 Streets with Specific Lighting Requirements per West Valley City Code

Lehman Avenue (West Valley City Code 7-6-406)

Market Street (West Valley City Code 7-6-407)

Constitution Blvd (West Valley City Code 7-6-408)

3500 South – City Center (West Valley City Code 7-6-408)

3650 South (West Valley City Code 7-6-409)

Weigh Station Road and Three Mill Lane (West Valley City Code 7-6-410)

3300/3500 South east of 2700 West, Redwood Road, and 5600 West between 2100 South and 3100 South (West Valley City Code 7-10-200P)

3500 South Streetscape – Between 2700 West and Bangerter Highway (West Valley City Code 7-10-300P)

Part 4: Drainage Design Standards

The following standards apply to new development, redevelopment or construction activities as described below within West Valley City.

4.1 Drainage Design Requirements

The objective of drainage design in the city is to address flood control and water quality impacts of land development activities.

4.1.1 Retention and Detention Standards

4.1.1.1 Land Disturbance Threshold

Certain development or land disturbance projects will be required to meet various requirements in these engineering standards if the following threshold is met:

> Any projects that disturb land greater than or equal to one acre, including projects that are part of a larger common plan of development or sale which collectively disturbs land greater than or equal to one acre (i.e., lots within a subdivision).

This threshold will be referred to as the "Land Disturbance Threshold". Retention Requirement

As directed by the Jordan Valley Municipalities MS4 Permit UTS000001, certain projects meeting the Land Disturbance Threshold are required to retain all or a portion of the *80th Percentile Storm Rainfall Depth* onsite using various low impact development techniques.

4.1.1.2 80th Percentile Storm Rainfall Depth

The following depth shall be used as the *80th Percentile Storm Rainfall Depth for all locations in West Valley City*:

0.43 inches
0.0358 feet

The *80th Percentile Storm Rainfall Depth* for West Valley City was determined using precipitation data from the Salt Lake City International Airport.

4.1.1.3 Retention Requirement on New Development

As directed by the Jordan Valley Municipalities MS4 Permit UTS000001, part 4.2.5.1.2, any new development projects meeting the "Land Disturbance Threshold" must manage rainfall on-site, and prevent the off-site discharge of the precipitation from all rainfall events less than or equal to the 80th percentile rainfall event or a **predevelopment hydrologic condition**, whichever is less.

This objective must be accomplished using practices that are designed, constructed, and maintained to infiltrate, evapotranspire and/or harvest and reuse rainwater.

4.1.1.4 Retention Requirement on Redevelopment

As directed by the Jordan Valley Municipalities MS4 Permit UTS000001, part 4.2.5.1.2, redevelopment projects meeting the "Land Disturbance Threshold" must provide a site-specific and project-specific plan aimed at net gain to onsite retention or a reduction to impervious surface to provide similar water quality

benefits. If a redevelopment project increases the impervious surface by greater than 10%, the project shall manage rainfall on-site, and prevent the off-site discharge of the net increase in the volume associated with the precipitation from all rainfall events less than or equal to the 80th percentile rainfall event. This objective must be accomplished using practices that are designed, constructed, and maintained to infiltrate, evapotranspire and/or harvest and reuse rainwater.

4.1.1.5 Low Impact Development (LID) Design

LID is an approach to land development (or re-development) that works with nature to more closely mimic pre-development hydrologic functions. LID employs principles such as preserving and recreating natural landscape features, minimizing effective imperviousness to create functional and appealing site drainage that treat storm water as a resource rather than a waste product. There are many practices that have been used to adhere to these principles such as bio-retention facilities, rain gardens, vegetated rooftops, rain barrels, and permeable pavements. By implementing LID principles and practices, storm water can be managed in a way that reduces the impact of built areas and promotes the natural movement of water within a watershed.

LID design methods should be used to meet the *Retention Requirements* above. Design methods within *A Guide to Low Impact Development within Utah*, published by the Utah Department of Environmental Quality, Division of Water Quality, may be used to meet LID objectives.

The Retention Requirement storage areas may not be altered in the future without a re-submittal of the Low Impact Development Analysis.

4.1.1.5.1 Project Volume Retention Goals

Compliance with the *Retention Requirements* will require a project to establish and meet a Project Volume Retention Goal.

The Project Volume Retention Goal (Vgoal) for new development is the product of the total area of the development (in square feet), the 80th percentile precipitation depth in feet and a volumetric runoff coefficient (R_V).

Methods for calculating the Volumetric runoff coefficient (R_V) can be found in *A Guide to Low Impact Development within Utah*. The Drainage Report must include Project Volume Retention Goal calculations.

4.1.1.5.2 Recommended LID Best Management Practices

The following BMPs may be considered for use in an LID implementation; additional information can be found in *A Guide to Low Impact Development within Utah.*

- Pervious surfaces in private parking areas or private sidewalks
- Rainwater harvest and reuse
- Rain Garden
- Bioretention Cell
- Bioswale
- Vegetated Strip
- Tree Box Filter

- Infiltration Basin
- Infiltration Trench
- Dry Well
- Underground Infiltration Galleries
- Minimize impervious area on the site
- Preserve natural areas undisturbed
- Reduce directly-connected impervious area, using landscaped areas to capture and store runoff from roof drains or drive/parking areas

4.1.1.5.2.1 Rainwater Harvesting

Since 2010, rainwater harvesting is legal in the State of Utah. If rainwater harvesting and onsite beneficial use is planned as a Low Impact Development technique, registration and other requirements of the Utah Division of Water Rights must be met.

http://waterrights.utah.gov/forms/rainwater.asp

4.1.1.5.2.2 Residential BMPs

Residential BMPs should be selected to meet *Project Volume Retention Goals*

Storm water runoff is not to be stored in the public right-of-way.

4.1.1.5.2.3 Commercial BMPs

Commercial BMPs should be selected to meet *Project Volume Retention Goals*

Storm water runoff is not to be stored in the public right-of-way.

4.1.1.5.3 LID Technical Resources

The following sites are potential technical resources for use in the preparation of a Low Impact Development (LID) Analysis.

Utah DEQ - *A Guide to Low Impact Development within Utah*

https://documents.deq.utah.gov/water-quality/stormwater/updes/DWQ-2019-000161.pdf

Utah DEQ Low Impact Development Resources

https://deq.utah.gov/water-quality/low-impact-development

EPA Green Infrastructure Resources

http://water.epa.gov/polwaste/green/index.cfm

4.1.1.6 Retention Standard Feasibility

It is recognized that certain Low Impact Development BMPs are not feasible in soils of low permeability or in areas with high ground water. Infiltration may be less desirable in areas where retention and/or use of storm water onsite or discharge of storm water onsite via infiltration has a significant adverse effect on the site or the down gradient water balance of surface waters, ground waters or receiving watershed ecological processes. The location of underground utilities should also be considered when analyzing

certain LID BMPs. Feasibility of LID techniques will be assessed within the Drainage Report submitted with each new development or re-development project.

If meeting the retention standards is infeasible, a rationale shall be provided for the use of alternative design criteria. The new development or redevelopment project must document and quantify that infiltration, evapotranspiration, and rainwater harvesting have been used to the maximum extent feasible and that full employment of these controls are infeasible due to constraints. LID infeasibility may be due to one or more of the following conditions: high groundwater, drinking water source protection areas, soil conditions, slopes, accessibility, excessive costs, or others.

4.1.1.7 Retention Only Areas

In some areas of the city (as shown on the Engineering Division Storm Water Release Rate Map) there is no public storm drain system available to receive site runoff, and offsite discharge is not allowed. In these areas, complete storm water retention is required. LID practices and/or ponds are to be sized to store the entire runoff volume of a 100-year 24-hour storm (assume no percolation).

4.1.1.8 Detention Requirement

Storm water detention is required in various locations within the city (as shown on the Engineering Division Storm Water Release Rate Map) to control system wide flood peaks, by capturing storm water onsite and releasing into the city system at a controlled reduced rate.

After the Project Volume Retention Goal has been established, the peak offsite discharge will be limited to the allowable release rate shown on the Engineering Division Storm Water Release Rate Map (see Appendix of these standards). The City Engineer has the latitude to modify the release rate for any given development parcel depending on the capacity of the local storm drain system.

Total onsite runoff storage must contain the required detention storage volume with 1-foot of freeboard. Project Volume Retention Goal may be counted among the required detention storage volume. Detention storage volumes required will be calculated based on the allowable release rate.

Detention calculations should be based on a 10-year storm. Modified Rational Based FAA Method may be used to calculate required detention. Other detention basin sizing methods may be used, together with an approved rainfall distribution.

4.1.1.9 On-Site Storm Water Storage Requirements

Project Volume Retention Goal storage must infiltrate into the soil within 72 hours. Open air ponds with stagnant standing water on soils of low permeability will not be allowed. Project Volume Retention Goal shall be stored in multiple small volume areas to avoid concentration of water into centralized locations.

Storm water detention volume and Project Volume Retention Goal water may be stored in detention basins, parking areas, landscaped areas (where allowed in Title 7), or underground in pipes or storage chambers. Underground storage using open-bottom chambers and open pond retention storage will require detail drawings and an evaluation of sub-surface conditions (water table, soil type, etc…) to demonstrate infiltration feasibility. Outfall pipes of any conveyance offsite will be placed in a manner to prevent the offsite discharge of the Project Volume Retention Goal storage.

4.1.2 Water Quality Standards

4.1.2.1 Pollutant Removal Requirements

A Drainage Report will include a summary of potential pollutants that could be generated from the site after construction stabilization has occurred. The Drainage Report will include structural and non-structural BMPs that will be included on the site to prevent the discharge of potential pollutants.

Potential pollutants from certain site operations are shown in the table below. This is not a comprehensive list.

Potential Pollutants from Various Site Operations					
Pollutant of Concern	Vehicle Operations	Waste Management	Site Maintenance Practices	Outdoor Materials	Landscaping
Nutrients (Nitrogen and Phosphorous)			X	X	X
Pesticides			X	X	X
Solvents			X	X	
Fuels			X	X	
Oil and grease	X			X	
Toxic chemicals		X		X	
Sediment		X	X	X	X
Road salt			X	X	
Bacteria		X			X
Trace metals	X			X	
Hydrocarbons	X			X	

Projects involving vehicle fueling should include BMPs designed to capture hydrocarbons. Projects must include the ability to isolate and store potential high-volume spills on-site.

BMPs selected for use on a project must be included in the Post-Construction (Long Term) Storm Water Management Plan, along with maintenance plans. See section on Drainage Related Permitting in these standards for more information on the Storm Water Management Plan requirements.

4.1.2.2 Non-Structural BMPs

New development and redevelopment projects should evaluate non-structural BMPs to minimize development in areas susceptible to erosion and sediment loss; to minimize the disturbance of native soils and vegetation; to preserve areas that provide important water quality benefits; and to protect the integrity of natural resources and sensitive areas. This evaluation should be included in the drainage report.

4.1.2.3 Other Water Quality Measures

Grease interceptors on sanitary sewer service lines should be located within a depressed landscaped area where feasible to prevent overflows from entering the storm drain system.

4.1.3 Design Storms – Precipitation Depths

The following design storms are for use in determining peak discharge and detention storage requirements.

A design storm is shown below for areas below an elevation of 4500 feet, and above an elevation of 4500 feet. The storm data is established from a NOAA Atlas 14 – Point Precipitation Frequency Estimate from representative areas.

DESIGN STORM FOR AREAS BELOW 4500 FEET IN ELEVATION								
	NOAA Atlas 14 Point Precipitation Frequency Analysis (Depth and Intensity) - For use in areas BELOW 4500 feet.							
	1-Year		2-Year		10-Year		100-Year	
	Depth	Intensity	Depth	Intensity	Depth	Intensity	Depth	Intensity
5-min	0.12 in	1.44 in/hr	0.15 in	1.81 in/hr	0.26 in	3.12 in/hr	0.52 in	6.28 in/hr
10-min	0.18 in	1.10 in/hr	0.23 in	1.38 in/hr	0.40 in	2.38 in/hr	0.80 in	4.78 in/hr
15-min	0.23 in	0.91 in/hr	0.29 in	1.14 in/hr	0.49 in	1.96 in/hr	0.99 in	3.95 in/hr
30-min	0.31 in	0.61 in/hr	0.39 in	0.77 in/hr	0.66 in	1.32 in/hr	1.33 in	2.66 in/hr
60-min	0.38 in	0.38 in/hr	0.48 in	0.48 in/hr	0.82 in	0.82 in/hr	1.65 in	1.65 in/hr
2-hr	0.49 in	0.24 in/hr	0.61 in	0.30 in/hr	0.96 in	0.48 in/hr	1.82 in	0.91 in/hr
3-hr	0.57 in	0.19 in/hr	0.70 in	0.23 in/hr	1.04 in	0.35 in/hr	1.85 in	0.62 in/hr
6-hr	0.73 in	0.12 in/hr	0.89 in	0.15 in/hr	1.25 in	0.21 in/hr	1.97 in	0.33 in/hr
12-hr	0.90 in	0.08 in/hr	1.10 in	0.09 in/hr	1.52 in	0.13 in/hr	2.32 in	0.19 in/hr
24-hr	1.06 in	0.04 in/hr	1.30 in	0.05 in/hr	1.75 in	0.07 in/hr	2.48 in	0.10 in/hr

DESIGN STORM FOR AREAS ABOVE 4500 FEET IN ELEVATION								
	NOAA Atlas 14 Point Precipitation Frequency Analysis (Depth and Intensity) - For use in areas ABOVE 4500 feet.							
	1-Year		2-Year		10-Year		100-Year	
	Depth	Intensity	Depth	Intensity	Depth	Intensity	Depth	Intensity
5-min	0.12 in	1.49 in/hr	0.16 in	1.88 in/hr	0.27 in	3.23 in/hr	0.53 in	6.41 in/hr
10-min	0.19 in	1.13 in/hr	0.24 in	1.43 in/hr	0.41 in	2.46 in/hr	0.81 in	4.88 in/hr
15-min	0.23 in	0.94 in/hr	0.30 in	1.18 in/hr	0.51 in	2.03 in/hr	1.01 in	4.04 in/hr
30-min	0.32 in	0.63 in/hr	0.40 in	0.80 in/hr	0.68 in	1.37 in/hr	1.36 in	2.72 in/hr
60-min	0.39 in	0.39 in/hr	0.49 in	0.49 in/hr	0.85 in	0.85 in/hr	1.68 in	1.68 in/hr
2-hr	0.49 in	0.25 in/hr	0.62 in	0.31 in/hr	0.98 in	0.49 in/hr	1.84 in	0.92 in/hr
3-hr	0.58 in	0.19 in/hr	0.71 in	0.24 in/hr	1.06 in	0.35 in/hr	1.88 in	0.63 in/hr
6-hr	0.75 in	0.12 in/hr	0.92 in	0.15 in/hr	1.29 in	0.22 in/hr	2.03 in	0.34 in/hr
12-hr	0.94 in	0.08 in/hr	1.14 in	0.10 in/hr	1.58 in	0.13 in/hr	2.40 in	0.20 in/hr
24-hr	1.14 in	0.05 in/hr	1.40 in	0.06 in/hr	1.91 in	0.08 in/hr	2.71 in	0.11 in/hr

4.1.4 Storm Drain Design for Publicly Owned Systems

4.1.4.1 Pipe Sizing

All pipes in the public storm drain system are to be sized to pass the peak flow on a 10-year storm without pressurizing. Peak flow shall be determined after runoff has been calculated using an approved rainfall distribution through time, addressed in the section below.

Minimum pipe size in the public right-of-way is 15-inch. Exceptions must be approved by the City Engineer. Pipe sizing calculations must be prepared by a Professional Engineer.

4.1.4.2 Rainfall Distribution

To compute runoff from a given storm, the distribution of rainfall through time must be known. Critical rain events in the region occur as cloudburst storms, with short durations of high intensity of rainfall. In sizing pipes, use a rainfall distribution reflecting these cloudburst rainfall events.

Options for a rainfall distribution could include a transformed SCS Type II distribution, or a Salt Lake County modified "Farmer-Fletcher" Distribution.

4.1.4.3 Minimum Velocity

Maintain a minimum velocity of 2.5 feet per second in all gravity pipe culverts, assuming the pipe is flowing full. Exceptions must be approved by the City Engineer.

4.1.4.4 Pipe Type

All storm drains or irrigation pipe in the public right-of-way shall be reinforced concrete pipe. Class of pipe is determined from recommendations of pipe manufacturers, based on soil type, depth of cover and loads.

Storm drain pipes (city-owned) located outside of the public right-of-way are required to be reinforced concrete pipe. Other pipe types may be considered for a specific application and must be approved by the City Engineer.

4.1.4.4.1 Video Inspection

A video inspection of all city-owned storm drain pipe is required at the expense of the developer or permit holder for the city to process the 90% Bond release.

4.1.4.5 Storm Drain Boxes

Storm Drain Cleanout Boxes shall be per the West Valley City Storm Drain Cleanout Box standard detail.

Other Storm Drain Boxes (Catch Basins, and Combination Catch Basin/Cleanout Boxes) shall be per APWA 315 and 316.

Thin walled "knock-out" boxes are not approved for use in the public right-of-way.

Deviations from this standard must be approved by the City Engineer.

4.1.4.5.1 Storm Drain Layout Principles

4.1.4.5.1.1 Use of Waterways or Cross-Gutters

In general, avoid the use of waterways or cross-gutters. No mid-block waterways are allowed. Waterways are not allowed at intersections of streets of right-of-way widths of 66-feet or larger. Any exception must be approved by the City Engineer.

4.1.4.5.1.2 Silt Traps

In general, do not install silt traps in each catch basin. Install silt traps in selected cleanout boxes at strategic locations designed to maximize the amount of sediment that can be cleaned from a single box.

4.1.4.5.1.3 Cleanout Spacing

Do not exceed 300 feet between cleanout access. Exceptions must be approved by the City Engineer.

4.1.4.5.1.4 Inlet Spacing

Drainage inlets are sized and located to limit the spread of water into traffic lanes. The following table summarizes allowable spread of water under various conditions.

Gutter Spread Design Criteria			
Roadway Classification		Design Frequency	Allowable Spread
Subdivision Streets		10-Year	Gutter + 6-feet
Collector	< 45 mph	10-Year	Gutter + 6-feet
	Sag Point	10-Year	Gutter + 3-feet
Arterial (ROW > than 66')	< 45 mph	10-Year	Gutter + 3-feet
	Sag Point	50-Year	Gutter + 6-feet

The Rational Method is an acceptable method for calculating momentary peak-flow rate for use in spread calculations.

4.2 Drainage Report Requirements

All new development and redevelopment sites must submit a drainage report, stamped by a Professional Engineer addressing items in this section.

4.2.1 Drainage Report Requirements – Plan Elements

Drainage Report should contain all relevant drainage data and calculations. Include a narrative describing hydrologic methodology and software used to determine runoff, routing, and other applicable information.

Complete layout of storm drainage system is required as part of the Drainage Report. Show drainage areas that will contribute to storm flows, both on-site and off-site. Provide data indicating cumulative pipe flows and full flow capacities for each segment of pipe. Each pipe segment is to be labeled with length, pipe material type, diameter and slope. Provide arrows indicating the flow direction of each pipe.

4.2.2 Drainage Report Requirements – Low Impact Development Evaluation

Drainage report must include a thorough evaluation of Low Impact Development techniques, and a rationale for the use of alternative design criteria on sites where retention/LID standards are infeasible must be included in the Drainage Report. The new or redevelopment project will be required to document

and quantify that infiltration, evapotranspiration and rainwater harvesting have been used to the maximum extent feasible.

Evaluate new development and redevelopment sites to determine if they are susceptible to erosion and sediment loss. Include BMPS to address erosion including preserving natural vegetation if feasible for the site. Natural Vegetation should not be completely removed from sites until required for construction. If mass grading is needed for the project, include alternative BMPs structural and nonstructural for erosion prevention/reduction.

The Low Impact Development Evaluation on redevelopment projects will address the net reduction of site runoff volume or reduction to impervious surfaces on the project. A Low Impact Development Evaluation must include calculations to determine if the Project Volume Retention Goal has been met if the impervious surface is increased by 10%.

4.2.3 Drainage Report Requirements – Retention Requirement Calculations

Drainage reports are to include Project Volume Retention Goal calculations and show retention storage locations.

4.2.4 Drainage Report Requirements – Detention Calculations

Drainage reports are to include peak discharge and detention storage calculations.

4.2.5 Drainage Report Requirements – Water Quality and Targeted Pollutants

Drainage reports are to include an evaluation of proposed land use and identify and target potential pollutants that will be generated in the long-term use of the project.

Drainage reports should address the following:

- BMP selection rationale. Discuss how long-term storm water BMPs were selected, and how they will protect water quality and reduce the discharge of pollutants to the city's drainage system.
- The pollutant removal expected from the selected BMPs
- The technical basis which supports the performance claims for the selected BMPs

4.2.6 Drainage Report Requirements - Hydrologic analysis

Include a hydrologic analysis used to design the system.

4.2.7 Drainage Report Requirements - Pipe sizing calculations

Drainage reports to include pipe sizing calculations, inlet spacing and gutter spread calculations.

4.3 Drainage Related Permitting

4.3.1 Storm Water Management Permits

A project will be required to obtain a West Valley City *Storm Water Management Permit* if the proposed work meets the requirements of Title 18-2-101 or 18-7-106 (largely based on area of disturbed soil). The *Storm Water Management Permit* addresses two separate components of storm water quality and is issued as two separate permits. The first component of the *Storm Water Management Permit* covers construction activities, and the second covers the post-construction (long term) storm water management of a proposed development, re-development, or other improvements. The construction *Storm Water*

Management Permit may be issued prior to full plan approval to allow for early site grading. The post-construction *Storm Water Management Permit* must be completed prior to issuance of a building permit or other type of permit.

Application for stormwater permits is made through the West Valley City Permitting and Licensing Portal. https://pllportal.wvc-ut.gov/portal

4.3.1.1 Construction Period Storm Water Management Permit

Address the following requirements to obtain a Construction Period Storm Water Management Permit.

4.3.1.1.1 Storm Water Pollution Prevention Plan (SWPPP)

Prepare a site-specific Storm Water Pollution Prevention Plan (SWPPP) for any site requiring a Construction Period Storm Water Management Permit. The SWPPP shall be prepared by a competent professional with experience in developing SWPPPs.

4.3.1.1.2 SWPPP Preparation Guidelines

The following are some of the resources available for use in the preparation of a Storm Water Pollution Prevention Plan:

DWQ SWPPP Template, and other guides – available on the Utah Department of Environmental Quality - Division of Water Quality website, under "Construction Activities"

4.3.1.1.3 NOI Required

A Utah State Notice of Intent (NOI) is required whenever a project meeting the "Land Disturbance Threshold" has been met. Application for NOI obligates the project to comply with all requirements contained in the UPDES General Permit for Discharges from Construction Activities (UTRC00000).

West Valley City storm water permits will not be issued until a copy of the NOI has been submitted to the Engineering Division.

4.3.1.1.4 NOI on Lots Smaller than One Acre

An NOI is also required on lots smaller than one acre when that lot is part of a common plan of development larger than one acre. An NOI will only be required on these smaller lots when the larger development has been stabilized, and when the NOT (Notice of Termination) has been issued for the larger common plan of development.

Construction on lots smaller than one acre which are part of a larger common plan of development will require a storm water pollution prevention plan, and a West Valley City Construction Storm Water Permit.

4.3.1.1.5 West Valley City Construction Storm Water Permit Required on All Projects

A West Valley City Storm Water Construction Permit is required on all construction projects, regardless of disturbance area.

4.3.1.1.6 Permit Application

Construction period Storm Water Management Permits are obtained through the West Valley City Permitting Portal

https://pllportal.wvc-ut.gov/portal

4.3.1.2 Post Construction Storm Water Management Permit

4.3.1.2.1 Storm Water Management Plan (SWMP)

All new development and redevelopment projects are required to develop a Storm Water Management Plan. Using the *Guidance Document for Storm Water Management* or other resources, prepare a Post-Construction (Long Term) Storm Water Management Plan (SWMP) to address long term storm water quality issues. SWMP must address the treatment of potential pollutant sources (as identified in the drainage report) from the proposed land use, BMPs to address the potential pollutants, maintenance practices of proposed BMPs, employee training, landscape maintenance, waste disposal and any other long term practice that will be required to maintain quality storm water runoff.

The SWMP will become part of the Storm Water Management Permit and annual post-construction inspections will be performed by the Engineering Division to ensure compliance with the requirements of the permit. **The SWMP is best prepared by the property owner, as they will be required to implement the plan in perpetuity.**

4.3.1.2.1.1 Storm Water Management Template

Commercial/Industrial Best Management Practices (BMPs) are those measures and/or practices to be maintained by the property owner or operator to prevent illicit discharges, pollutants, and other contaminants from entering the City storm water system. These measures and practices are to be implemented upon completion of construction activities, to be conducted and maintained in perpetuity.

A template for the Long-Term Stormwater Management Plan can be downloaded from the West Valley City Webpage: http://www.wvc-ut.gov/785/Development-Section

4.3.1.2.1.2 Permit Application

Long Term Storm Water Management Permits are obtained through the West Valley City Permitting Portal. https://pllportal.wvc-ut.gov/portal

Part 5: Development Review

The following standards apply to all new development or redevelopment projects.

5.1 Development Plan Set Submittal Requirements

5.1.1 Digital Plan Submittal

Plans may be submitted electronically through the West Valley City Permitting and Licensing Portal. https://pllportal.wvc-ut.gov/portal

Plans should be submitted as pdf files formatted to print to scale on a standard paper size.

5.1.2 Subdivisions

5.1.2.1 Subdivision Plan Elements

Engineering drawings should include the following:

- Cover sheet with vicinity map and a sheet index
- Subdivision plat. (Subdivision plans must be approved prior to final approval of plat)
- Site Plan
- Street Plan
    - Show existing and proposed improvements on opposite and adjacent frontages
    - Show plan and profile of streets, including sidewalk, curb and gutter
    - Include TBC and Centerline stations and elevations to be shown at 50' intervals and at all PC, PT, PRC, PVI, BVC and EVC locations
    - Vertical curve stations and elevations to be shown at 25' intervals
    - Pavement section shall be per soils report recommendations or West Valley City standards, whichever is greater
    - Include storm drain improvements in both plan and profile views. Label size, type, slope and length of each segment (minimum 15" RCP required within public right-of-way)
    - Show all monuments to be installed, include monument to monument bearings and distances
    - Include north arrow, scale and legend (horizontal scale to be 1"=20')
    - Reference plans to specific APWA standard plans and WVC standards
- Grading and drainage plan with drainage calculations (see Storm Water Design Requirements).
    - Subdivision grading plans shall conform to West Valley City Code 7-2-116, and 7-13-102, 7-13-805.
    - On drainage plan, reference Drainage Report completed for the project
    - Final grading of individual lots shall be performed in such a way that excess water shall be contained entirely on the site or directed to an improved street or directed to an approved drainage inlet, drainage channel or drainage easement. Excess water shall not be allowed to drain onto adjacent private property unless approved as part of an overall system, as reflected in the subdivision approval or otherwise
    - Storm water retention areas on individual lots are permanent designed features to prohibit movement of water from one lot to the next and may not be altered. Individual lot

grading and Drainage Plans will be required at building permit stage in areas where stormwater runoff cannot be directed to an improved street. The retention areas shall be designed to capture a 10-year, 1-hour storm event. Only directly connected impervious areas need to be modeled to evaluate required storage. Infiltration rates, determined from a percolation test, may be used in retention volume calculations.

        - Retention areas are to be constructed underground, with a buried perforated pipe, gravel and fabric with an inlet and lot grading to direct runoff into the storage system

    - Show existing and finish grade contours (clearly differentiated) at minimum one-foot intervals
    - Identify County benchmark location and elevation
    - Label size, type, slope and length of each gravity flow pipe. All storm drain piping within the public right-of-way to be minimum 15" RCP
    - Label high water contour of detention areas
    - Show all irrigation and drainage ditches and proposed piping (Written approval from water users to pipe or abandon any ditches on property)
- Utilities Drawing
- A Storm Water Pollution Prevention Plans (SWPPP) is required for developments meeting the "Land Disturbance Threshold". Developments of area less than one acre will still be required to take appropriate measures to prevent sediment from entering the storm drain system and to prevent the tracking of mud and debris onto city streets. Developments of less than one acre will be required to prepare an erosion control plan and obtain a West Valley City Storm Water Management Permit – Construction Period. Refer the Drainage Standards in this document in preparing a SWPPP.
- Applicable notes and details

Upon plan approval, a bond will be calculated, and a list of applicable fees will be provided for the developer (see bonding).

Submit a street lighting plan. See the Modified APWA Specification Section 26 56 19 – Roadway Lighting for details.

5.1.2.2 Subdivision Drainage Design Submittal

Submit a Drainage Report as addressed in the Drainage Design section of these standards.

5.1.3 Commercial, Industrial and Multi-Family Plan Set Requirements

Engineering drawings should include the following:

- Cover sheet with vicinity map and a sheet index.
- Site plan
    - Show existing off-site improvements on opposite and adjacent frontages, including drive approaches, existing utilities, storm drain, sewer, water, and proposed improvements
    - Dimension site plans (i.e. drive approach widths, throat length, setbacks, etc.)
    - Include north arrow, scale, vicinity map and legend
    - Show plan and profile and/or spot elevations of sidewalk, curb and gutter

- Indicate right-of-way dedication, if necessary, to match major street plan. Include road centerline information (ties to existing monuments)
- Reference plans to specific APWA Standard Plans and Specifications and WVC standards

- Grading and Drainage Plan.
  - Site grading must conform to West Valley City Code 7-2-116 relating to grade changes.
  - Submit an overall grading and drainage plan for the entire site. Include final and existing contours at no greater than 1-foot intervals. Identify County benchmark and elevation.
  - On drainage plan, reference Drainage Report completed for the project.
  - High water contour required in detention areas. Identify orifice plate location, size and elevation. Clearly identify any LID Capture Volume storage areas.
  - Provide oil/water separator for all parking areas or other approved BMP.
  - Label size, type, slope and length of each gravity flow pipe.
  - Label invert, grate and/or lid elevations of storm drain inlets and boxes
  - Show all irrigation and drainage ditches and proposed piping (Written approval from water users is required to pipe or abandon any ditches on property)

- Plan and Profile drawings of any street improvements in new or along existing streets (see Roadway Design).
- Utility Plans.
- A Storm Water Pollution Prevention Plan (SWPPP) for developments meeting the "Land Disturbance Threshold". Developments of area less than one acre will still be required to take appropriate measures to prevent sediment from entering the storm drain system and to prevent the tracking of mud and debris onto city streets. Refer to the Drainage Standards in this document in preparing a SWPPP.A Post-Construction (Long Term) Storm Water Management Plan is required. Refer to Drainage Standards in this document in preparing a Storm Water Management Plan.

  Upon plan approval, a bond will be required to guarantee the construction of certain public improvements and appurtenances. The plan review staff will determine a bond amount and a list of applicable fees will be provided to the developer (see section on Bonding for Public Improvements in these standards).

5.1.3.1 Commercial, Industrial and Multi-Family Drainage Design Submittal

Submit a Drainage Report containing all pertinent data and calculations as discussed in the Drainage Design section of these standards.

Submit a drainage construction plan set showing pipes and drainage structures to be constructed together with all information necessary to construct the drainage system.

See section on Drainage Design Concepts in this document for drainage standards.

5.2 Subdivision Platting Requirements

This section contains information required on a Preliminary Plat, Final Plat or Subdivision by Metes and Bounds.

(Note: Per West Valley City Code; 1-2-110, Consolidated Fee Schedule; Plan review - $50 (Fees will be assessed for plan reviews in which the developer or engineer has not made appropriate modifications requested in the previous review.)

5.2.1 Preliminary Plat Requirements

The following items should be addressed on a preliminary plat:

- A vicinity sketch at a scale of 1000 feet or more to the inch. The vicinity sketch shall show the street and tract lines and names and numbers of all existing subdivisions, and the outline of parcels of land adjacent to the proposed subdivision.
- The date, North point, written and graphic scales (North to top or right of sheet).
- A legal description to define the location and boundaries of the proposed subdivision.
- The location, names and existing widths of adjacent streets.
- The contours, at one-foot intervals, for predominant ground slopes within the subdivision between level and five percent, and two-foot contours for predominant ground slopes within the subdivision over five percent. Such contours shall be based on Salt Lake County datum. The closest City or County survey monument shall be used, and its elevation called out on the map. Survey monument information shall be obtained from the Salt Lake County Surveyor.
- A grading and drainage plan showing the proposed grading of the subdivision. Contours should be consistent with West Valley City Code 7-19-603(2)(j).
- Preliminary indication of needed storm drainage facilities with location, size and outlets of the drainage system. Preliminary Drainage calculations to include flows from offsite, flows to be generated onsite, and flows to be discharged to existing storm drain systems.
- The boundaries of areas subject to flooding or storm water overflow, as determined by the Public Works Department, and the location, width and direction of flow of all watercourses, including all existing and proposed irrigation and natural runoff channels and courses.
- The locations, proposed names, widths and a typical cross section of curbs, gutters, sidewalks and other improvements of the proposed street and access easements.
- Street names to be approved by the Salt Lake County Addressing Division.
- Preliminary location and size of sanitary sewers, water mains and any other public or private utility.
- The dimensions and locations of all existing or proposed dedications, easements and deed restrictions. These shall include easements for drainage, sewerage and public utilities.
- The location of any of the foregoing improvements which may be required to be constructed beyond the boundaries of the subdivision.
- The name of the subdivision. Such subdivision names shall not duplicate or nearly duplicate the name of any subdivision in the City or in the incorporated and unincorporated area of Salt Lake County.
- Layout of all lots, including the average and minimum lot size, lot divisions, building setback lines and consecutive numbering.
- The name and address of the subdivider and his or her agent, if applicable.
- The name and address of the person, firm or organization preparing the preliminary plat.

- The names and numbers of adjacent subdivisions and the names of owners of adjacent unplatted land.
- The location of all isolated trees worthy of preservation with a trunk diameter of four inches or greater, within the boundaries of the subdivision, and the outlines of groves or orchards.
- The existing use or uses of the property and the outline of any existing buildings and their locations in relation to existing or proposed street and lot lines drawn to scale.
- The location and description of all existing fencing.
- A statement of the present zoning and proposed use of the property, as well as proposed zoning changes, whether immediate or future.
- Location and dimensions of proposed sites to be dedicated or reserved for open space or recreational use.
- Any proposed lands to be reserved in private ownership for community use.
- The boundaries of phases, along with the estimated construction schedule for each phase.
- The words "Preliminary Plat - Not to be Recorded" shall be shown on the plat.

5.2.2 Final Plat

- Submit copy or Record of Survey Map used to determine existing or proposed boundaries of the proposed subdivision.
- Submit closure sheets for all lots, parcel, streets and exterior boundary of proposed subdivision.

5.2.2.1 Plat Information Requirements

The following information is to be shown on a final plat:

- Title shall include approved name and phase number of subdivision, 1/4 Section, Section, Township and Range followed by words "West Valley City." Subdivision name is to be distinct from any name on a plat recorded in the office of the Salt Lake County Recorder.
- Plat to be signed, sealed, and certified by a Professional Land Surveyor (PLS). PLS stamp, signature and date required on all plats submitted for review.
- Plat plotted on a 24"x 36" sheet(s) with a north arrow, and both written & graphic scales.
- Legend required for all symbols and line types depicted.
- Exterior boundary to agree with existing or proposed division lines as depicted on filed or approved Record of Survey ROS Map(s).
- Exterior boundary clearly defined (heavy line) with Point of Beginning (POB), lines, and curves labeled.
- Boundary tied spatially to at least two existing (found) clearly described PLSS monuments or other monuments of record. Basis of bearings (B of B) identified between two PLSS monuments or other found monuments of record.
- Written legal description to agree with exterior boundary labels, ties to monuments, and Basis of Bearing.
- Total acres shown and total number of lots noted.
- Show recording information for adjoining plats of record and to vesting documents for adjoining parcels.

- Plat boundary checked spatially for harmony with legal descriptions for adjoining parcels and plats.
- Lot distances equal boundary and street distances.
- Vicinity map required.
- Monuments shown at intersections, P.C. and P.T. or at P.I. if within roadway. Monument to monument, and monument to boundary bearings and distances to be labeled.
- Right-of-Way widths to be labeled at all PC & PT locations.
- Show centerlines and widths of all existing streets (within 200 feet of subdivision boundary) clearly defined with line, curve, and offset labels, also identify and show dimensions to any existing (found) street monuments.
- Proper approach angle on streets; intersections with major streets must dedicate right-of-way to chord.
- Existing easements are to be depicted graphically on the plat along with references to their instrument(s) of record or to ROS map(s) asserting any observed evidence of possible unrecorded, statutory, or prescriptive easements, said easements are to be clearly defined with line and curve labels, centerline offsets, and dimensions to future ownership interest lines.
- Public utility easements to be shown as required.
- Shown any other easements as may be required. Include specific conveyance language (to whom it is in favor) and declared purpose for each easement type created by the plat.
- Streets, lots, parcels and easements to be adequately labeled with necessary line, curve, and offset dimensions.
- Subdivision boundary, lots, parcels and streets to close mathematically.
- Postal easements shown (streets without parkstrips).
- Street names shown and approved (non-linear streets to have alpha name as well as coordinates). Names required for non-linear streets (may not duplicate existing street names within the County). Street names to be approved by the Salt Lake County Addressing Division.
- Lot and street addresses required.
- Floodplain boundary and base flood elevation (BFE) information should be shown for all plats lying with a Special Flood Hazard Area.

5.2.2.2 Required Notes on a Final Plat

When applicable, the following notes should be included on the plat.

- A soils report in accordance with Section 7-13-504 of the West Valley City Ordinances has been prepared. Include name of geotechnical engineer or firm, report #, and date.
- Note indicating historical depth of high-water table and elevation of lowest floor slab (min 3' above water table). Include table showing finished floor elevation for each lot referenced to finished TBC (based upon soils report findings).
- Identify lots where easements for special drainage facilities will be required.
- 5/8" x 24" rebar with survey cap to be placed at all lot corners (Cap shall include the business name or “P.L.S.” followed by the license number of the surveyor in charge). Off-set pins to be placed in the back of the curb, in lieu of rebar and cap at front corners.

- Building permits will not be issued for any structure until 1) asphalt paving is installed; and 2) fire hydrants are installed, approved & charged.
- This area is adjacent to Agriculturally Zoned property and is subject to the normal, everyday sounds, odors, and all other aspects associated with an agricultural lifestyle (If adjacent to A zones).

5.2.2.3 Additional Requirements

Letters from all utility companies may be required, indicating their review and approval of plat.

5.2.3 Subdivision by Metes and Bounds

Requirements for Subdivision by Metes and Bounds will follow those plat (map) requirements per Utah State law for boundary surveys as outlined in West Valley City Code 17-23-17 (3) & (4). The following should be addressed on a Subdivision by Metes and Bounds:

5.2.3.1 Plat Requirements

Utah State Code as amended, Section 17-23-17(3)

- The location of survey by quarter section and township and range;
- The date of survey;
- The scale of drawing and; north point
- The distance and course of all lines traced or established, giving the basis of bearing and the distance and course to two or more section corners or quarter corners, including township and range, or to identified monuments within a recorded subdivision;
- All measured bearings, angles, and distances separately indicated from those of record;
- A written boundary description of property surveyed;
- All monuments set and their relation to older monuments found;
- A detailed description of monuments found, and monuments set, indicated separately;
- The surveyor's seal or stamp; (seal requirements see R156-22-701 (1) (c) states "Each seal shall be signed and dated with the signature and date appearing across the face of each seal imprint.")
- The surveyor's business name and address

5.2.3.2 Narrative Requirements

Utah State Code as amended Section 17-23-17(4)

- The map shall contain a written narrative that explains and identifies;
    - The purpose of the survey;
    - The basis on which the lines were established; and
    - The found monuments and deed elements that controlled the established or reestablished lines

5.2.3.3 Additional West Valley City Requirements

- Vicinity map
- Checks with ownership plat; adjoining ownership shown
- Addresses shown
- Lot area shown; total acres shown

- Existing easements and rights-of-way of record
- Final approval signature block included
- Print on 24" x 36" sheet

5.2.4 Survey Monuments

Survey monuments to be placed in accordance with West Valley City Code 7-19-909

5.2.4.1 Disturbance of existing Section Corner, Quarter Corner or Street Monuments

Prior to any disturbance or removal of any existing survey monuments, the office of the Salt Lake County Surveyor must be notified and a Monument Permit must be obtained.

In accordance with Utah State Code as amended, 17-23-14, a Monument Permit is issued by the County Surveyor or Designee prior to disturbing, damaging, removing, moving or covering any public survey monument. If a permit is not issued, a person may be guilty of a Class C misdemeanor and is additionally responsible for assessed penalties and fees.

5.2.4.2 Street monuments in conjunction with new subdivisions or road dedication plats

Street monuments are required to be set at street centerline intersections and at radius points of cul-de-sacs, and inter-visibly along street rights-of-way corridors on curve PIs (if within asphalt), PCs, PTs, or Midpoints.

Subdivision monuments shall be installed by the subdivider's land surveyor at such points designated on the final plat as approved by the City Engineer. Monuments must be placed prior to the release of the improvement bonds. All monuments shall be certified by the subdivider's land surveyor as accurate.

5.2.4.2.1 Monument Permit required for new monuments

It is unlawful for any person to install survey monuments having a spatial relationship with any section or quarter section corner without first obtaining from the Salt Lake County Surveyor's Office a monument permit for such installation. All survey monuments installed shall be in accordance with the permit issued and shall be subject to inspection and approval by the Salt Lake County Surveyor's Office.

5.2.4.2.2 Lot and property corners to be monumented

Rebar five-eighths inch in diameter and 24 inches in length, with surveyor cap, shall be located in the ground, flush at finished grade and at all lot corners. Cap shall include the business name or “P.L.S.” followed by the license number of the surveyor in charge. Off-set pins to be placed in the back of the curb where applicable, in lieu of rebar and cap at front corners.

5.3 Bonding for Public Improvements

In accordance with West Valley City Code 7-19-618, a subdivider is required to either complete all improvements, or enter into a performance bond agreement with the city prior to plat recordation to ensure the completion of all required public improvements. Improvements installed prior to plat recording shall be bonded at a rate of 10 percent for the duration of the warranty period and must be inspected during construction by West Valley City Engineering staff.

5.3.1 Bonding Procedures

Performance Bond agreements shall be entered into in accordance with West Valley City Code 7-19-618.

5.3.1.1 Acceptable Bond Agreement Types

- With a surety company licensed to do business in the State of Utah
- An irrevocable letter of credit with a financial institution federally or state insured
- Cash or a cashier's check made payable only to the city

5.3.1.2 Bond Time Period Requirements

Per West Valley City Code; Completion of the improvements within a period of time not to exceed two years from the date the agreement is executed.

The time period for the completion of the required public improvements may be extended in the following manner:

- Upon approval of the City Manager, the time period may be extended an additional two years from the expiration date of the original bond agreement.
- Said approval shall be in a form approved by the City Attorney's Office and in compliance with all provisions of West Valley City Code.
- Any further extension shall be by approval of the City Council.

Per Utah State Code as amended, 10-9a-604.5; the warranty period for subdivision or other development activity improvements may extend up to one year after final acceptance of the improvement or warranty work. In some cases, the city may require two years of warranty after final acceptance of the improvement or warranty work if the city determines for good cause that a lesser period would be inadequate to protect the public health, safety, and welfare and had substantial evidence of prior poor performance of the applicant, unstable soil conditions within the subdivision or development area, or extreme fluctuations in climatic conditions that would render impracticable the discovery of substandard or defective performance within a one-year period.

5.4 Floodplain Development Requirements

5.4.1 Flood Plain Development

5.4.1.1 Flood Plain Development Permit

In accordance with and to ensure compliance to West Valley City Code, Title 25 (Flood Damage Prevention), a *Development Permit* is required within *Special Flood Hazard Areas* as defined on the FEMA *Flood Insurance Rate Maps* (FIRM).

5.4.1.1.1 Flood Plain Development Permit Procedures

Flood Plain Development Permit Procedures are defined in West Valley City Code 25-4-103.

A Flood Plain Development Permit application is available in the office of the Engineering Division. Contact the engineering development personnel for more information.

5.4.1.1.2 Establishment of a Base Flood Elevation

The FEMA Flood Insurance Study, including floodway data tables and profiles must be used to establish the base flood elevation to the nearest tenth of a foot.

Part 6: General Construction Requirements

The following standards apply to construction activities within the public right-of-way.

6.1 Construction in the Public Right-of-Way

6.1.1 Quality Control

Quality control is the responsibility of the Contractor and shall be performed in compliance with the WVC Minimum Sampling and Testing Guide.

Contractors doing work or placing materials in a public road or what will become a public road or other infrastructure, will be required to have qualified quality control personnel on site to test and document material placement in accordance with the WVC Minimum Sampling and Testing Guide.

All work and quality control testing must be performed in coordination with and under the supervision of a West Valley City technician. Random testing locations shall be identified by a West Valley City technician. Inspections with the Engineering Division must be scheduled 24-hours in advance of proposed work.

Quality control documentation must be submitted for all required tests outlined in the WVC Minimum Sampling and Testing Guide. Documentation will be required prior to the advancement to the next phase of construction and the release of bonds.

6.1.2 Right-of-Way Permit

6.1.2.1 A Right-of-Way Permit is Required

Any excavation work in a West Valley City right-of-way requires West Valley City Right-of-Way Permit. Exceptions in emergency cases are noted in West Valley City Code 19-2-301.

6.1.2.2 General Right-of-Way Permit Requirements

6.1.2.2.1 Permitting and Licensing Portal

Application for Right-of-Way Permits is made through the West Valley City Permitting and Licensing Portal.

https://www.wvc-ut.gov/177/Right-of-Way-Permits

6.1.2.2.2 Insurance and Completion Bond

Insurance requirements shall be per West Valley City Code 19-2-304

A completion bond is required in the amount specified in West Valley City Code 19-2-305. A minimum amount of $10,000 is required, but a larger bond may be required based upon the extent of the construction.

6.1.2.2.3 Contractor's License

A copy of the contractor's license must be submitted to receive a Right-of-Way Permit.

6.1.2.2.4 Traffic Control Plan

A traffic control plan must be submitted and approved for all work in the public right-of-way prior to issuance of a Right-of-Way Permit.

6.1.2.2.5 Proposed Work Plan

A plan showing the proposed work must be submitted with the permit application.

6.1.2.2.6 Boring or Directional Drilling in the Right-of-Way

Permits involving directional boring will be charged a fee for each instance that a storm drain is crossed to verify the culvert or structure has not been compromised. The contractor will be notified of any damage and required to remedy prior end of the warranty period.

6.1.2.2.7 Peak Hour Lane Use Restrictions

Certain streets have peak-hour lane use restrictions, requiring an additional fee for peak hour lane restrictions. Peak Hour Lane Use Fee is shown in the consolidated fee schedule in Title 1.

The AM Peak is defined as 6:00 am to 10:00 am. The PM Peak is defined as 4:00 pm to 7:00 pm.

Restrictions are as follows:

Peak Hour Lane Use Fee - Major Roads				
Road	**From**	**to**	**AM Peak**	**PM Peak**
4700 South	2700 West	5600 West	Eastbound	Westbound
4100 South	Jordan River	8400 West	Eastbound	Westbound
3100 South	Redwood Road	5600 West	Eastbound	Westbound
Parkway Blvd/Lake Park Blvd.	Redwood Road	5600 West	Eastbound	Westbound
Parkway Blvd/Lake Park Blvd.	5600 West	7200 West	Either Direction	Either Direction
2700 West	4100 South	2700 South	Either Direction	Either Direction
3200 West	2100 South	4100 South	Either Direction	Either Direction
3600 West	3500 South	4100 South	Either Direction	Either Direction
4000 West	3100 South	4700 South	Either Direction	Either Direction
4800 West	3500 South	Lake Park Blvd	Northbound	Southbound
7200 West	3500 South	SR-201	Northbound	Southbound

6200 South	5600 West	SR-111	Eastbound	Westbound
3030 West	Lehman Avenue	3500 South	Either Direction	Either Direction
Lehman Avenue	Market Street	3030 West	Either Direction	Either Direction
Market Street	Lehman Avenue	3500 South	Either Direction	Either Direction
Weigh Station Road	Market Street	3030 West	Either Direction	Either Direction
SR-201 Frontage Road	7200 West	2700 West	Either Direction	Either Direction

6.1.3 Roadway Excavation Restoration Standards

6.1.3.1 Minimum Pavement Replacement Requirements

Any pavement excavation in which the remaining pavement width is less than the width shown below shall be removed and replaced to the existing edge of pavement.

	Minimum Allowable Remaining Pavement Width
Roads with curb and gutter	2-feet
Roads with no curb and gutter	4-feet

6.1.3.2 Embankment Material

Material used to build fill under a roadway or sidewalk grade shall meet the requirements for *Granular Borrow*, in Section 31 05 13 of the Utah APWA Standard Specifications. Exceptions to be approved by the City Engineer. Trench backfill requirements are discussed in the Utility Trench section below.

6.1.3.3 Compaction Requirements

Per WVC Minimum Sampling and Testing Guide.

6.1.3.4 Asphalt Restoration Standard

Trenches in asphalt pavement shall be restored per WVC Standard Drawing 255 – Asphalt Concrete T-Patch

Cuts with a profile deviation of 1/4 inch or greater in a 10-foot area will require a profile grind to eliminate a bump, or re-mill and pave the cut area to fill depressions with a minimum of 2-inches of newly placed asphalt.

6.1.3.5 Concrete Pavement Restoration Standard

Concrete pavement shall be removed and replaced in full slabs only. APWA Plan 256 does not apply. The Engineering Division will define restoration requirements for each excavation. Restoration plans must be approved by the City Engineer prior to the issuance of a permit.

6.1.3.6 Exploratory Pothole Restoration Standard

Exploratory potholes must be backfilled using an approved Flowable Fill (APWA 31 05 15, Part 2.1).

Removed pavement cores may be replaced as the pavement restoration material provided that the core is in good condition and that it is secured and sealed with epoxy or other approved material.

The limits of repair for openings greater than eight (8) inches in diameter are the same as any asphalt repair done in West Valley City right-of-way. The minimum overcut patch required on exploratory potholes is 3-feet by 3-feet. Cold patch asphalt mix is not allowed as a permanent restoration and must be maintained by the contractor until the permanent patch is installed.

6.1.4 Work Zone Traffic Control Requirements

All traffic control placed on West Valley City roads must conform to current MUTCD Standards. Traffic control plans must be signed and sealed by a Professional Engineer licensed in the State of Utah or be a certified Traffic Control Supervisor. Traffic control must be placed and maintained by a certified traffic control maintainer.

6.1.5 Pavement Cut Moratorium and Special Restoration Standard

West Valley City enforces a pavement cut moratorium on all newly paved or constructed roadways.

6.1.5.1 Pavement Cut Moratorium

1. Overlaid Streets
    a. Overlaid streets shall not be cut for one (1) year from the time the street was overlaid. Roads cut on emergency basis must be restored with Special Restoration Standards.
2. New or Reconstructed Streets
    a. New Streets shall not be cut for two (2) years from the time of construction. Any new or reconstructed street cut within five (5) years of construction must be restored with the Special Restoration Standard.
3. Slurry Sealed Streets
    a. May be cut anytime. If cut within one year of slurry seal, must be restored with Special Restoration Standard.
4. Chip Sealed Streets
    a. May be cut anytime. If cut within one year of chip seal, must be restored with Special Restoration Standard.

6.1.5.2 Special Restoration Standard

6.1.5.2.1 New or Reconstructed Streets

Asphalt T-Patches per WVC Standard Drawing 255 are required on all roadway excavations.

Final driving surface over road cuts with noticeable bump or with a profile deviation of 1/8 inch or greater over a 10-foot area will require a profile grind to eliminate a bump, or re-mill and pave the entire cut area to fill depressions with a minimum of 2-inches of newly placed asphalt.

Any settlement within the warranty period will require rotomilling and repaving.

Special restoration on new or reconstructed streets also requires a crack seal around the perimeter of the cut per APWA 32 01 17.

Cuts on newly constructed or reconstructed streets within the last ten years will be subject to a road damage fee, assessed according to the age of the pavement.

6.1.5.2.2 Overlaid Streets

Asphalt T-Patches per WVC Standard Drawing 255 are required on all roadway excavations.

Cuts with a noticeable bump, or with profile deviation of 1/8-inch or greater in a 10-foot area will require a profile grind to eliminate a bump, or re-mill and pave the cut area to fill depressions with a minimum of 2-inches of newly placed asphalt.

Special restoration on new or reconstructed streets also requires a crack seal around the perimeter of the cut per APWA 32 01 17.

Cuts on streets overlaid within the last five years will be subject to a road damage fee, assessed according to the age of the pavement.

6.1.5.2.3 Slurry Sealed and Chip Sealed Streets

Asphalt T-Patches per WVC Standard Drawing 255 are required on all roadway excavations.

Special restoration requires a crack seal around the perimeter of the cut per APWA 32 01 17.

6.2 Utility Trench Requirements

6.2.1 Trench Safety

Excavating is one of the most hazardous construction operations. Trench safety is the highest priority to West Valley City in any excavation. The contractor is responsible for the safety of the construction site; however West Valley City will issue a Stop Work Order when unsafe conditions are observed. When required by OSHA, protective systems must be put into place to protect workers, either by benching, sloping, shoring or shielding. OSHA access and egress standards must be met by the contractor.

Contractor is responsible to provide safe access into trenches for inspectors to perform backfill density measurement or other inspection purposes.

6.2.2 Backfill and Compaction Requirements in Storm Drain Trenches

All pipe zone material and trench backfill to be performed per West Valley City Special Provision Section 33 05 20-M.

6.2.3 Compaction Requirements in Water, Sewer and other Utility Trenches

Bedding and pipe zone material placed may be in accordance with utility owner requirements. If Sewer Rock or open graded material is used as pipe bedding or pipe zone backfill, a separation geotextile fabric (APWA 31 05 19) must be used.

Trench Backfill to be performed per West Valley City Special Provision Section 33 05 20-M. Any deviations from this standard must be approved by the City Engineer.

6.3 Temporary Surfacing Requirements

6.3.1 Trench Plate Requirements

Trench plates may be placed directly on top of the asphalt when the plate will be in place for 24 hours or less. Surface trench plates must be placed with mastic and secured to the pavement by some mechanical means. Where necessary, plates should be welded together to avoid movement.

Hot or cold mix asphalt must be placed around the perimeter surface of the plate when placed on top of the asphalt surface.

NEVER overcut for a T-Patch when trench plates will be used. Sawcut only after the trench is backfilled prior to asphalt placement.

Any trench plate to be left in place longer than 24 hours must be milled into the asphalt so the top of the plate is flush with the pavement surface.

Use sign W8-24 "Steel Plate Ahead" when steel plates are placed on the roadway. Place sign WI-1 "Bump" with a W16-7P diagonal downward pointing arrow adjacent to the steel plate.

Between the months of November and March, trench plates are not to be used but must be recessed into the pavement if they are necessary.

6.3.2 Temporary Asphalt

Temporary asphalt surfaces are required on any roadway with a right-of-way width of 66-feet or greater by the end of each workday (unless trench plates are to be used). The temporary asphalt must be maintained by the permit holder until the permanent surface is completed and accepted.

Temporary asphalt or trench plates may be required on minor roads at the discretion of the West Valley City Permits Officer, especially if a longer period will pass before final pavement placement.

If trenches remain unpaved for any period during construction, unpaved trenches must be monitored and maintained regularly for safety and dust control purposes. Citations will be issued for unsafe or neglected trenches.

Any pavement placed outside of acceptable paving temperatures and density requirements will be considered temporary pavement.

6.4 Aggregate Base Course Material

6.4.1 Untreated Base Course

Aggregate base course in pavement sections shall meet the requirements of APWA 32 11 23 – *Aggregate Base Course*, Part 2.1 *Untreated Base Course*, Grade 1-1/2 or Grade 1.

6.4.2 Treated Base Course

Treated base course may only be used with materials containing crushed concrete, and must meet the requirements stated in APWA 32 11 23 – *Aggregate Base Course*, Part 2.2 *Treated Base Course*, Paragraph C. Grade 1-1/2 or Grade 1.

6.5 Asphalt Pavement Requirements

6.5.1 Asphalt Mix Requirements

6.5.1.1 Minor Streets and Minor Collectors

APWA Section 32 12 05 Mix Design Parameters in Table 6 – **Marshall 50 blow**

Gradation - DM-1/2

Binder – PG58-28

RAP/ROSP content shall not exceed 15 percent by weight.

6.5.1.2 Major Arterial, Minor Arterial and Collector

APWA Section 32 12 05 Mix Design Parameters in Table 6 – **Superpave – 75Nd**

Gradation - SP-1/2

Binder – PG64-28

RAP/ROSP content shall not exceed 15 percent by weight.

6.5.1.3 Small Quantity – Asphalt Patch Mix Design

Other mix designs will be considered for small quantity asphalt patches.

6.5.2 Asphalt Placement Standard

See WVC Special Provisions 32 12 05-M and 32 12 16.13-M for asphalt placement requirements.

6.5.2.1 Weather

Paving will not be allowed unless the air temperature is 50 degrees F and rising. Cease paving if air temperature falls below 50 degrees F.

Do not pave if the weather is wet. Cease paving if precipitation begins.

6.5.2.2 Tack Coat

Tack coat shall be applied as specified in WVC Special Provision 32 12 13.13-M.

6.5.2.3 Quality Control

Quality control is the responsibility of the Contractor and shall be performed in compliance with the WVC Minimum Sampling and Testing Guide. Contractors placing asphalt pavement in a public road or what will become a public road or other infrastructure, will be required to have qualified quality control personnel on site to split samples with engineer, perform all necessary quality control testing and obtain cores at locations marked by engineer. Density and thickness will be measured from cores taken by the developer or contractor.

Quality control documentation must be submitted on the placed asphalt for all required tests outlined in the WVC Minimum Sampling and Testing Guide. Documentation will be required prior to the release of bonds.

6.5.2.4 Quality Assurance

West Valley City reserves the option to perform quality assurance testing at randomly selected locations or to utilize the submitted QC results as QA.

6.5.2.5 Asphalt Acceptance

As a requirement for the city to accept asphalt pavement installed, the following conditions must be met:

Compaction Pay Factors: (WVC Special Provision 32 12 16.13-M, 1.8 E - Compaction) Density of asphalt placed must meet the requirements for a pay factor of 1.0. Pavement placed with a pay factor between 0.9 and 1.0 will be accepted only after the placement of a slurry seal product to be approved by the city. Pavement placed with density pay factors below 0.9 will be rejected and replaced at no cost to the city.

Thickness: (APWA Section 32 12 16.13, 1.8 F - Thickness) Thickness of asphalt placed must meet the requirements for a pay factor of 1.0. Pavement placed with a thickness pay factor between 0.9 and 1.0 will be accepted only after the placement of a slurry seal product to be approved by the city. Pavement placed with thickness pay factors below 0.9 will be rejected and replaced at no cost to the city.

Binder Content: (APWA Section 32 12 05, 1.6 C – Pay Reduction) Binder Content of asphalt placed must meet the requirements for a pay factor of 1.0. Pavement placed with a pay factor between 0.9 and 1.0 will be accepted only after the placement of a slurry seal product to be approved by the city. Pavement placed with pay factors below 0.9 will be rejected and replaced at no cost to the city.

Gradation Targets: (APWA Section 32 12 05, 1.6 C – Pay Reduction) Gradation Targets of asphalt placed must meet the requirements for a pay factor of 1.0. Pavement placed with a pay factor between 0.85 and 1.0 on any sieve will be accepted only after the placement of a slurry seal product to be approved by the city. Pavement placed with pay factors below 0.85 on any sieve will be rejected and replaced at no cost to the city.

6.6 Concrete Pavement Standards

6.6.1 Concrete Pavement Restoration Standards

Concrete pavement must be replaced in full panels (this is a deviation from the APWA Standard Drawings). The existing depth must be matched. Tie new panels to existing panels as shown in APWA Plan 256. Dowels and tie-bars must be replaced matching the existing placement.

Some concrete pavement replacement may be required to be completed using pre-cast concrete paving slabs. This will be required when impacts to the traveling public from traditional restoration methods will be more significant. The determination to require pre-cast concrete paving slabs will be reviewed and approved by the City Engineer. When pre-cast concrete paving slabs are required, construction will conform to UDOT Standards for pre-cast concrete paving slabs.

6.7 Concrete Placement Standard

6.7.1 Placement Weather

6.7.1.1 Cold Weather Concrete Placement

If air temperature is predicted to fall below 32 degrees F. within 14 days of placement, follow procedures as shown in APWA 03 30 10, 3.4C. Do not increase cement content in the mix design.

Contractor is required to place and monitor thermometers capable of recording high and low temperatures in each 24-hour period until concrete reaches 90 percent of design strength.

6.7.1.2 Hot Weather Concrete Placement

If the rate of evaporation exceeds 0.2 lb./ft^2/hr, implement practices shown in ACI 305.

6.7.2 Air Entrainment

Concrete should have entrained air at a target of 6%, with tolerances between 5% and 7.5%, unless otherwise specified by the concrete supplier, and approved by the Engineering Division. Admixtures for air entrainment will be allowed on-site to correct low air content results. Only ONE attempt per batch will be allowed. Batch will be rejected if the test immediately following the attempt fails.

6.7.3 Slump

Concrete slump is to be proposed by the concrete supplier, and appropriate for the proposed application i.e., fixed form vs. slip form, etc.

6.7.4 Tempering

Do not add water without notifying the inspector. Water may be added if all conditions of APWA Section 03 30 10 Part 3.3.D are met. Do not add water after 1 cubic yard of concrete has discharged from the delivery vehicle.

6.7.5 Placement Time

Concrete must be placed within 60 minutes of batching if air temperature is greater than 90 degrees Fahrenheit and within 90 minutes if air temperature is less than 90 degrees Fahrenheit. Concrete will be rejected if not placed within these time limits. Hydration stabilizers will not be allowed to extend placement time.

6.8 Geotechnical Considerations

6.8.1 Soil Stabilization

6.8.1.1 Soft Spot Repair in Sub-Grade

Contractors should propose solutions for soft spot repair techniques and have proposals approved by the City Engineer. Minimum measures should include excavation of soft material, placement of a stabilization fabric and backfill using a granular material.

6.9 Other Construction Considerations

6.9.1 Collars on Utility Covers

Concrete collars on utility covers and survey monuments are required in most circumstances in asphalt paving. Collars are to be built per APWA Plan 362, 413, or 574. In a deviation from the standard drawings, concrete collars are to be recessed below the pavement from 1/8-inch to a maximum of 1/4-inch. Any concrete collar on a utility cover recessed above or below the allowable tolerances must be replaced.

Concrete collars must be protected during concrete curing periods with steel plates. Plates are to be secured and monitored for movement. Damaged concrete will be replaced by the contractor.

Utility covers in concrete pavement must be coordinated with the Engineering Division. Utility covers must be considered in joint layout plan.

6.9.2 Survey Monuments

Survey monuments are not to be disturbed without having obtained a Monument Preservation Permit from the Salt Lake County Surveyor's Office.

6.9.3 Patterned Concrete Park Strip

When patterned concrete park strip is to be placed, construct per APWA Plan 232, (as a modification from the standard drawing, thickness of patterned concrete parkstrip shall be a minimum of 4-inches). Unless specified otherwise, pattern and color shall be as follows:

1. Pattern – "Ashlar Slate" or approved equal.
2. Color – Two-part color compound; base color with color release.
    a. Base Color shall be:
        i. Yosemite Brown, Per Davis Colors
        ii. Sahara No. 242, Solomon Liquid Color
        iii. or approved equal
    b. Color release shall be Dark Gray (Per Brickform Standard Color Selector Brochure (or equal approved by West Valley City Engineering Division).

6.9.4 Detectable Warning Surface on Pedestrian Access Ramps

The detectable warning surface panels on pedestrian access ramps shall be yellow and adhere to the standards set forth on the "UDOT Pedestrian Access Evaluation Form C170." Exceptions must be approved by the City Engineer.

6.9.5 Pipe Removal/Abandonment Standard

When pipes are removed the trench shall be backfilled per WVC Special Provision 33 05 20-M. All existing pipes that are to be abandoned in the right-of-way should be completely removed when possible.

6.9.5.1 Gravity Pipe Removal/Abandonment

Complete removal will be required on reconstruction projects or when the removal does not require excessive disturbance of hard surface improvements as determined by the city. If the pipe removal will result in excessive disturbance of hard surface improvements the abandoned pipes shall be filled

completely with flowable fill. In rare circumstances where removing the abandoned pipe or placing flowable fill is infeasible, and with approval from City Engineer, abandoned pipe may be plugged with a permanent, water-tight concrete (4000 PSI) plug extending into the abandoned pipe at least two feet. All openings in walls of remaining manholes, catch basins, or structures must be plugged as well. This will not be an option for pipes showing signs of significant deterioration (i.e. corrugated metal pipes).

6.9.5.2 Pressure Pipe Removal/Abandonment

Complete removal will be required on reconstruction projects or when the removal does not require excessive disturbance of hard surface improvements as determined by the city. If the pipe removal will result in excessive disturbance of hard surface improvements the contractor shall cap and restrain the pipe with a blind flange or equivalent type of plug.

Part 7: Utilities in the Right-of-Way

7.1 Utilities

7.1.1 Public Utilities in the Right-of-Way

7.1.1.1 Franchise Agreement is Required

A franchise agreement is required prior to the installation of any facilities associated with a public utility within a public right-of-way. Permits will not be reviewed unless a current franchise agreement with the city is in place.

7.1.2 Small Cell Wireless Facilities

7.1.2.1 Small Cell Wireless Facilities Permit Required

Refer to Title 7 for Small Cell Wireless Facility Permits

Part 8: Appendix

8.1 Storm Water Release Rate Map

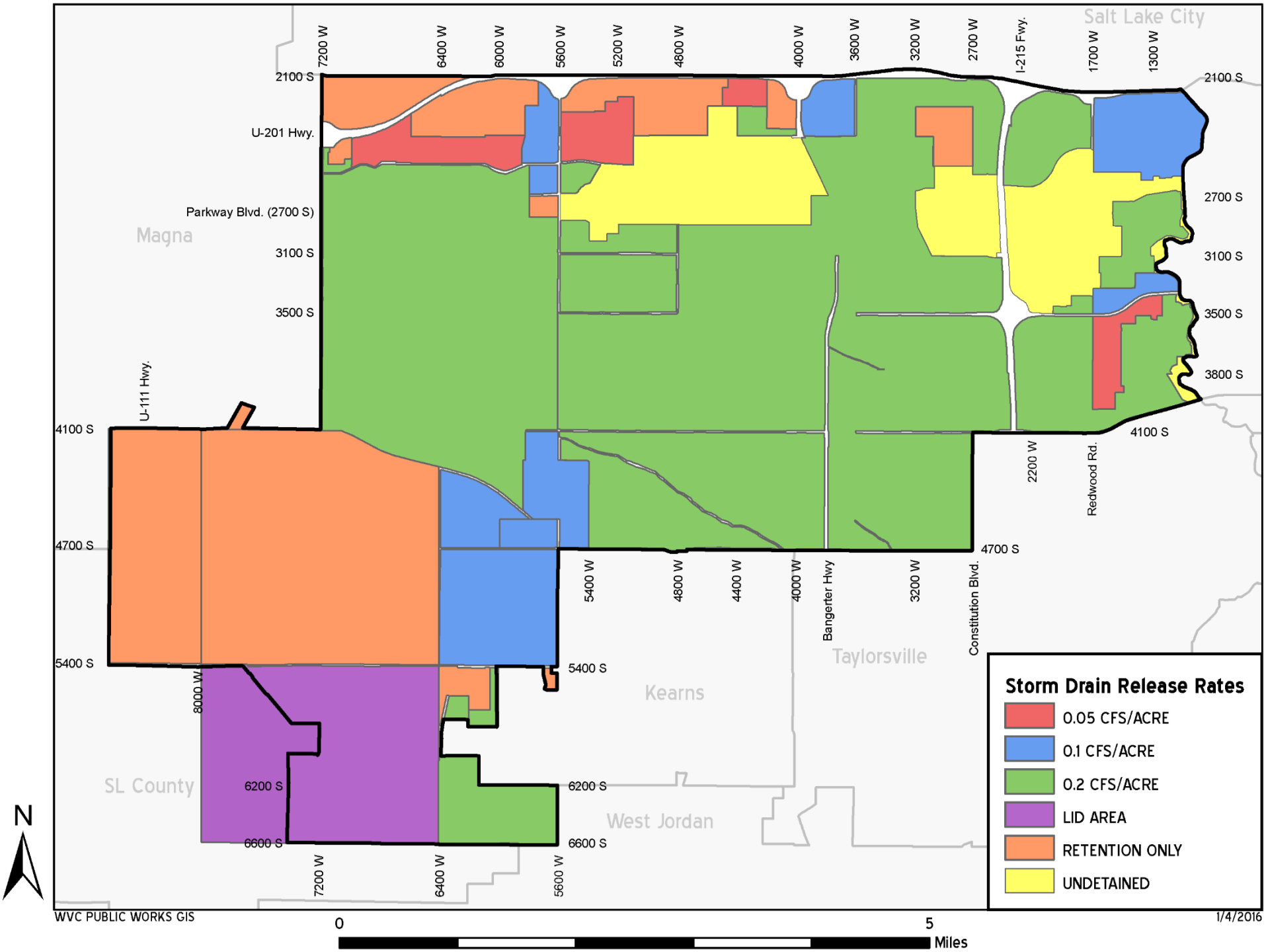
8.2 West Valley City Standard Drawings

Available for download on the West Valley City Engineering Division webpage.

8.3 West Valley City Special Provisions (Modifications to the APWA Standard Specifications)

Available for download on the West Valley City Engineering Division webpage.

West Valley City Storm Drain Release Rates



WEST VALLEY CITY

WEST VALLEY CITY
2020 ENGINEERING STANDARDS
VOLUME II

MINIMUM SAMPLING AND TESTING REQUIREMENTS

APPLICABLE FOR WORK IN THE PUBLIC RIGHT OF WAY AND ON PUBLIC INFRASTRUCTURE AND APPURTENANCES

WEST VALLEY CITY - PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION
ADOPTED BY WEST VALLEY CITY COUNCIL August 25, 2020

Table of Contents

Part 1: Introduction

This document provides the minimum sampling and testing requirements for all construction materials placed inside the public right-of-way. These requirements are intended to ensure quality and uniform construction of public infrastructure in West Valley City (WVC). This document shall be used to determine the frequency of verification sampling and testing on all public improvements constructed within the city right-of-way. Test results will be used to determine acceptance or rejection of material placed. Where permitted by contract provisions, some rejected material may remain in place at the discretion of the Engineer with appropriate adjustments to the contract price. Exceptions to specific sampling and testing requirements must be approved by the City Engineer.

1.1 Modifications

Sections that have been modified from the previous version are noted with a solid vertical line to the right of the paragraph. Not applicable for version adopted August 26, 2020.

1.2 Testing Standards

Generally, WVC uses the Utah Chapter of the APWA Standard Specifications which typically outline sampling and testing frequencies. This guide has been assembled to consolidate that information and to provide guidance to personnel responsible for verification sampling and testing. However, some of the requirements in this guide have modified those found in the APWA Standard Specifications. In case of difference between this guide and the APWA Standard Specifications, this guide governs. Also, when a submitted manufacture's recommendation differs from the requirements outlined in this guide or APWA Standards, the most stringent requirement applies for acceptance.

Items not identified in these minimum sampling and testing requirements still require appropriate testing or verification as outlined in the Utah Chapter of the APWA Specifications, supplemental specifications and/or approved special provisions.

1.3 General Procedures

1.3.1 Contractor Submittals

Contractor submittals are required for all materials placed in the public right-of-way. Refer to the APWA Standard Specifications or project special provisions for submittal requirements. The WVC Engineering Division "Contractor's Submittal Transmittal Form" should be attached to each submittal. The submittal transmittal form is found in the appendix to this document. All submittals must be reviewed and approved by the Engineering Division **prior** to placement. Once approved, contractors are not allowed to change material or material source without submitting and obtaining approval for the new material prior to placement.

1.3.2 Lots and Sub-lots

Lot sizes and requirements vary depending on the type of material being placed. Acceptance is based upon lots. A Lot will not be accepted with a defective sub-lot. Any failed sub-lot will result in rejection of the entire lot in accordance with APWA Section 01 35 10.

Each lot requires a report. Do not combine different lots or materials on the same report.

1.3.3 Quality Control

The contractor is responsible for quality control. Part of those responsibilities include providing all testing and substantiating documentation needed to show specification compliance. The Contractor is required to promptly submit the documentation to the WVC Engineering Division for review. Materials placed without proper testing and supporting documentation provided by the contractor will not be accepted. In addition, Contractor's field quality control testing does not constitute acceptance. Such testing, however, may be used by ENGINEER for acceptance at the discretion of the Engineer.

1.3.4 Quality Assurance

The WVC Engineering Division must obtain documentary evidence to certify the materials incorporated into each project are in conformance with the approved plans and specifications. Verification of conformance is required prior to acceptance of materials placed and when applicable, payment to the contractor for materials furnished and work completed. This verification may be accomplished by performing quality assurance testing independent from the contractor, splitting samples with the contractor, utilizing the Contractor's quality control results, or a combination thereof. The method of acceptance will be determined by the City representative based upon project complexity, schedule, and available resources. The acceptance method may vary throughout the project at the discretion of the City; however, the contractor is required to provide all quality control documentation regardless of acceptance method.

Samples of any material may be taken at any time. Any material found to be out of specification shall be rejected and removed from the project site at the contractor's expense or be subject to applicable price adjustments.

In the case of a failure to meet the material quality requirements, the documentation will constitute the basis for rejection of work, or it may be the basis for its acceptance upon appropriate contract price adjustment where permitted under the contract provisions. If such contract provisions do not exist and negotiations are unattainable, the material will be rejected and require replacement. Complete records including test and inspection reports covering acceptance or rejection are to be maintained in the project files. Refer to WVC Engineering Standards for development projects.

1.3.5 Application of Pay Factors on Developments

Acceptance of materials placed on development projects with pay deduction factors defined by specification will be based on material test results falling within the requirements for Pay Factors of 1.00.

A development project may elect to leave a materials lot in place with test results falling below a Pay Factor of 1.00 by applying a pay deduction factor to the contractor and paying the reduced payment amount to the city. Calculation of the pay deduction factor will be based on actual bid prices paid to the contractor. Developer will be required to show documentation of bid prices. The city retains sole discretion to accept a Pay Factor for materials placed in reject.

Part 2: Backfilling – Roadways/Structures/Trenches

Backfilling Roadways

Assurance: In-place density

Assurance Reference: ASTM D2922

APWA Reference: Section 31 05 13, Section 31 23 26, Section 32 05 10

Lot Size: Production Day

Frequency per Lot: One test per lift per sublot. A sublot is 1000 square yards of contiguous area. If area is not contiguous, lot sizes for Base Course Type II apply.

Required Density: 95 percent or greater relative to a modified proctor density (A-1 Soils) or standard proctor density (all other soils), APWA Section 31 23 26.

Comments: N/A

Backfilling Structures

Assurance: In-place density

Assurance Reference: ASTM D2922

APWA Reference: Section 31 23 26, Section 31 23 23

Lot Size:

Structure Type	Lot Size
Small Structures (e.g. manholes, drainage boxes, etc.):	**Each Structure**
Strip Footings:	40 Linear Feet
Structure Footing excluding strip footings:	225 Square Feet
Embankments:	625 Square Feet
Interior Slab on Grade:	625 Square Feet
Side of Foundation Walls and Retaining Walls:	New lot every time wall changes direction or exceeds 40 Linear Feet

Frequency per Lot: One test per lift on each lot.

Required Density: 95% minimum of modified proctor.

Comments: N/A

Backfilling Trenches

Assurance: In-place density

Assurance Reference: ASTM D2922

APWA Reference: Section 31 23 26, Section 33 05 20

Lot Size: One pipe, pipe culvert, or box culvert and not more than 40 linear feet along a pipe, pipe culvert, or box culvert. When pipe/culvert connects to a

structure the lot is complete and a new lot will begin on the other side of the structure.

Frequency per Lot: One test per lift on each lot.

Required Density: 95 percent or greater relative to a modified proctor density (A-1 Soils) or standard proctor density (all other soils), APWA Section 31 23 26.

Comments: N/A

Part 3: Aggregate Base Course

Base Course Type I Placement: Pavement (includes curb, gutter and waterway when in conjunction with pavement placement).

Base Course Type II Placement: Curb, Gutter, Waterway, Sidewalk, Driveway Approach, Concrete Park Strip, Pedestrian Ramps, and Flatwork.

Base Course Type III Placement: Shoulders, landscaping and other non-structural, non-load bearing areas or areas determined by the Engineer as too small to test.

Base Course Type I Placement

Assurance: In-place density

Assurance Reference: ASTM D2922

APWA Reference: Section 31 23 26, Section 32 11 23

Lot Size: Production Day

Frequency per Lot: One per sublot of 1000 square yards.

Required Density: 95% minimum of modified proctor.

Comments: N/A

Base Course Type II Placement

Assurance: In-place density

Assurance Reference: ASTM D2922

APWA Reference: Section 31 23 26, Section 32 11 23

Lot Size: Production Day

Frequency per Lot:

Curb, Gutter, or Waterway:	One per 200 Linear Feet
Sidewalk or Concrete Park Strip:	One per 400 Linear Feet
Driveway approach, Ped Ramp, or Flatwork:	One per 400 Square Feet

Required Density: 95% minimum of modified proctor.

Comments: N/A

Base Course Type III Placement

Assurance: Visual acceptance of In-place density

Assurance Reference: Acceptance is limited to materials being furnished from sources found satisfactory under normal sampling and testing procedures.

APWA Reference: Section 31 23 26, Section 32 11 23

Lot Size: Production Day

Frequency per Lot: One report for each day material is placed.

Required Density: Suitable to overlying surface, or installation, or use. Verify compaction effort with Engineer.

Comments: N/A

Part 4: Concrete

Concrete Type I Placement: Concrete Paving

Concrete Type II Placement: Includes placement for Curb, Curb and Gutter, Driveways, Drive Approaches, Pedestrian Access Ramps, Sidewalks, Waterways, Flatwork, Patterned Concrete Park Strip, and Surface Utility Collars.

Concrete Type III Placement: Includes Class 2000 and Class 3000 concrete. Also includes Class 4000 concrete that is being used as utility collars underground.

NOTE: Concrete must be placed within 60 minutes of batching if air temperature is greater than 90 degrees Fahrenheit and within 90 minutes if air temperature is less than 90 degrees Fahrenheit. Concrete will be rejected if not placed within these time limits. Hydration stabilizers will not be allowed to extend placement time.

Concrete Type I Placement

Assurance: Slump, Air Content, and Concrete Temperature

Assurance Reference: ASTM C143, ASTM C231, ASTM C1064

APWA Reference: Section 32 13 13, Section 03 30 05, Section 03 30 10

Lot Size: Paving Day

Frequency per Lot: For each mix design test until two consecutive batches meet specification at the beginning of placement, after shutdowns of 1 hour or more, and after each failed batch. Randomly thereafter perform one test for every 200 cubic yards placed. If first determination fails, immediately retest. If

second test meets specification, immediately retest. Batch is rejected on two failed determinations.

Comments: Air results to be adjusted per results of correlation testing. Admixtures for air entrainment will be allowed on-site to correct low air content results. **Only ONE attempt per batch will be allowed**. Batch will be rejected if the test immediately following the attempt fails.

Concrete Type I Placement

Assurance: Air Content Correlation test to determine loss of air through the paver.

Assurance Reference: ASTM C231

APWA Reference: Section 32 13 13, Section 03 30 05, Section 03 30 10

Lot Size: Paving Day

Frequency per Lot: Two tests, one at the beginning of the pave and one approximately halfway through the pave. Perform air test in front of paver and again from the same load in the finished pavement. Apply adjustment to all remaining air tests.

Comments: N/A

Concrete Type I Placement

Assurance: Compressive Strength Test

Assurance Reference: ASTM C31, ASTM C39

APWA Reference: Section 32 13 13, Section 03 30 05, Section 03 30 10

Lot Size: Paving Day

Frequency per Lot: One strength test on the second batch and randomly thereafter every 800 square yards. Hand placements will be considered Type II Placements. A strength test consists of four cylinders. Break one cylinder at seven days and three cylinders at 28 days. The average strength of these three cylinders will be considered the test result.

Comments: Refer to APWA Section 32 13 13 for pay deductions applied when strength is under specification.

Concrete Type I Placement

Assurance: Thickness

Assurance Reference: ASTM C134

APWA Reference: Section 32 13 13

Lot Size: Paving Day

Frequency per Lot: One core per 1000 square yards. Final areas less than 500 square yards will be added to the previous section. Final areas over 500 square yards

	will constitute a separate area. Hand placements are considered separately. One core per hand placement area
Comments:	Refer to APWA Section 32 13 13 for pay deductions applied when thickness is deficient.

Concrete Type II Placement

Assurance:	Slump, Air Content, and Concrete Temperature
Assurance Reference:	ASTM C143, ASTM C231, ASTM C1064
APWA Reference:	Section 32 16 13, Section 32 16, 14, Section 03 30 05, Section 03 30 10
Lot Size:	Production Day
Frequency per Lot:	For each mix design test until two consecutive batches meet specification at the beginning of placement, after shutdowns of 1 hour or more, and after each failed batch. Randomly thereafter perform one test for every 50 cubic yards placed If first determination fails, immediately retest. If second test meets specification, immediately retest. Batch is rejected on two failed determinations.
Comments:	Admixtures for air entrainment will be allowed on-site to correct low air content results. **Only ONE attempt per batch will be allowed**. Batch will be rejected if the test immediately following the attempt fails.

Concrete Type II Placement

Assurance:	Compressive Strength Test
Assurance Reference:	ASTM C31, ASTM C39
APWA Reference:	Section 32 16 13, Section 32 16 14, Section 03 30 05, Section 03 30 10
Lot Size:	Production Day
Frequency per Lot:	One strength test for each 50 cubic yards or fraction thereof for each mix design. Visual acceptance and laboratory testing are done at Engineers discretion for daily quantities between 4 and 8 cubic yards. A strength test consists of four cylinders. Break one cylinder at seven days and three cylinders at 28 days. The average strength of these three cylinders will be considered the test result.
Comments:	Refer to APWA Section 32 16 13 for pay deductions applied when strength is under specification.

Concrete Type II Placement

Assurance:	Visual Acceptance of very small quantities of material.
Assurance Reference:	Acceptance is limited to materials being furnished from sources found satisfactory under normal sampling and testing procedures.

APWA Reference: Section 03 30 05, Section 03 30 10

Lot Size: Not to exceed 4 cubic yards per day and not to exceed 50 cubic yards of total continuous visual acceptance quantities.

Frequency per Lot: One report for each day material is accepted.

Comments: Visual acceptance will not be allowed unless a West Valley City representative is on-site to perform the inspection.

Concrete Type III Placement

Assurance: Visual Acceptance or as mandated by Contractor Submittal

Assurance Reference: N/A

APWA Reference: Section 03 30 05, Section 03 30 10

Lot Size: Daily Placement

Frequency per Lot: One report for each day material is accepted.

Comments: Visual acceptance will not be allowed unless a West Valley City representative is on-site to perform the inspection.

Part 5: Asphalt

HMA Type I Placement: For projects with plan quantities of more than 1,000 tons.

HMA Type II Placement: For small projects with plan quantities of less than 1,000 tons or for work such as approaches, detours, driveways, traffic signals, utility work, etc.

-Or-

Type I projects with a production day of less than 500 tons AND when additional production days are not anticipated within 7 calendar days.

HMA Type I Placement

Assurance: Asphalt Sieve Analysis and Binder Content

Assurance Reference: ASTM C117, ASTM C136, ASTM D6307

APWA Reference: Section 32 12 05, Section 32 12 16.13

Lot Size: Production Day

Frequency per Lot: One random sample per 500 tons sublot. Binder content by ignition oven test. Sieve analysis on the residue of the ignition oven tests.

If at least three random samples cannot be taken (less than 1100 tons placed), combine test results with the next day of production if it is a similar placement on the same lift, otherwise pay factors will be determined on the available sample results.

The lot may be increased to include up to three production days when agreed upon in advance by both the Contractor and the Engineer when less than 750 tons are anticipated per production day.

Comments: Contractor to sample from grade behind the paver and split the sample with the Engineer. Refer to APWA Section 32 12 05 for pay deductions applied when material is deficient.

HMA Type I Placement

Assurance: Theoretical Maximum Specific Gravity (Rice)

Assurance Reference: ASTM D2041

APWA Reference: Section 32 12 05, Section 32 12 16.13

Lot Size: Production Day

Frequency per Lot: One per sample (500 tons sublot) for the first three sublots in conjunction with VMA from samples taken with those for gradation and binder content. A determination is the average of two test results split from a single sample.

Comments: The average for the lot will be used to determine density of cores.

HMA Type I Placement

Assurance: Voids in the Mineral Aggregate (VMA) and Air Voids (V_a)

Assurance Reference: ASTM D6925 using Superpave Gyratory Compactor

APWA Reference: Section 32 12 05, Section 32 12 16.13

Lot Size: Production Day

Frequency per Lot: One per sample (500 tons sublot) for the first three sublots in conjunction with Rice determination from samples taken with those for gradation and binder content.

Comments: N/A

HMA Type I Placement

Assurance: In-Place Mat Density (Core Densities)

Assurance Reference: ASTM D5361, ASTM D2725

APWA Reference: Section 32 12 16.13

Lot Size: Production Day

Frequency per Lot: One set of cores per 1000 square yards sub-lots. Collect two cores for each set. Final areas less than 250 square yards will be added to the

	previous sub-lot. Final areas over 250 square yards will constitute an additional sub-lot.
Comments:	Provide one core from each set to the Engineer immediately after extracting. Refer to APWA Section 32 12 16.13 for pay deductions applied when density is deficient.

HMA Type I Placement

Assurance:	Thickness
Assurance Reference:	ASTM D5361
APWA Reference:	Section 32 12 16.13
Lot Size:	Production Day
Frequency per Lot:	In conjunction with in-place mat density determination.
Comments:	Refer to APWA Section 32 12 16.13 for pay deductions applied when thickness is deficient.

HMA Type I Placement

Assurance:	Smoothness
Assurance Reference:	ASTM E950, ASTM E1274
APWA Reference:	Section 32 01 31
Lot Size:	
Frequency per Lot:	
Comments:	Refer to referenced sections in APWA for acceptance procedures. Required on all Major Roads. Consult with ENGINEER prior to paving Minor Roads to determine if profilograph will be required.

HMA Type II Placement

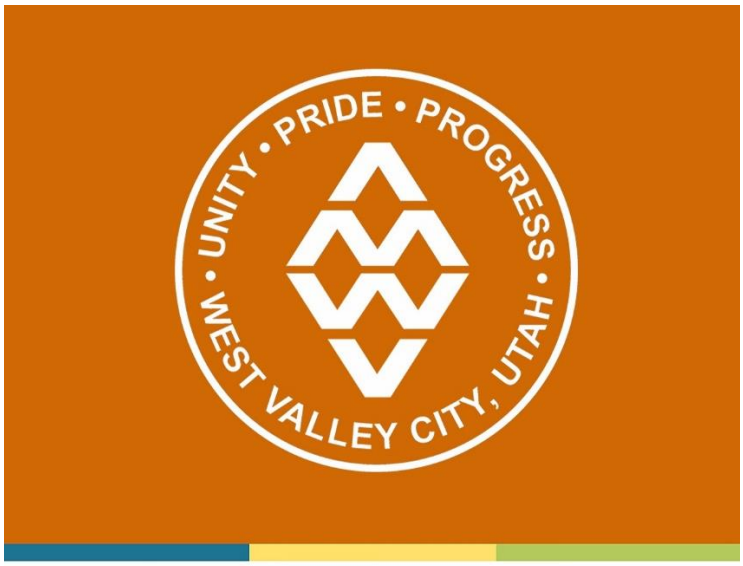
Assurance:	In-Place Mat Density (Nuclear Density Gauge)
Assurance Reference:	ASTM D2950
APWA Reference:	Section 32 12 16.13
Lot Size:	Production Day
Frequency per Lot:	One density determination per 1000 square yards sub-lots. Final areas less than 250 square yards will be added to the previous sub-lot. Final areas over 250 square yards will constitute an additional sub-lot.
Comments:	Refer to APWA Section 32 12 16.13 for pay deductions applied when density is deficient.

HMA Type II Placement

Assurance:	Smoothness
Assurance Reference:	West Valley City Engineering Standards
APWA Reference:	West Valley City Standards
Lot Size:	See Comments
Frequency per Lot:	N/A
Comments:	Cuts with a profile deviation of 1/4 inch or greater in a 10-foot area will require a profile grind to eliminate a bump, or re-mill and pave the cut area to fill depressions with a minimum of 2-inches of newly placed asphalt. If the cut is in a roadway that requires special restoration per the WVC Engineering Standards, the profile deviation is reduced to 1/8-inch or greater in a 10-foot area.

HMA Placement

Assurance:	Visual Acceptance – Requires City Engineer Approval
Assurance Reference:	Acceptance is limited to materials being furnished from sources found satisfactory under normal sampling and testing procedures.
APWA Reference:	Section 32 12 05, Section 32 12 16.13
Lot Size:	Determined by City Engineer
Frequency per Lot:	One report for each day material is accepted.
Comments:	Visual acceptance will not be allowed unless a West Valley City representative is on-site to perform the inspection.

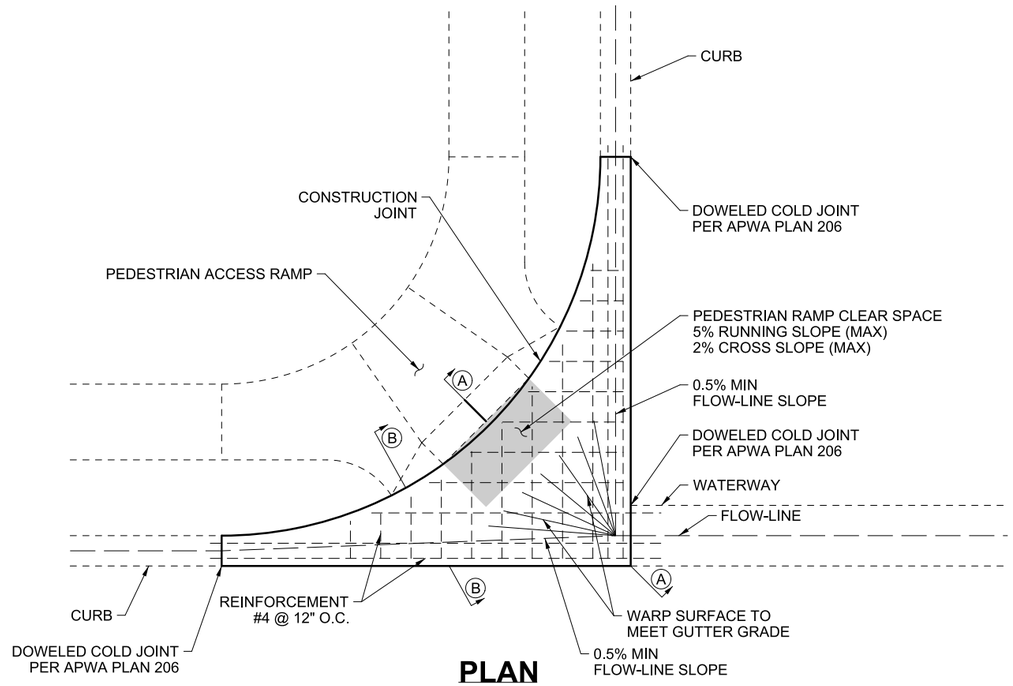


WEST VALLEY CITY

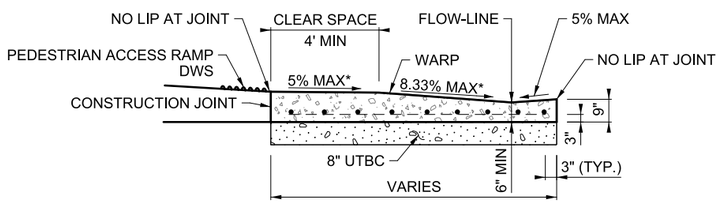
WEST VALLEY CITY
2020 ENGINEERING STANDARDS
8.2 - APPENDIX

WEST VALLEY CITY STANDARD DRAWINGS

APPLICABLE FOR WORK IN THE PUBLIC RIGHT OF WAY AND ON PUBLIC INFRASTRUCTURE AND APPURTENANCES

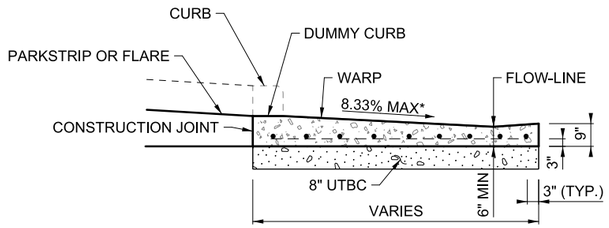


PLAN



SECTION A-A

WITHIN CLEAR SPACE/DWS
* 0.5% MIN SLOPE TO FLOW-LINE



SECTION B-B

OUTSIDE CLEAR SPACE/DWS
* 0.5% MIN SLOPE TO FLOW-LINE

NOTES:

1. GENERAL
   - A. VARIANCE FROM SPECIFIED DIMENSIONS AND SLOPES MUST BE ACCEPTABLE TO THE ENGINEER. SYSTEM CONFIGURATION MAY BE CHANGED AT ENGINEER'S DISCRETION.
   - B. ADDITIONAL REQUIREMENTS ARE SPECIFIED IN APWA SECTION 32 16 13.

2. PRODUCTS
   - A. BASE COURSE: UNTREATED BASE COURSE, APWA SECTION 32 11 23. DO NOT USE GRAVEL AS A BASE COURSE.
   - B. EXPANSION JOINT FILLER: 1/2-INCH THICK TYPE F1 FULL DEPTH, APWA SECTION 32 13 73.
   - C. CONCRETE. CLASS 4000, APWA SECTION 03 30 04. IF NECESSARY, PROVIDE CONCRETE THAT ACHIEVES DESIGN STRENGTH IN LESS THAN 7 DAYS. USE CAUTION; HOWEVER, AS CONCRETE CRAZING (SPIDER CRACKS) MAY DEVELOP IF AIR TEMPERATURE EXCEEDS 90 DEGREES F.
   - D. REINFORCEMENT. GALVANIZED OR EPOXY COATED, DEFORMED, 60 KSI YIELD GRADE STEEL, ASTM A615.
   - E. CONCRETE CURING AGENT: CLEAR MEMBRANE FORMING COMPOUND WITH FUGITIVE DYE (TYPE ID CLASS A), APWA SECTION 03 39 00.

3. EXECUTION
   - A. BASE COURSE PLACEMENT: APWA SECTION 32 05 10. MAXIMUM LIFT THICKNESS BEFORE COMPACTION IS 8-INCHES WHEN USING RIDING EQUIPMENT OR 6-INCHES WHEN USING HAND HELD EQUIPMENT. COMPACTION IS 95 PERCENT OR GREATER RELATIVE TO A MODIFIED PROCTOR DENSITY, APWA SECTION 31 23 26.
   - B. CONCRETE PLACEMENT: APWA SECTION 03 30 10.
     1) INSTALL EXPANSION JOINTS VERTICAL, FULL DEPTH, WITH TOP OF FILLER SET FLUSH WITH CONCRETE SURFACE. INSTALL AT THE START OR END OF A STREET INTERSECTION CURB RETURN. EXPANSION JOINTS ARE NOT REQUIRED IN CONCRETE PLACEMENT USING SLIP-FORM CONSTRUCTION.
     2) INSTALL CONTRACTION JOINTS VERTICAL, 1/8-INCH WIDE OR 1/4 SLAB THICKNESS IF THE SLAB IS GREATER THAN 8-INCHES THICK. MATCH JOINT LOCATION IN ADJACENT PORTLAND-CEMENT CONCRETE ROADWAY PAVEMENT.
     3) PROVIDE 1/2-INCH RADIUS EDGES. APPLY A BROOM FINISH. APPLY A CURING AGENT.
   - C. PROTECTION AND REPAIR. PROTECT CONCRETE FROM DEICING CHEMICALS DURING CURE. FLOW-LINE SLOPE NOT TO BE LESS THAN 0.5%, UNLESS APPROVED BY THE ENGINEER. REPAIR CONSTRUCTION THAT DOES NOT DRAIN. IF NECESSARY, FILL FLOW-LINE WITH WATER TO VERIFY.

NO.	BY	DATE	REMARKS
			REVISIONS

DESIGN ____ CHECK ____
DRAWN ____ CHECK ____

WEST VALLEY CITY PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION
3600 CONSTITUTION BOULEVARD
WEST VALLEY CITY, UTAH 84119-3720

7/15/2020
DATE

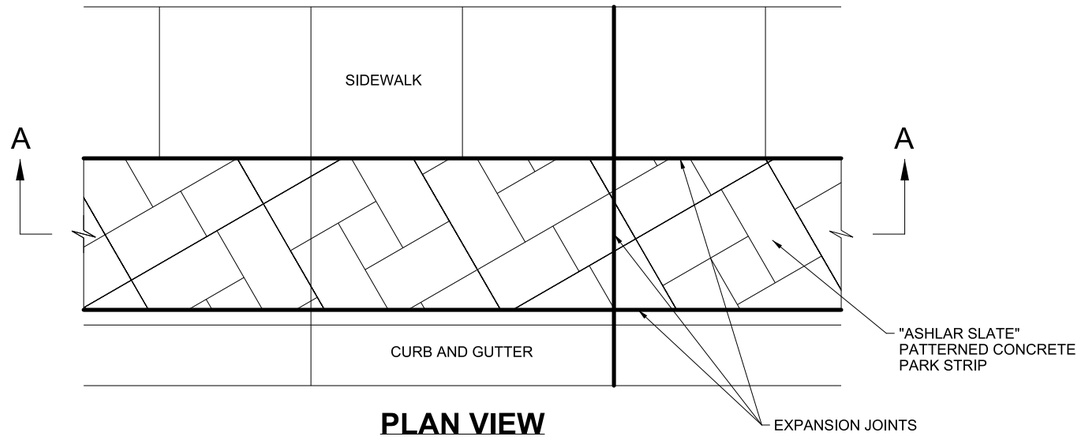
PROFESSIONAL ENGINEER

DESIGN

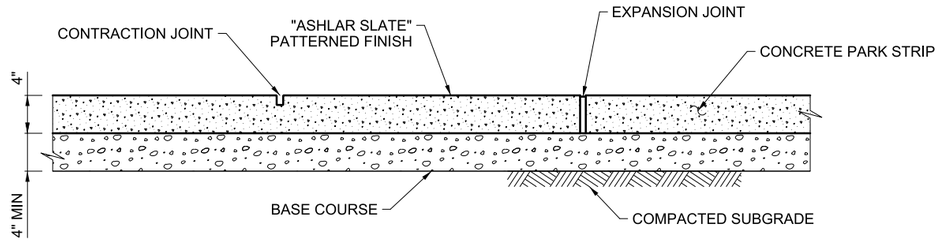
WVC STANDARD DRAWING

WATERWAY TRANSITION TABLE

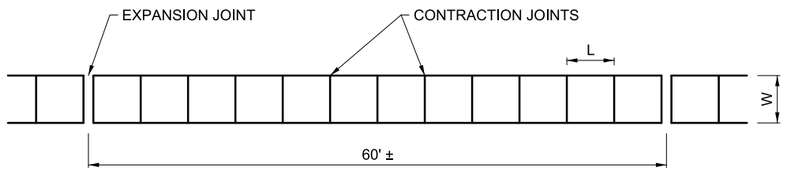
WVC STD. DWG. NO.
WVC 213



PLAN VIEW



SECTION A-A



$L_{MIN} = W$

L_{MAX} (IN FEET) = 1.5 x W

PARK STRIP JOINT DETAIL

NOTES:

1. GENERAL
   - A. VARIANCE FROM SPECIFIED DIMENSIONS AND SLOPES MUST BE ACCEPTABLE TO THE ENGINEER. SYSTEM CONFIGURATION MAY BE CHANGED AT ENGINEER'S DISCRETION.
   - B. COLOR: TWO-PART SHAKE COLOR COMPOUND; BASE COLOR WITH COLOR RELEASE. SCOFIELD UV RESISTANT:
     1) BASE COLOR: YOSEMITE BROWN PER DAVIS COLORS OR EQUAL APPROVED BY ENGINEER.
     2) COLOR RELEASE: DARK GRAY PER BRICKFORM STANDARD COLOR SELECTOR BROCHURE OR EQUAL APPROVED ENGINEER.
   - C. PATTERN: "ASHLAR SLATE" OR EQUAL APPROVED BY ENGINEER.
   - D. ADDITIONAL REQUIREMENTS ARE SPECIFIED IN APWA SECTION 32 16 13 AND WEST VALLEY CITY SPECIAL PROVISION 32 16 24-S.

2. PRODUCTS
   - A. BASE COURSE: UNTREATED BASE COURSE, APWA SECTION 32 11 23. DO NOT USE GRAVEL AS BASE COURSE.
   - B. EXPANSION JOINT FILLER: 1/2-INCH THICK TYPE F1 FULL DEPTH, APWA SECTION 32 13 73.
   - C. CONCRETE: CLASS 4000, APWA SECTION 03 30 04. IF NECESSARY, PROVIDE CONCRETE THAT ACHIEVES DESIGN STRENGTH IN LESS THAN 7 DAYS. USE CAUTION; HOWEVER, AS CONCRETE CRAZING (SPIDER CRACKS) MAY DEVELOP IF AIR TEMPERATURE EXCEEDS 90 DEGREES FAHRENHEIT.
   - D. CONCRETE CURING AGENT: CLEAR MEMBRANE FORMING COMPOUND WITH FUGITIVE DYE (TYPE ID CLASS A), APWA SECTION 03 39 00.

3. EXECUTION
   - A. BASE COURSE PLACEMENT: APWA SECTION 32 05 10. MAXIMUM LIFT THICKNESS BEFORE COMPACTION IS 8-INCHES WHEN USING RIDING EQUIPMENT OR 6-INCHES WHEN USING HAND HELD EQUIPMENT. COMPACTION IS 95 PERCENT OR GREATER RELATIVE TO A MODIFIED PROCTOR DENSITY, APWA SECTION 31 23 26.
   - B. CONCRETE PLACEMENT: APWA SECTION 03 30 10.
     1) INSTALL EXPANSION JOINTS VERTICAL, FULL DEPTH, WITH TOP OF FILLER SET FLUSH WITH CONCRETE SURFACE.
     2) INSTALL CONTRACTION JOINTS VERTICAL, 1/8-INCH WIDE OR 1/4 SLAB THICKNESS IF THE SLAB IS GREATER THAN 8-INCHES THICK. MAXIMUM LENGTH TO WIDTH RATIO FOR NON-SQUARE PANELS IS 1.5 TO 1. MAXIMUM PANEL LENGTH (IN FEET) IS 1.5 TIMES THE SLAB THICKNESS (IN INCHES).
     3) PROVIDE 1/2-INCH RADIUS EDGES. APPLY A BROOM FINISH. APPLY A CURING AGENT.

NO.	BY	DATE	REMARKS

REVISIONS

DESIGN ____ CHECK ____ DRAWN ____ CHECK ____

WEST VALLEY CITY PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION
3600 CONSTITUTION BOULEVARD
WEST VALLEY CITY, UTAH 84119-3720

7/21/2020
DATE

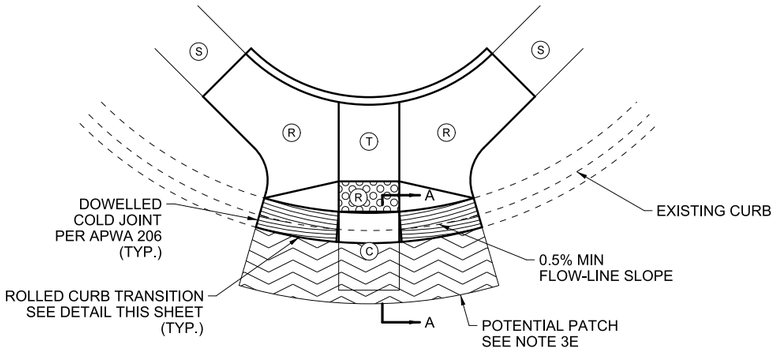
DESIGN

PROFESSIONAL ENGINEER

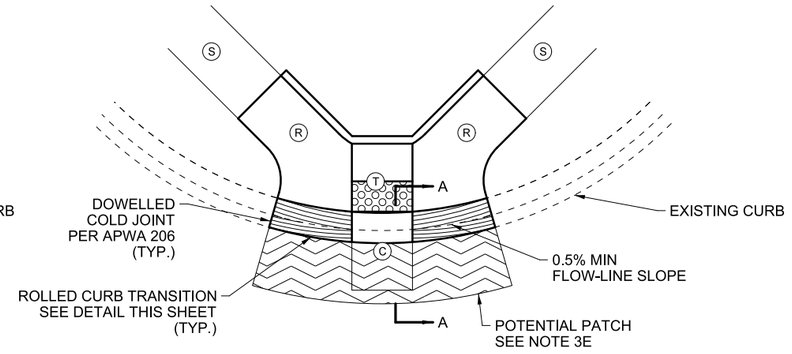
WVC STANDARD DRAWING

PATTERNED
CONCRETE PARK STRIP

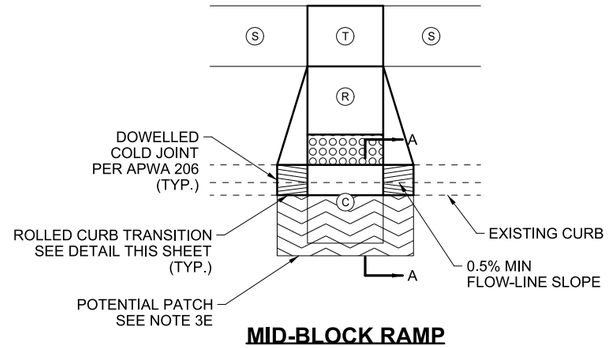
WVC STD. DWG. NO.
WVC 232.1



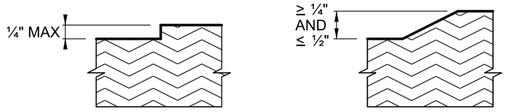
COMBINATION AND PERPENDICULAR RAMP EXAMPLE



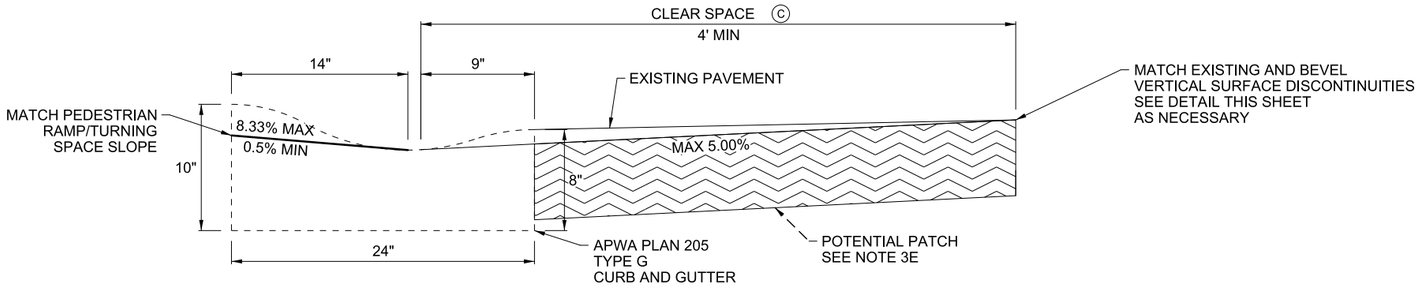
PARALLEL RAMP EXAMPLE



MID-BLOCK RAMP EXAMPLE



BEVEL VERTICAL SURFACE DISCONTINUITIES



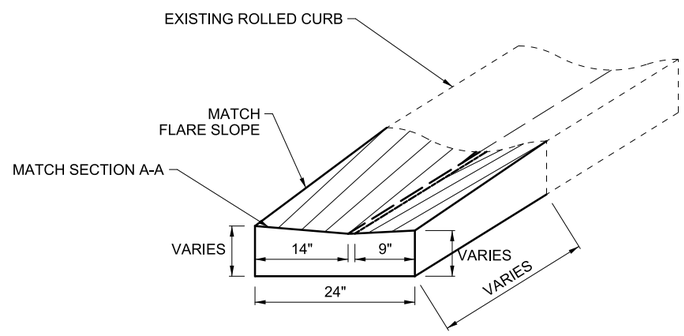
SECTION A-A

NOTES:

1. GENERAL
   - A. THE DRAWING SHOWS TYPICAL ROLLED CURB TRANSITIONS AND CONNECTIONS. REFER TO CONSTRUCTION DRAWINGS FOR ROLLED CURB TRANSITIONS AND CONNECTION LOCATIONS OR REFER TO FIELD LOCATION OF EXISTING ROLLED CURB WHEN DETERMINING ROLLED CURB TRANSITIONS.
   - B. WHERE EXISTING ELEMENTS OR SPACES ARE ALTERED TO RECEIVE AN ASSEMBLY, SLOPES AND DIMENSIONS SHALL COMPLY WITH SLOPES AND DIMENSIONS SHOWN ON THE UDOT PA SERIES STANDARD DRAWINGS, OR TO THE MAXIMUM EXTENT FEASIBLE PERMITTED BY THE ENGINEER. FINAL CONFIGURATION OF THE ASSEMBLY MAY BE DIFFERENT THAN SHOWN.
   - C. DEFINITIONS AND SUPPLEMENTAL REQUIREMENTS ARE SPECIFIED IN WVC SPECIAL PROVISION 32 16 14-S AND UDOT FORM C-170.

2. PRODUCTS
   - A. EXPANSION JOINT FILLER: 1/2-INCH THICK TYPE F1 FULL DEPTH, APWA SECTION 32 13 73

3. EXECUTION
   - A. A COMPLETED ROLLED CURB TRANSITION SECTION SURFACE WILL HAVE A SMOOTH "NON- SLIP" TEXTURED SURFACE FINISH WITHOUT ANY ROUGH EDGES.
   - B. PROTECTION: PROVIDE EXPANSION JOINT FILLER 1/2" THICK WHERE CURB RAMP ADJOINS TO ANY RIGID PAVEMENT OR STRUCTURE WITH THE TOP OF JOINT FILLER FLUSH WITH ADJACENT CONCRETE SURFACE.
   - C. REPAIR CONSTRUCTION THAT DOES NOT DRAIN. FLOW-LINE SLOPE NOT TO BE LESS THAN 0.5%, UNLESS APPROVED BY THE ENGINEER. IF NECESSARY, FLOOD FLOW-LINE WITH WATER TO VERIFY.
   - D. CONSTRUCT THE DEPRESSED CURB TO BE FLUSH WITH ADJACENT SURFACES (RAMPS, TURNING SPACE, CLEAR SPACE, FLARES).
   - E. IF NECESSARY, SAWCUT AND REPLACE PAVEMENT 4 FEET FROM LIP OF CURB AND FLARE TO FLARE, TO PREVENT TRIP HAZARDS IN THE CLEAR SPACE.
     1) MINOR ROADS: REPLACE PAVEMENT WITH 4 INCHES OF HOT MIX ASPHALT MINOR ROAD MIX.
     2) MAJOR ROADS: REPLACE PAVEMENT WITH 6 INCHES OF HOT MIX ASPHALT MAJOR ROAD MIX.
   - F. CONSTRUCT GRADE BREAKS TO BE FLUSH, PREVENT OR CORRECT ANY VERTICAL DIFFERENCES IN SURFACES GREATER THAN 0.5 IN. BEVEL VERTICAL DIFFERENCES BETWEEN 0.25 IN AND 0.5 IN WITH A SLOPE NOT STEEPER THAN 2H:1V ACROSS THE VERTICAL DIFFERENCE.



ROLLED CURB TRANSITION

NO.	BY	DATE	REMARKS
			REVISIONS

DESIGN | CHECK | DRAWN | CHECK

WEST VALLEY CITY PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION
3600 CONSTITUTION BOULEVARD
WEST VALLEY CITY, UTAH 84119-3720

7/15/2020
DATE

PROFESSIONAL ENGINEER

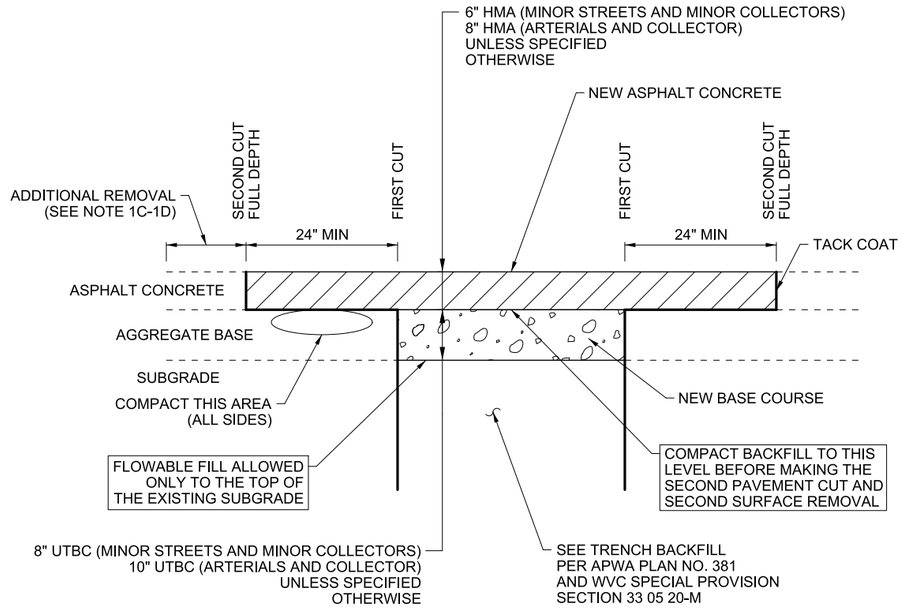
DESIGN

WVC STANDARD DRAWING

PEDESTRIAN ACCESS RAMP
ROLLED CURB TRANSITION

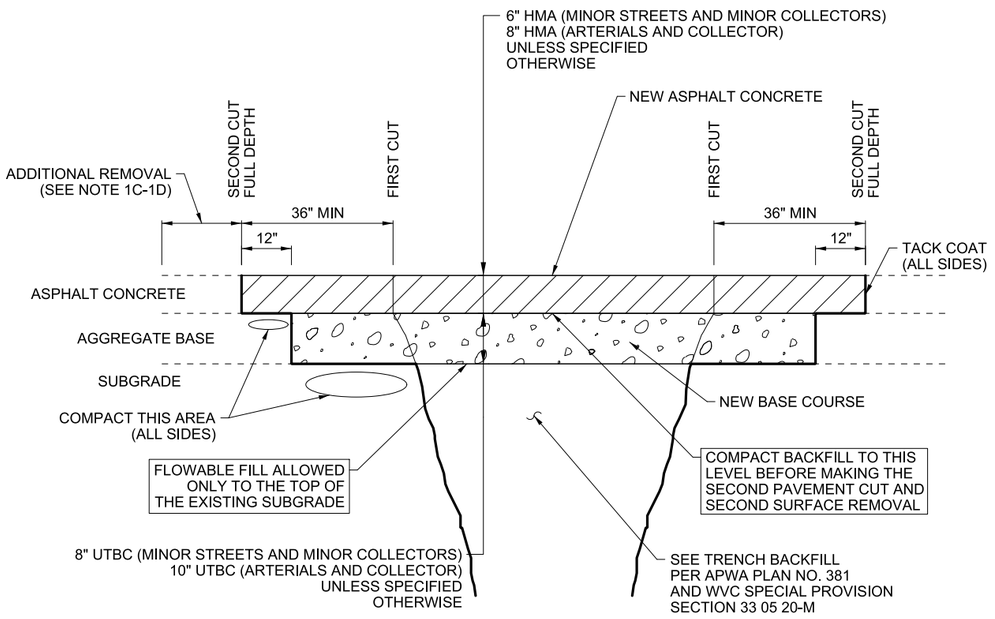
WVC STD. DWG. NO.
WVC 239

7/15/2020 10:05:48 AM H:\ENGDIV\STANDARDS\WEST VALLEY CITY\WVC Standard Drawings\WVC 239 - PAR Rolled Curb Transition.dgn



SHALLOW EXCAVATION

(LESS THAN 72 INCHES FROM PAVEMENT SURFACE TO BOTTOM OF EXCAVATION)



DEEP EXCAVATION

(MORE THAN 72 INCHES FROM PAVEMENT SURFACE TO BOTTOM OF EXCAVATION)

NOTES:

1. GENERAL
   - A. VERTICAL CUTS IN ASPHALT CONCRETE MAY BE DONE BY SAW OR PAVEMENT ZIPPING. IF CUTS GREATER THAN 10 INCHES ARE NECESSARY TO PREVENT PAVEMENT "BREAK OFF" CONSULT ENGINEER FOR DIRECTIONS ON HANDLING ADDITIONAL COSTS.
     - a. FIRST CUT IS TO BE THE WIDTH OF THE TRENCH AND IS INCIDENTAL TO THE PIPE REMOVAL/INSTALLATION PAY ITEMS.
     - b. SECOND CUT IS NOT TO BE PERFORMED UNTIL THE TRENCH HAS BEEN BACK FILLED AND THE UNTREATED BASE COURSE HAS BEEN PLACED AND COMPACTED. THE SECOND CUT IS INCIDENTAL TO THE ASPHALT T-PATCH BID PAY ITEM.
   - B. REPAIR T-PATCH IF ANY OF THE FOLLOWING CONDITIONS OCCUR PRIOR TO FINAL PAYMENT OR AT THE END OF THE ONE YEAR CORRECTION PERIOD:
     - a. PAVEMENT SURFACE DISTORTION EXCEEDS 1/4-INCH DEVIATION IN 10 FEET. REPAIR OPTION - PLANE OFF SURFACE DISTORTIONS. COAT PLANED SURFACE WITH A CATIONIC OR ANIONIC EMULSION THAT COMPLIES WITH APWA SECTION 32 12 03 OR RE-MILL AND PAVE THE CUT AREA TO FILL DEPRESSIONS WITH A MINIMUM OF 2-INCHES OF NEWLY PLACED ASPHALT.
     - b. SEPARATION APPEARS AT A CONNECTION TO AN EXISTING PAVEMENT OR ANY STREET FIXTURE. REPAIR OPTION - BLOW SEPARATION CLEAN AND APPLY JOINT SEALANT, PLAN 265.
     - c. CRACKS AT LEAST 1-FOOT LONG AND 1/4-INCH WIDE OCCUR MORE OFTEN THAN 1 IN 10 SQUARE FEET. REPAIR OPTION - BLOW CLEAN AND APPLY CRACK SEAL, PLAN 265.
     - d. PAVEMENT RAVELING IS GREATER THAN 1 SQUARE FOOT PER 100 SQUARE FEET. REPAIR OPTION - MILL AND INLAY, APWA SECTIONS 32 01 16.71 AND 32 12 05.
   - C. IF A SAW CUT IN THE DIRECTION OF VEHICULAR TRAVEL IS IN A WHEEL PATH, CONSULT ENGINEER FOR DIRECTIONS ON REMOVING ADDITIONAL PAVEMENT OTHER THAN THE AMOUNT SHOWN ON THE DRAWINGS.
   - D. ALLOWABLE REMAINING PAVEMENT WIDTH AS FOLLOWS:
     - a. ROADS WITH CURB AND GUTTER: 2 FEET MINIMUM.
     - b. ROADS WITHOUT CURB AND GUTTER 4 FEET MINIMUM.

2. PRODUCTS
   - A. BASE COURSE: UNTREATED BASE COURSE, APWA SECTION 32 11 23. DO NOT USE GRAVEL AS A BASE COURSE.
   - B. FLOWABLE FILL: TARGET IS 60 PSI IN 28 DAYS WITH 90 PSI MAXIMUM IN 28 DAYS, APWA SECTION 31 05 15. IT MUST FLOW EASILY REQUIRING NO VIBRATION FOR CONSOLIDATION.
   - C. TACK COAT: WVC SPECIAL PROVISION SECTION 32 12 13.13-M
   - D. ASPHALT CONCRETE: WVC SPECIAL PROVISION SECTION 32 12 05-M

3. EXECUTION
   - A. BASE COURSE PLACEMENT: APWA SECTION 32 05 10. MAXIMUM LIFT THICKNESS BEFORE COMPACTION IS 8-INCHES WHEN USING RIDING EQUIPMENT OR 6-INCHES WHEN USING HAND HELD EQUIPMENT. COMPACTION IS 95 PERCENT OR GREATER RELATIVE TO A MODIFIED PROCTOR DENSITY, APWA SECTION 31 23 26
   - B. FLOWABLE FILL: CURE TO INITIAL SET BEFORE PLACING AGGREGATE BASE OR ASPHALT PAVEMENT. USE IN EXCAVATIONS THAT ARE TOO NARROW TO RECEIVE COMPACTION EQUIPMENT. ALLOWED ONLY TO THE TOP OF THE EXISTING SUBGRADE.
   - C. TACK COAT. CLEAN ALL HORIZONTAL AND VERTICAL SURFACES. APPLY FULL COVERAGE ALL SURFACES.
   - D. ASPHALT CONCRETE: UNLESS INDICATED OTHERWISE, LIFT THICKNESS PLACEMENT IS 3-INCHES MINIMUM AFTER COMPACTION. COMPACT TO 94 PERCENT OF ASTM D 2041 (RICE DENSITY).

NO.	DATE	REVISIONS	REMARKS

DESIGN ____ CHECK ____ DRAWN ____ CHECK ____

WEST VALLEY CITY PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION
3600 CONSTITUTION BOULEVARD
WEST VALLEY CITY, UTAH 84119-3720

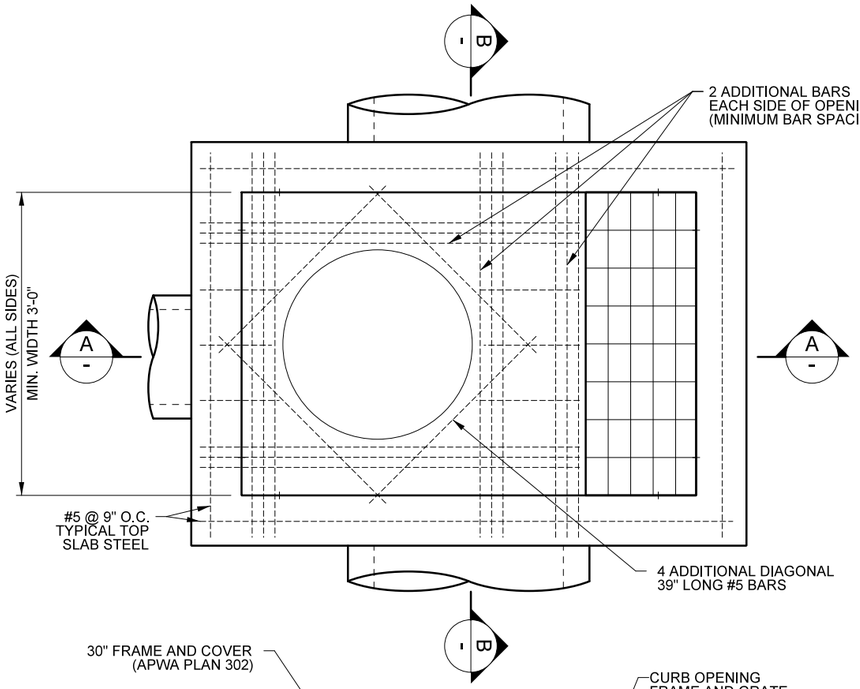
7/15/2020
DATE

DESIGN ENGINEER
PROFESSIONAL ENGINEER

WVC STANDARD DRAWING

ASPHALT CONCRETE T-PATCH

WVC STD. DWG. NO.
WVC 255



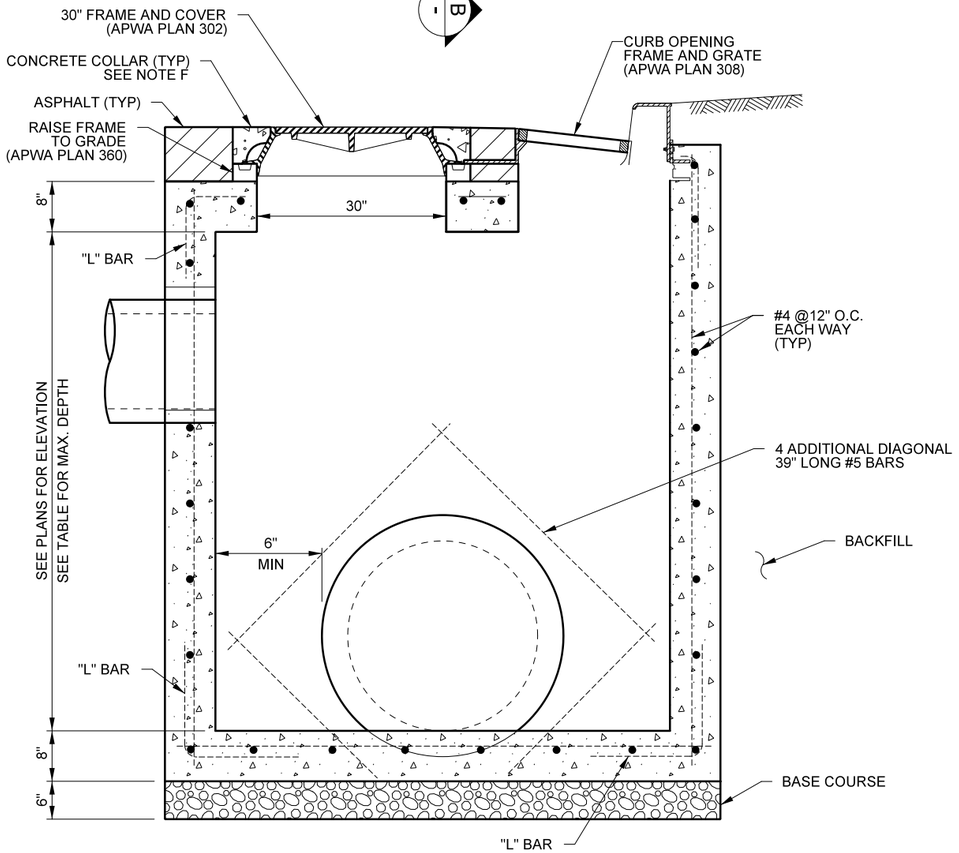
WALL THICKNESS AND WALL STEEL				
LOW WATER TABLE				
MAXIMUM BOX WIDTH	6 FEET	8 FEET	8 FEET	9 FEET
MAXIMUM BOX DEPTH	5 FEET	8 FEET	12 FEET	12 FEET
WALL THICKNESS	8 INCHES	8 INCHES	12 INCHES	12 INCHES
WALL CURTAIN STEEL	#5 @ 12"	#5 @ 6"	#5 @ 6"	#7 @ 9"
MODIFICATIONS FOR HIGH WATER TABLE				
WALL THICKNESS	8 INCHES	10 INCHES	16 INCHES	12 INCHES
WALL CURTAIN STEEL	#5 @ 9"	#5 @ 6"	#5 @ 6"	#6 @ 6"

NOTES:

1. **GENERAL**
   A. THE DRAWING SHOWS TYPICAL PIPE CONNECTIONS. REFER TO CONSTRUCTION DRAWINGS FOR CONNECTION LOCATIONS OR REFER TO FIELD LOCATION OF EXISTING PIPING WHEN DETERMINING PIPE CONNECTION TO THE BOX.

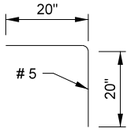
2. **PRODUCTS**
   A. BASE COURSE: UNTREATED BASE COURSE, APWA SECTION 32 11 23.
   B. BACKFILL: GRANULAR BACKFILL BORROW PER APWA SECTION 31 05 13.
   C. CONCRETE: CLASS 4000, APWA SECTION 03 30 04.
   D. REINFORCEMENT: DEFORMED, 60 ksi YIELD GRADE STEEL, ASTM A 615.
   E. STABILIZATION-SEPARATION GEOTEXTILE: HIGH MARV, WOVEN OR NON-WOVEN, APWA SECTION 31 05 19.

3. **EXECUTION**
   A. FOUNDATION STABILIZATION: GET ENGINEER'S PERMISSION TO USE FREE DRAINING GRANULAR BACKFILL IN A GEOTEXTILE WRAP TO STABILIZE AN UNSTABLE FOUNDATION.
   B. BASE COURSE PLACEMENT: APWA SECTION 32 11 23. MAXIMUM LIFT THICKNESS IS 8-INCHES BEFORE COMPACTION. COMPACTION IS 95 PERCENT OR GREATER RELATIVE TO A MODIFIED PROCTOR DENSITY, APWA SECTION 31 23 26.
   C. REINFORCEMENT: CENTER STEEL IN WALLS AND SLABS WITH A MINIMUM COVER OF 2-INCHES. KEEP STEEL 2-INCHES CLEAR AROUND PIPE AND LID OPENING. TIE-BARS REQUIRED AT ALL CORNERS, VERTICAL AND HORIZONTAL. TIE-BARS CONNECTING TWO WALLS MUST MATCH WALL BAR SIZE AND SPACING. TIE-BARS CONNECTING WALLS TO TOP AND BOTTOM SLABS MUST MATCH SLAB STEEL SIZE SPACING.
   D. CONCRETE PLACEMENT: APWA SECTION 03 30 10. ADJUST CONCRETE DIMENSIONS AT FRAME ACCORDINGLY. PROVIDE 1/2-INCH RADIUS EDGES. APPLY A BROOM FINISH. APPLY A CURING AGENT.
   E. BACKFILL: PROVIDE BACKFILL AGAINST ALL OF THE BOX WALLS. PEA GRAVEL AND RECYCLED RAP AGGREGATE IS NOT ALLOWED. WATER JETTING IS NOT ALLOWED. MAXIMUM LIFT THICKNESS (BEFORE COMPACTION) IS 8-INCHES WHEN USING RIDING EQUIPMENT AND 6-INCHES WHEN USING HAND HELD EQUIPMENT. COMPACTION IS 95 PERCENT OR GREATER OF PROCTOR PER APWA SECTION 31 23 26.
   F. INSTALL CONCRETE COLLAR PER APWA PLAN 362 WITH A DEVIATION FROM TE DRAWING FOR THE COLLARS TO BE RECESSED BELOW PAVEMENT FROM 1/8-INCH TO 1/4-INCH. ANY CONCRETE COLLAR ON A UTILITY COVER RECESSED ABOVE OR BELOW THE ALLOWABLE TOLERANCES MUST BE REPLACED.

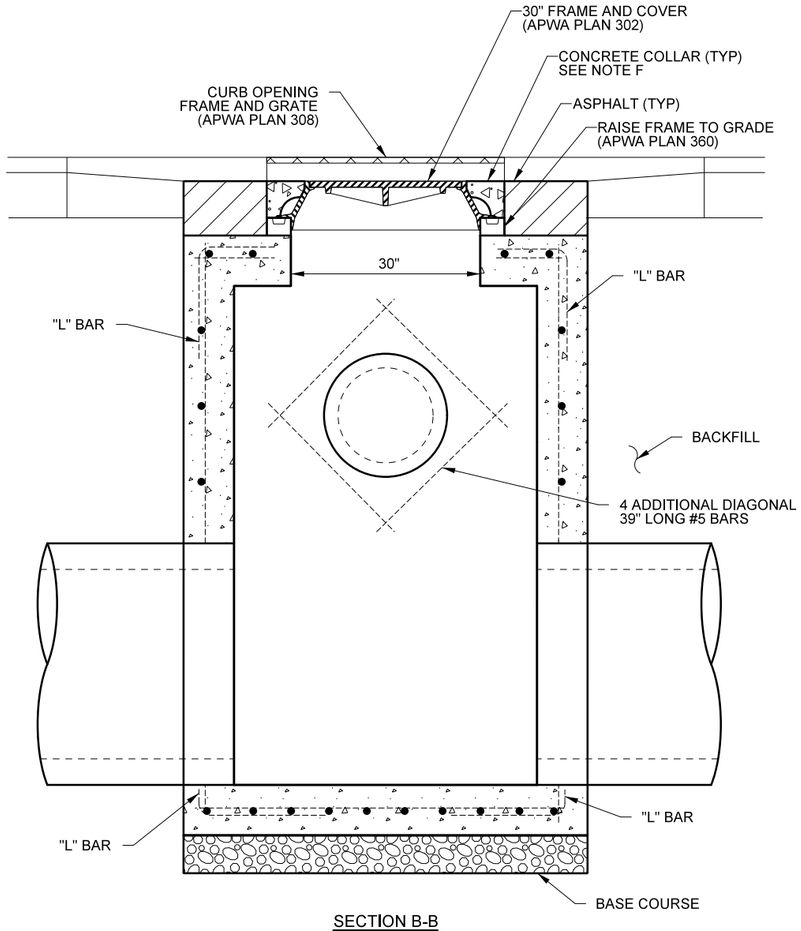


SECTION A-A

NO SUMP UNLESS NOTED OTHERWISE



'L' BAR



SECTION B-B

NO SUMP UNLESS NOTED OTHERWISE

NO.	BY	DATE	REMARKS
			REVISIONS

DESIGN | CHECK | DRAWN | CHECK

WEST VALLEY CITY PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION
3600 CONSTITUTION BOULEVARD
WEST VALLEY CITY, UTAH 84119-3720

7/15/2020
DATE

DESIGN

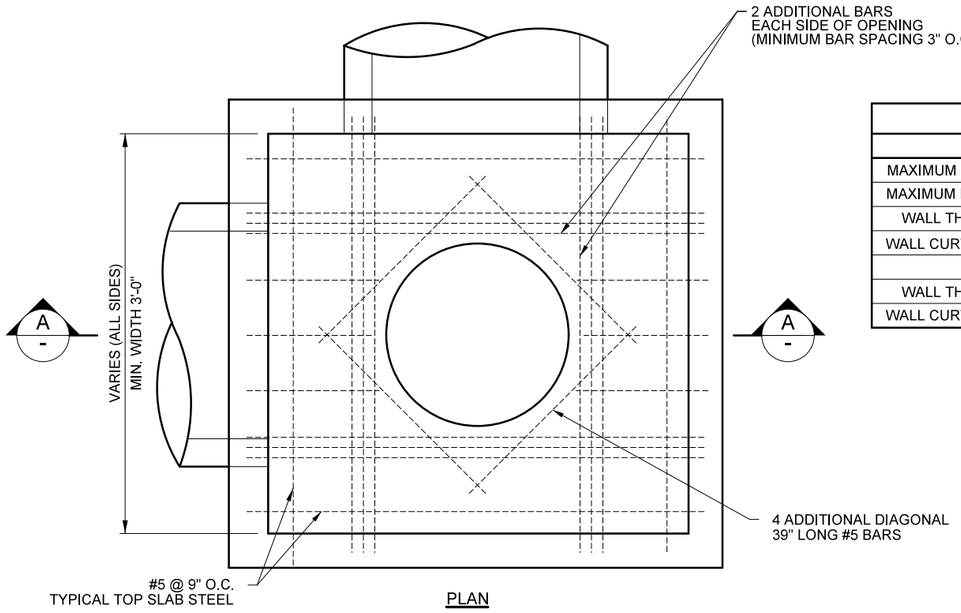
PROFESSIONAL ENGINEER

WVC STANDARD DRAWING

MODIFIED COMBO BOX

WVC STD. DWG. NO.
WVC 316

7/15/2020 3:50:52 PM H:\ENGDIV\STANDARDS\WEST VALLEY CITY\WVC Standard Drawings\Adopted WVC Standard Drawings\WVC 316 - Modified Combo Box.dgn



PLAN

WALL THICKNESS AND WALL STEEL				
LOW WATER TABLE				
MAXIMUM BOX WIDTH	6 FEET	8 FEET	8 FEET	9 FEET
MAXIMUM BOX DEPTH	5 FEET	8 FEET	12 FEET	12 FEET
WALL THICKNESS	8 INCHES	8 INCHES	12 INCHES	12 INCHES
WALL CURTAIN STEEL	#5 @ 12"	#5 @ 6"	#5 @ 6"	#7 @ 9"
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NOTES:

1. **GENERAL**
   A. THE DRAWING SHOWS TYPICAL PIPE CONNECTIONS. REFER TO CONSTRUCTION DRAWINGS FOR CONNECTION LOCATIONS OR REFER TO FIELD LOCATION OF EXISTING PIPING WHEN DETERMINING PIPE CONNECTION TO THE BOX.

2. **PRODUCTS**
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   B. BACKFILL: GRANULAR BACKFILL BORROW PER APWA SECTION 31 05 13.
   C. CONCRETE: CLASS 4000, APWA SECTION 03 30 04.
   D. REINFORCEMENT: DEFORMED, 60 ksi YIELD GRADE STEEL, ASTM A 615.
   E. STABILIZATION-SEPARATION GEOTEXTILE: HIGH MARV, WOVEN OR NON-WOVEN, APWA SECTION 31 05 19.

3. **EXECUTION**
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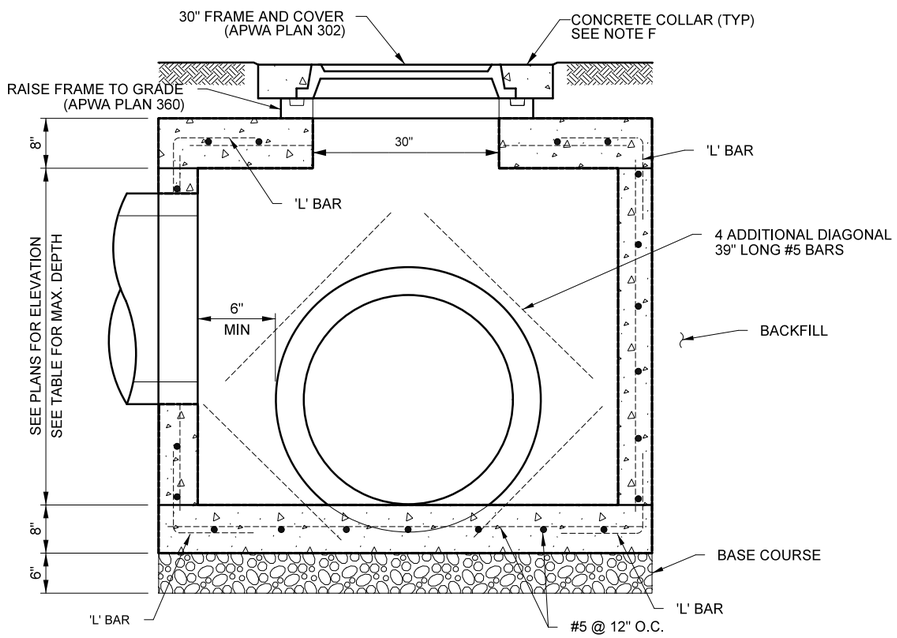
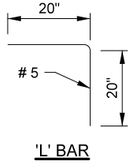
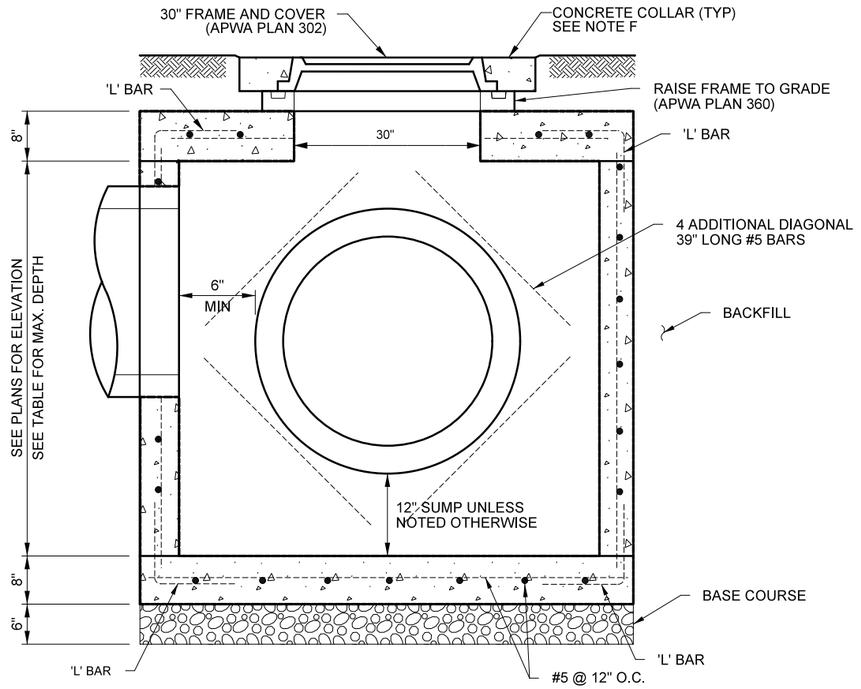


SECTION A-A WITHOUT SUMP



'L' BAR



SECTION A-A WITH SUMP

NO.	BY	DATE	REVISIONS	REMARKS

DESIGN ___ CHECK ___ DRAWN ___ CHECK ___

WEST VALLEY CITY PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION
3600 CONSTITUTION BOULEVARD
WEST VALLEY CITY, UTAH 84119-3720

7/15/2020
DATE

PROFESSIONAL ENGINEER

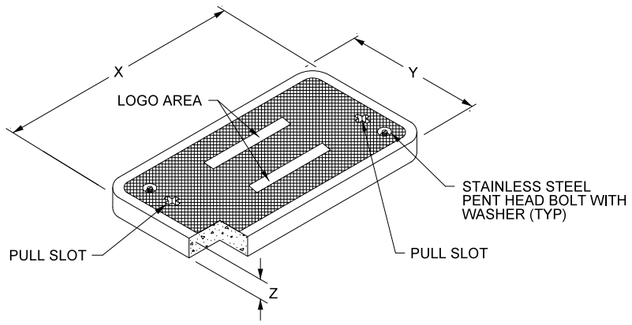
DESIGN

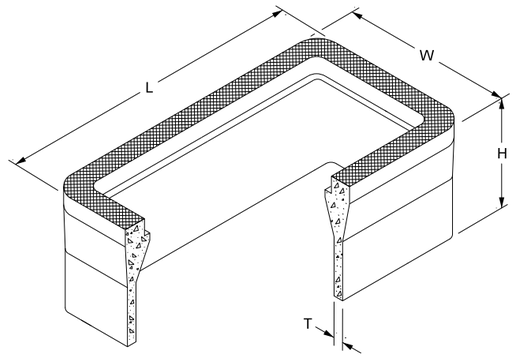
WVC STANDARD DRAWING

CLEANOUT BOX

WVC STD. DWG. NO.
WVC 331

7/15/2020 3:53:08 PM H:\ENGDIV\STANDARDS\WEST VALLEY CITY\WVC Standard Drawings\Adopted WVC Standard Drawings\WVC 331 - Cleanout Box.dgn





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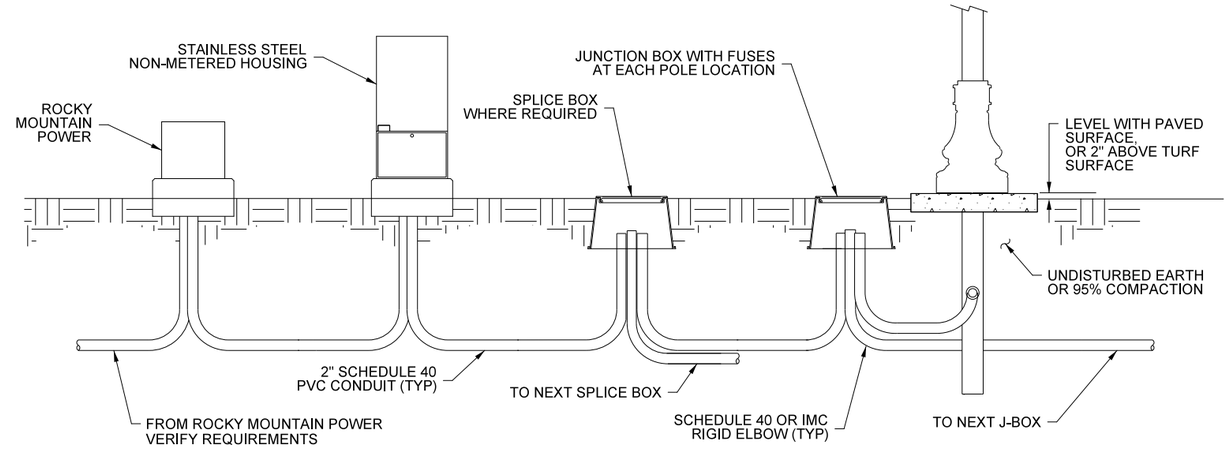
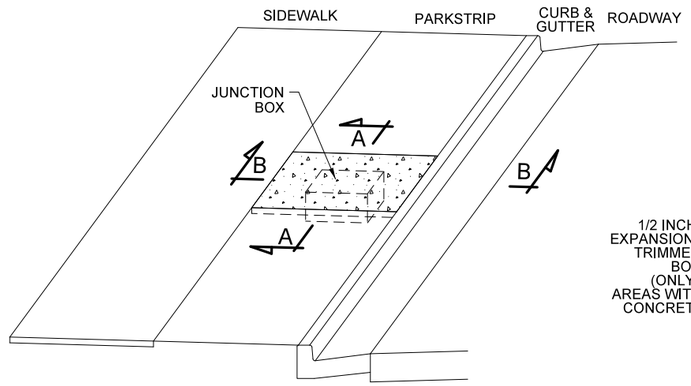
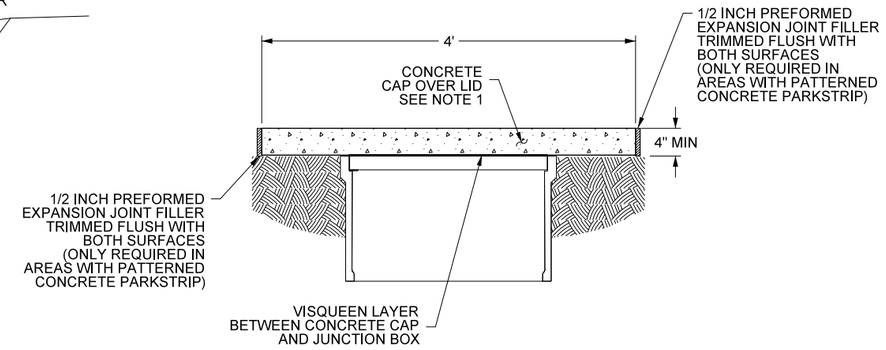
I-PC	24	25	1 ½	16	23 ¼	13 ¾	2
II-PC	24	37 ⅞	1 ½	26	35 ⅝	24	3
III-PC	24	49 ⅝	2	32 ⅛	47 ⅝	30 ⅛	3

POLYMER-CONCRETE JUNCTION BOX DETAIL

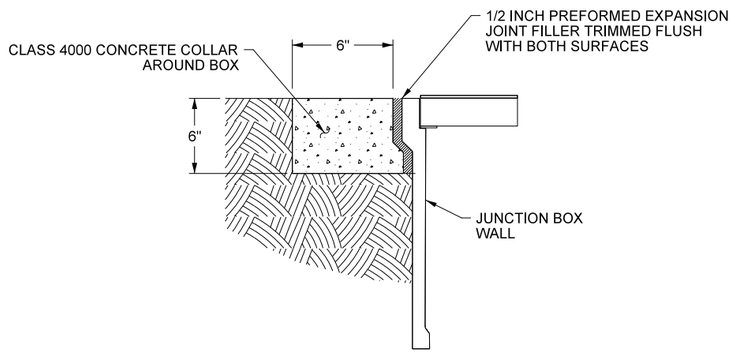


STREET LIGHT UNDERGROUND DETAIL



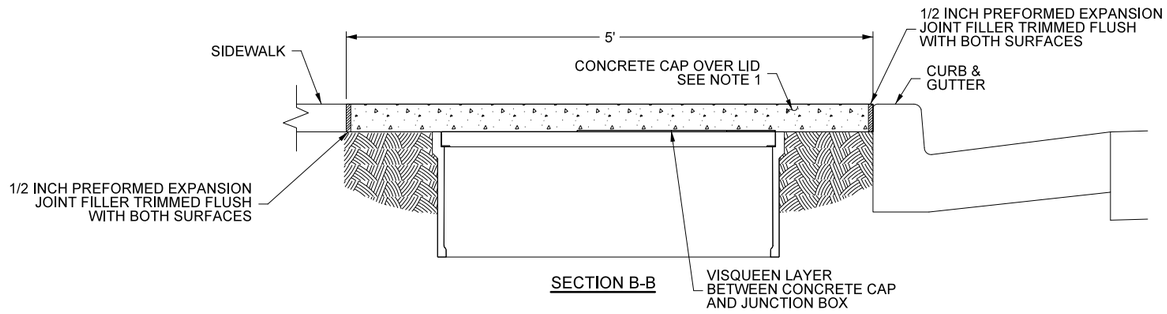


SECTION A-A



JUNCTION BOX CONCRETE COLLAR DETAIL

(ONLY REQUIRED ON BOXES WITHOUT CONCRETE CAP - FUTURE USE JUNCTION BOXES)



JUNCTION BOX CONCRETE CAP DETAIL

(CONCRETE CAP REQUIRED ON ALL JUNCTION BOXES UTILIZED FOR STREET LIGHTING SYSTEMS)

NOTE:

1. IF JUNCTION BOX IS IN A PATTERNED CONCRETE PARKSTRIP AREA THE CONCRETE CAP IS TO BE PATTERNED CONCRETE PARKSTRIP WITH AN EXPANSION JOINT AROUND ALL 4 SIDES OF THE CAP. OTHER AREAS TO BE CLASS 4000 CONCRETE.

NO.	BY	DATE	REMARKS

REVISIONS

DESIGN ____ CHECK ____

DRAWN ____ CHECK ____

WEST VALLEY CITY PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION
3600 CONSTITUTION BOULEVARD
WEST VALLEY CITY, UTAH 84119-3720

7/15/2020
DATE

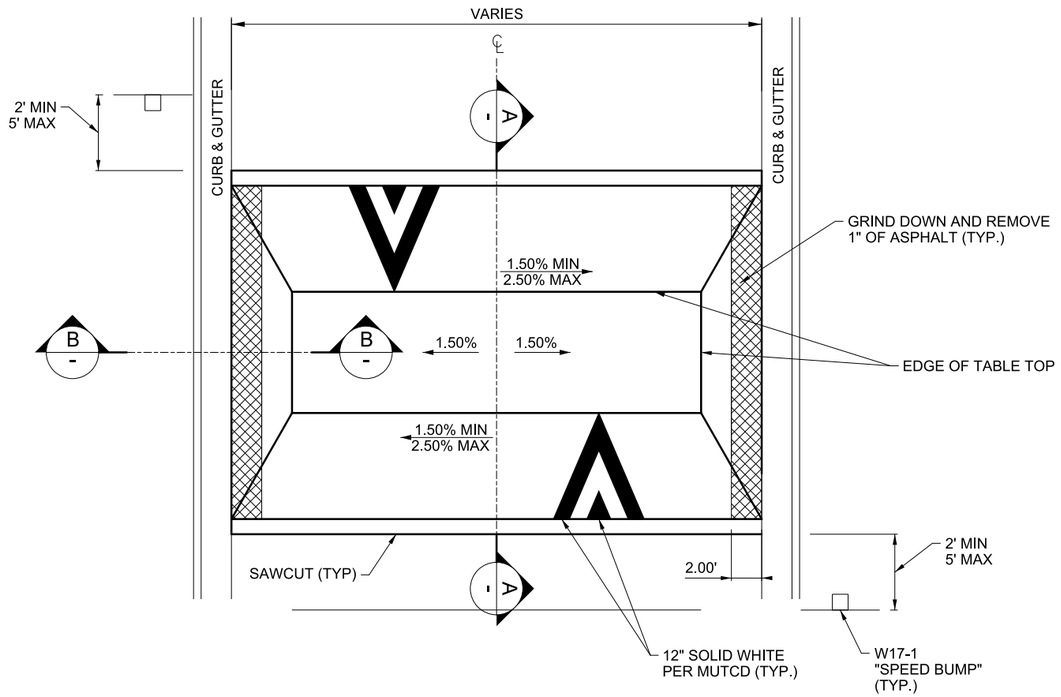
PROFESSIONAL ENGINEER

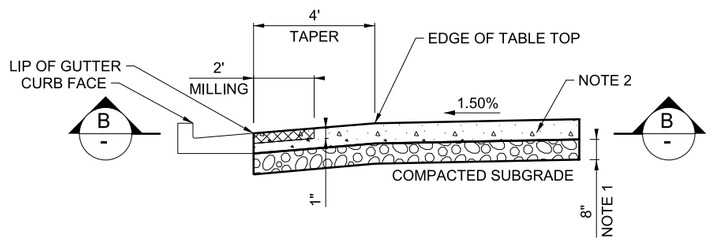
DESIGN

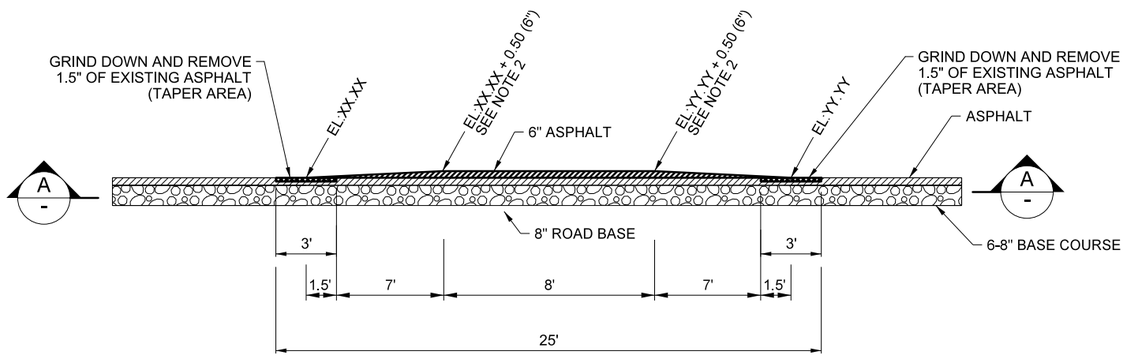
WVC STANDARD DRAWING

JUNCTION BOX

WVC STD. DWG. NO.
WVC 731







NOTES:

1. UNTREATED BASE COURSE; PROVDE CLASS A UNTREATED BASE COURSE SPECIFIED IN APWA SECTION 32 11 23.
   A. DO NOT USE GRAVEL AS A SUBSTITUTE FOR UNIREATED BASE COURSE.
   B. PLACE MATERIAL PER APWA SECTION 32 05 10.
   C. COMPACT PER APWA SECTION 31 23 26 TO A MODIFIED PROCTOR DENSITY OF 95 PERCENT OR GREATER. MAXIMUM LIFT THICKNESS BEFORE COMPACTION IS 8 INCHES WEN USING RIDING COMPACTION EQUIPMENT OR 6 INCHES WHEN USING HAND HELD COMPACTION EQUIPMENT.
2. ASPHALT PAVMENT: USE PG 64-34 DM 1/2 ASPHALT CONCRETE PAVEMENT SPECIFIED IN APWA SECTION 32 12 05.
   A. INSTALL IN LIFT NO GREATR THAN 3 INCHES AFTR COMPACTON.
   B. COMPACT EACH LIFT TO 93.5 PERCENT OF AST D 2041 (RICE MEIHOD} PLUS OR MINUS 2 PERCENT.
3. TACK COAT: APWA SECTION 32 12 13.13 CLEAN ALL VERTICAL SURFACES ADJACENT TO THE PATCH. APPLY FULL COVRAGE TACK COAT.
4. ASPHALT PAVMENT JOINTS: PROVIDE A NEAT SIRAIGHT JOINT BETWEEN EXISTNG AND NEW ASPHALT CONCRETE. SAW-CUT JOINT IF EXISTING PAVEMENT EXCEEDS 2 INCHES IN THICKNESS PAVMENT.
5. JOINT REPAIR: IF A CRACK OCCURS AT THE CONNECTON TO EXISTING PAVEMENT OR AT ANY STREET FIXTURE, SEAL THE CRACK PER APWA SECTION 32 01 17.
6. MILLNG: APWA SECTION 02 41 14
   A. REMOVE COMPACTED MILLNG ON PREPARED SURFACES
   B. MILL AROUND GUTTER LIP RADII TO SPECIFIED DEPIH PRIOR TO PAVNG.
7. PAINT: PROVIDE ALKYD RESIN PAINT AS SPECIFIED IN UDOT SECTION 02765 AND SECTION 02768. REMOVE DIRT, LOOSE STONES, OR OIHER FOREIGN MATERIAL IMMEDIATELY PRIOR TO APPLYING. APPLY PER UDOT SECTON 02765 AND 02768.

W17-1
30" x 30" SINGLE LANE
36" x 36" MULTI LANE

NO.	DATE	REMARKS
		REVISIONS

DESIGN ____ CHECK ____ DRAWN ____ CHECK ____

WEST VALLEY CITY PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION
3600 CONSTITUTION BOULEVARD
WEST VALLEY CITY, UTAH 84119-3720

PROFESSIONAL ENGINEER ____ DATE ____

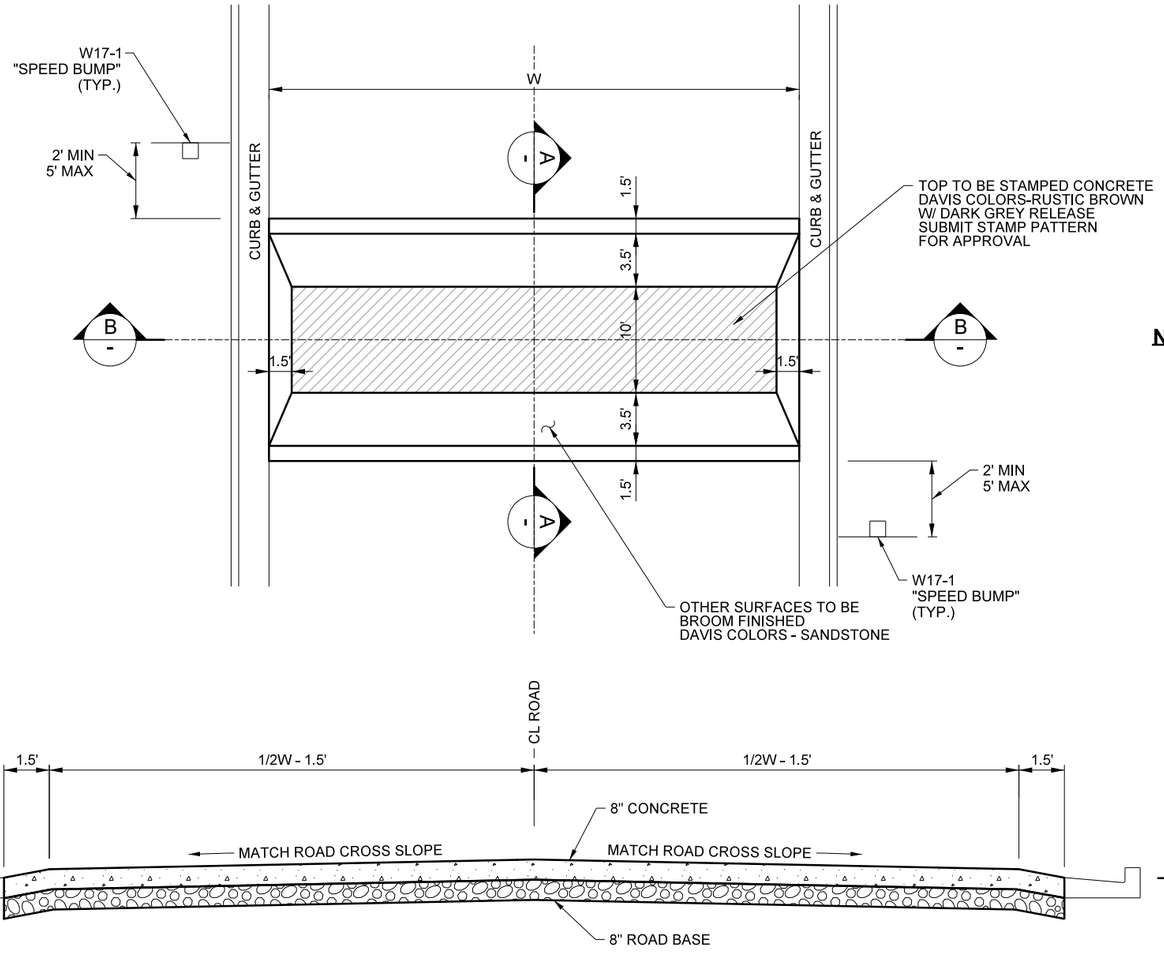
DESIGN

WVC STANDARD DRAWING

ASPHALT SPEED TABLE

WVC STD. DWG. NO.
WVC 762.1

7/20/2020 7:12:39 PM H:\ENGDIV\STANDARDS\WEST VALLEY CITY\WVC Standard Drawings\WVC 762.1 - Asphalt Speed Table.dgn



SPEED TABLE DETAILS

NTS

NOTES:

1. UNTREATED BASE COURSE; PROVDE CLASS A UNTREATED BASE COURSE SPECIFIED IN APWA SECTION 32 11 23.
   A. DO NOT USE GRAVEL AS A SUBSTITUTE FOR UNIREATED BASE COURSE.
   B. PLACE MATERIAL PER APWA SECTION 32 05 10.
   C. COMPACT PER APWA SECTION 31 23 26 TO A MODIFIED PROCTOR DENSITY OF 95 PERCENT OR GREATER. MAXIMUM LIFT THICKNESS BEFORE COMPACTION IS 8 INCHES WEN USING RIDING COMPACTION EQUIPMENT OR 6 INCHES WHEN USING HAND HELD COMPACTION EQUIPMENT.
2. CONCRETE: CLASS 4000, APWA SECTION 03 30 04,
   A. IF NECESSARY, PROVIDE CONCRETE THAT ACHIEVES DESIGN STRENGTH IN LESS THAN 7 DAYS. USE CAUTION; HOWEVER, AS CONCRETE CRAZING (SPIDER CRACKS) MAY DEVELOP IF AIR TEMPERATURE EXCEEDS 90°F.
   B. CONCRETE PLACEMENT PER APWA SECTION 03 30 10. CLEAN ALL EDGES OF DIRT, OIL AND LOOSE DEBRIS. PROVIDE 1/2" RADIUS EDGES, APPLY A CURING AGENT
3. CONCRETE CURING AGENT: WHITE PIGMENTED MEMBRANE FORMING COMPOUND (TYPE II CLASS A OR B), APWA SECTION 03 39 00.
4. EXPANSION JOINT: VERTICAL, FULL DEPTH WITH TOP OF FILLER SET FLUSH WITH CONCRETE SURFACE.
5. CONTRACTION JOINT: VERTICAL, 1/8" WIDE AND 1/3 SLAB THICKNESS. MATCH JOINT LOCATIONS IN ADJACENT PORTLAND-CEMENT CONCRETE ROADWAY PAVEMENT.
6. JOINT REPAIR: IF A CRACK OR SEPARATION OCCURS AT A CONNECTION TO EXISTING PAVEMENT DURING THE ONE YEAR CORRECTION PERIOD, BLOW THE CRACK OR SEPPARATEION CLEAN AND APPLY JOINT SEALANT PER PLAN 265.
7. PAINT: PROVIDE ALKYD RESIN PAINT AS SPECIFIED IN UDOT SECTION 02765 AND SECTION 02768. REMOVE DIRT, LOOSE STONES, OR OIHER FOREIGN MATERIAL IMMEDIATELY PRIOR TO APPLYING. APPLY PER UDOT SECTON 02765 AND 02768.

W17-1
30" x 30" SINGLE LANE
36" x 36" MULTI LANE

REVISIONS

NO.	BY	DATE	REMARKS

DESIGN ____ CHECK ____ DRAWN ____ CHECK ____

WEST VALLEY CITY PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION
3600 CONSTITUTION BOULEVARD
WEST VALLEY CITY, UTAH 84119-3720

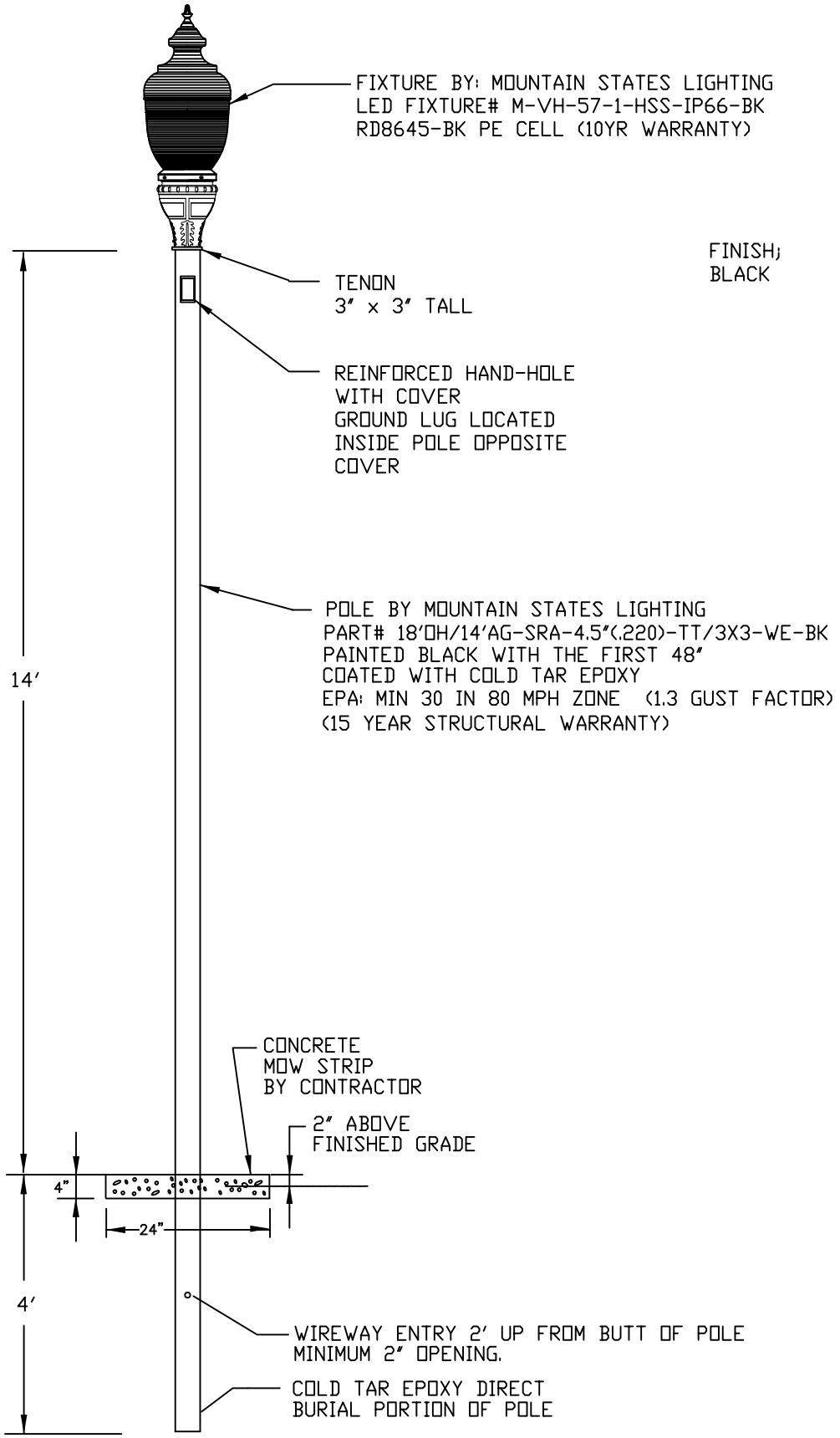
DESIGN ____ DATE ____ PROFESSIONAL ENGINEER

WVC STANDARD DRAWING

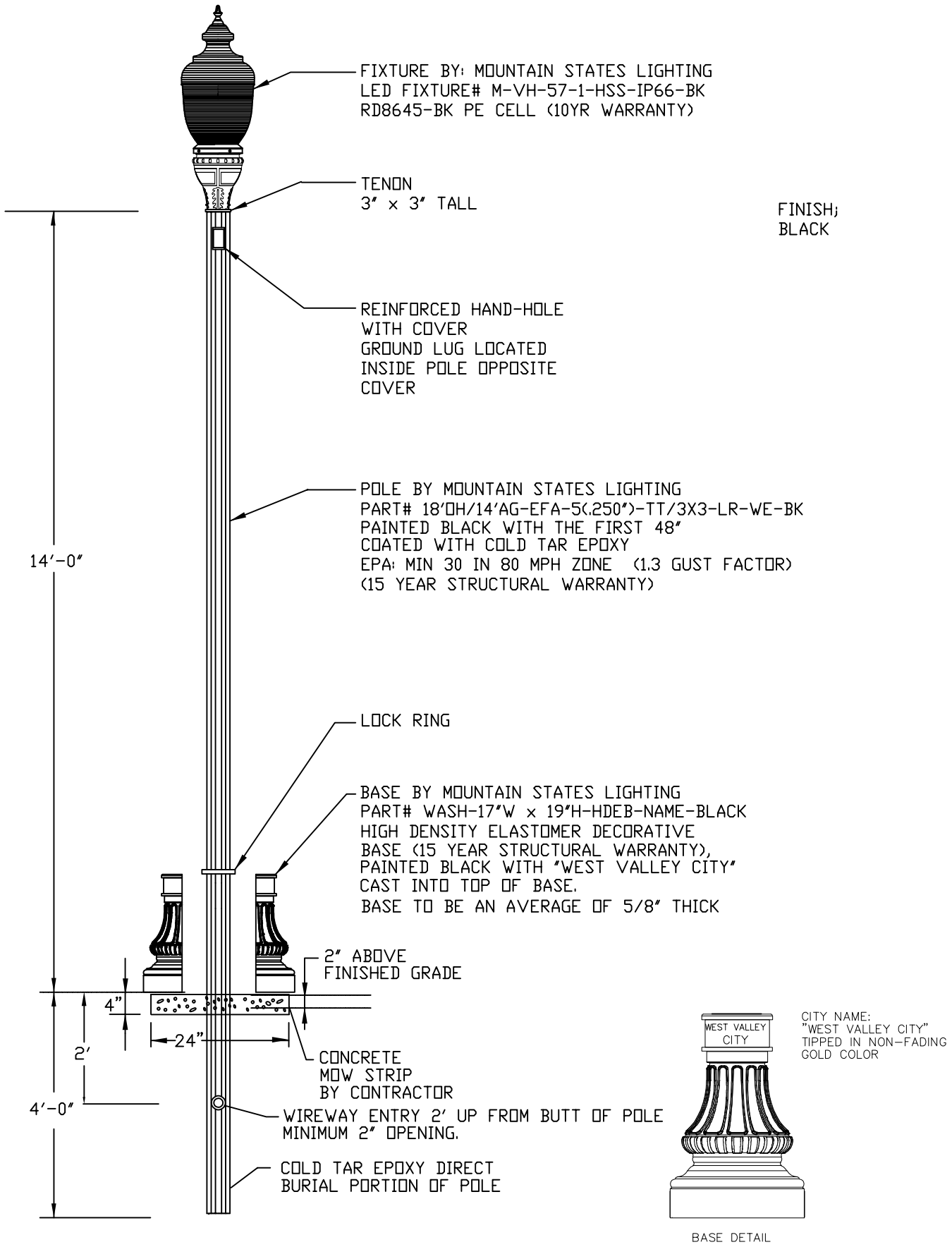
CONCRETE SPEED TABLE

WVC STD. DWG. NO.
WVC 762.2

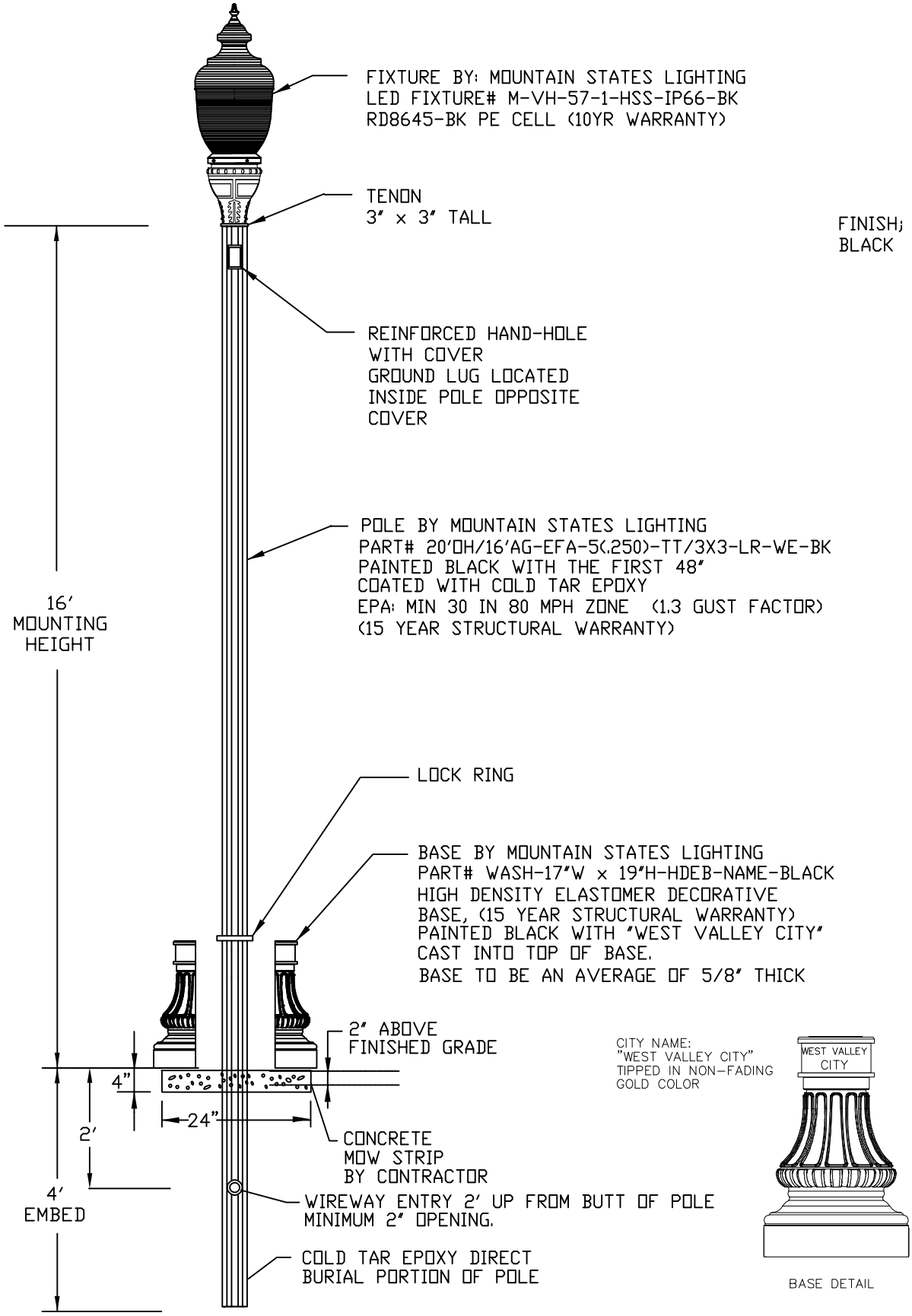
7/20/2020 7:29:39 PM H:\ENGDIV\STANDARDS\WEST VALLEY CITY\WVC Standard Drawings\WVC 762.2 - Concrete Speed Table.dgn



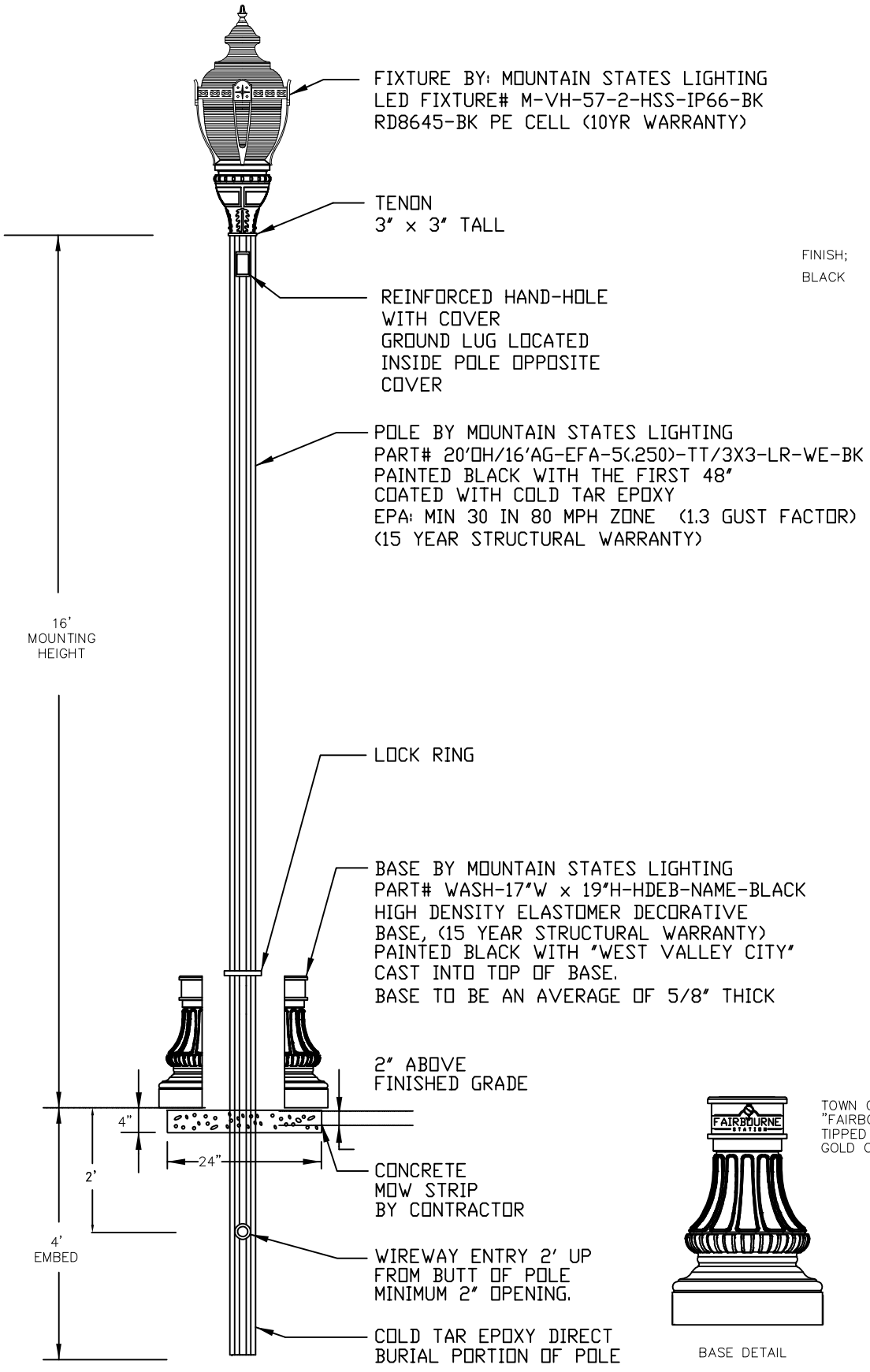
SHEET NO. 1	STANDARD DRAWING LP-01 RESIDENTIAL STREET LIGHT PROJECT NUMBER WVC STREET LIGHTING	WEST VALLEY CITY PUBLIC WORKS DEPARTMENT TRANSPORTATION DIVISION 3600 CONSTITUTION BOULEVARD WEST VALLEY CITY, UTAH 84119-3720 DESIGN FTM 10-09-2019 DATE	REMARKS / DATE / NO. / BY REVISIONS



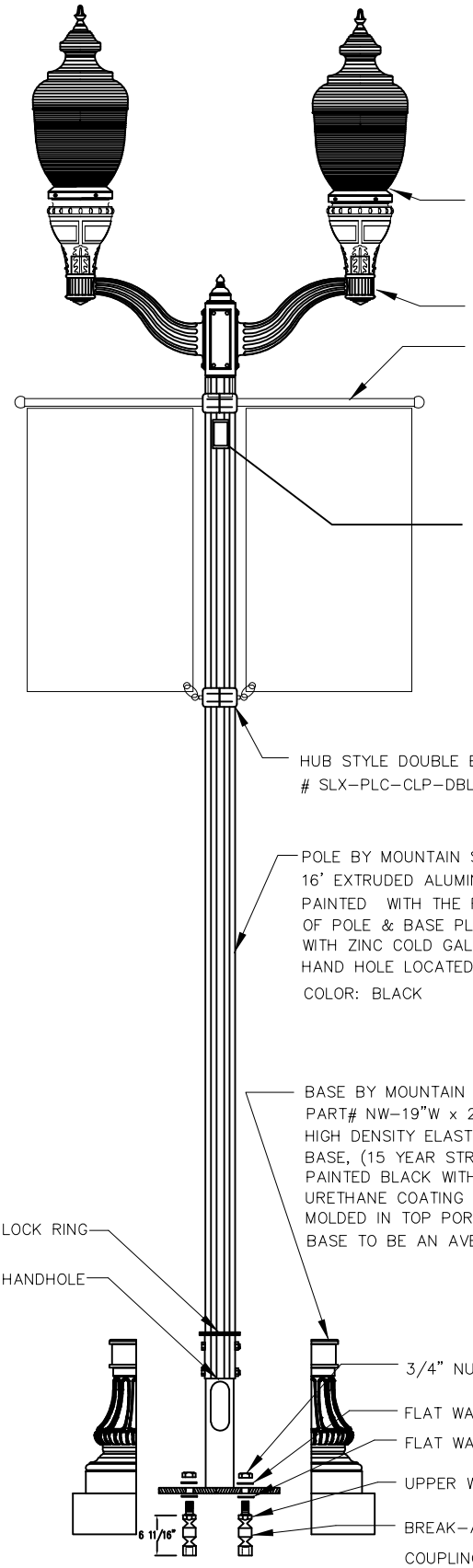
SHEET NO. 2	STANDARD DRAWING	WEST VALLEY CITY PUBLIC WORKS DEPARTMENT TRANSPORTATION DIVISION 3600 CONSTITUTION BOULEVARD WEST VALLEY CITY, UTAH 84119-3720	REMARKS / DATE / NO. / BY REVISIONS
	LP-02		
	SECONDARY STREET LIGHT		
	PROJECT NUMBER WVC STREET LIGHTING	DESIGN FTM 10-09-2019 DATE	

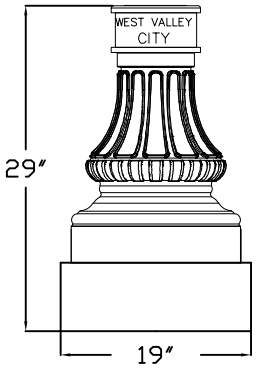


SHEET NO. 3	STANDARD DRAWING LP-03 ARTERIAL STREET LIGHT PROJECT NUMBER WVC STREET LIGHTING	WEST VALLEY CITY PUBLIC WORKS DEPARTMENT TRANSPORTATION DIVISION 3600 CONSTITUTION BOULEVARD WEST VALLEY CITY, UTAH 84119-3720 DESIGN FTM 10-09-2019 DATE	REMARKS / DATE / NO. / BY REVISIONS



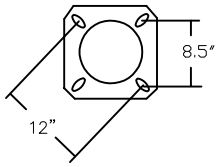
SHEET NO. 4	STANDARD DRAWING	WEST VALLEY CITY PUBLIC WORKS DEPARTMENT TRANSPORTATION DIVISION 3600 CONSTITUTION BOULEVARD WEST VALLEY CITY, UTAH 84119-3720	REMARKS / DATE / NO. / BY REVISIONS
	LP-3A		
	FAIRBOURNE STREET LIGHT		
	PROJECT NUMBER WVC STREET LIGHTING	DESIGN FTM 10-09-2019 DATE	



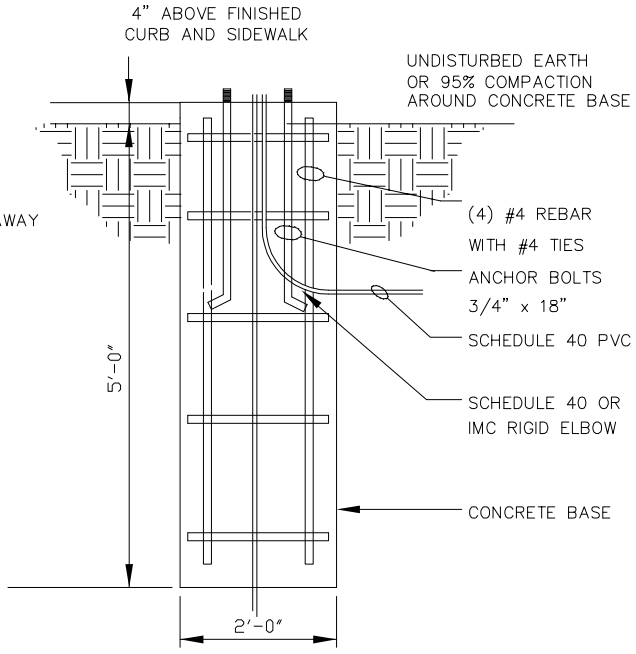


CITY NAME:
"WEST VALLEY CITY"
TIPPED IN NON-FADING
GOLD COLOR

BASE DETAIL

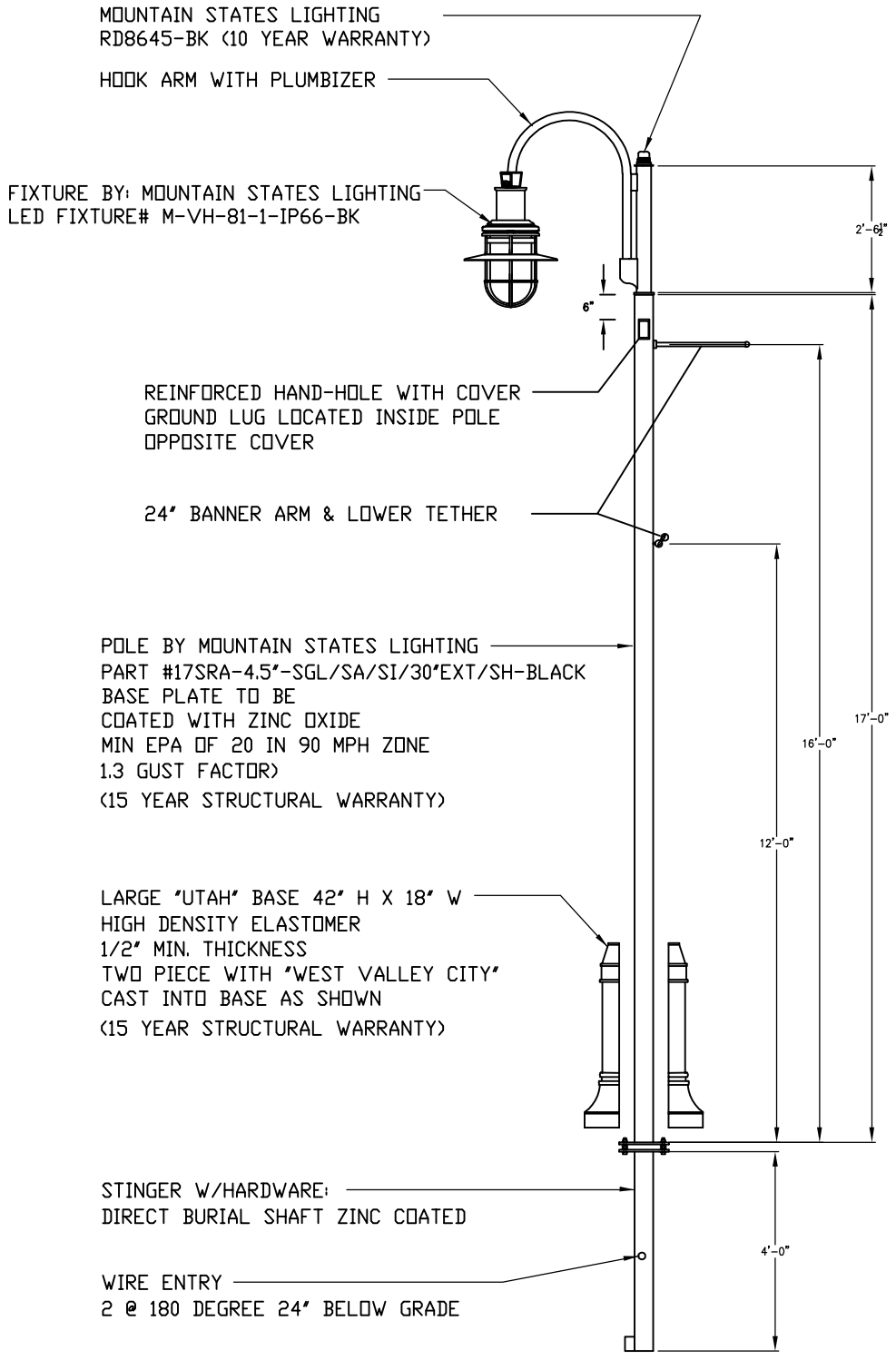


ANCHOR BASE DETAIL
12" BOLT CIRCLE
ANCHOR BOLTS: 3/4" x 18"



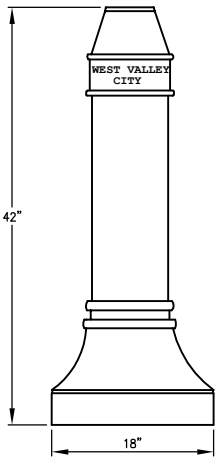
CONCRETE BASE

SHEET NO. 5	STANDARD DRAWING LP-04 RESIDENTIAL STREET LIGHT PROJECT NUMBER WVC STREET LIGHTING	WEST VALLEY CITY PUBLIC WORKS DEPARTMENT TRANSPORTATION DIVISION 3600 CONSTITUTION BOULEVARD WEST VALLEY CITY, UTAH 84119-3720 DESIGN FTM 10-09-2019 DATE	REMARKS / DATE / NO. / BY REVISIONS



ASSEMBLY COLOR; BLACK

CITY NAME:
"WEST VALLEY CITY"
TIPPED IN NON-FADING
GOLD COLOR



DECORATIVE BASE
ENLARGED DETAIL

SHEET NO. 9

STANDARD DRAWING

LP-05

SINGLE SIDEWALK STREET LIGHT

PROJECT NUMBER WVC STREET LIGHTING

WEST VALLEY CITY PUBLIC WORKS DEPARTMENT
TRANSPORTATION DIVISION
3600 CONSTITUTION BOULEVARD
WEST VALLEY CITY, UTAH 84119-3720

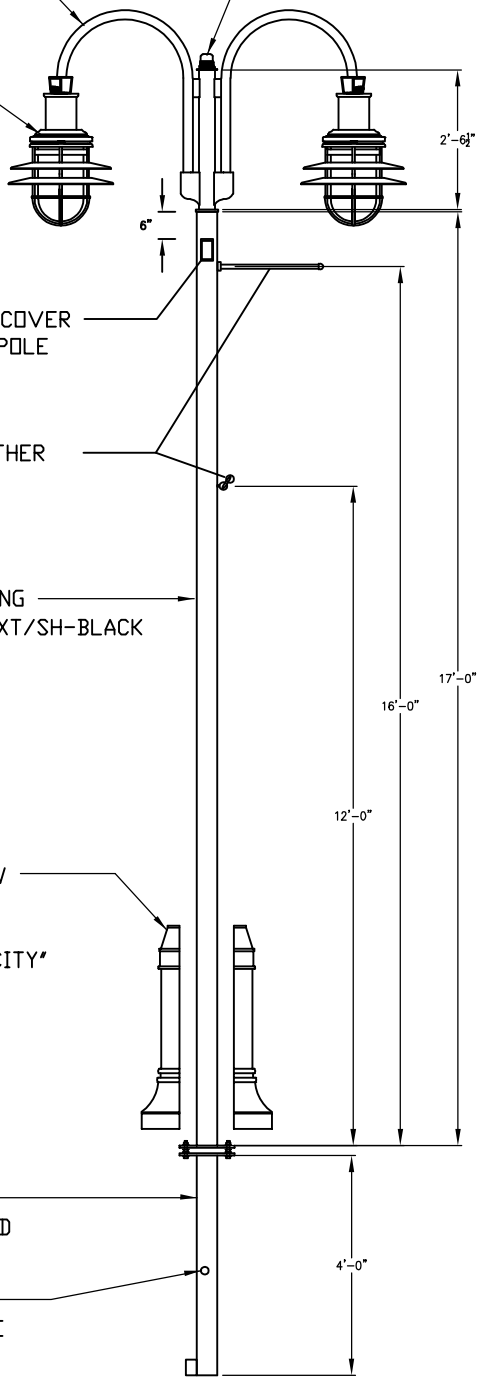
DESIGN FTM 10-09-2019 DATE

REMARKS	DATE	NO.	BY
REVISIONS			

MOUNTAIN STATES LIGHTING
PHOTOCELL 10 YEAR WARRANTY

HOOK ARM WITH PLUMBIZER
(TYPICAL OF TWO)

FIXTURES BY: MOUNTAIN STATES LIGHTING
LED FIXTURE# M-VH-81-1-IP66-BK



REINFORCED HAND-HOLE WITH COVER
GROUND LUG LOCATED INSIDE POLE
OPPOSITE COVER

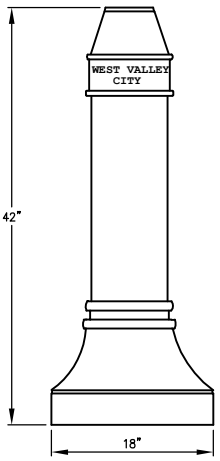
24" BANNER ARM & LOWER TETHER

ASSEMBLY COLOR; BLACK

POLE BY MOUNTAIN STATES LIGHTING
PART #17SRA-4.5"-SGL/SA/SI/30"EXT/SH-BLACK
BASE PLATE TO BE
COATED WITH ZINC OXIDE
MIN EPA OF 20 IN 90 MPH ZONE
1.3 GUST FACTOR)
(15 YEAR STRUCTURAL WARRANTY)

CITY NAME:
"WEST VALLEY CITY"
TIPPED IN NON-FADING
GOLD COLOR

LARGE "UTAH" BASE 42" H X 18" W
HIGH DENSITY ELASTOMER
1/2" MIN. THICKNESS
TWO PIECE WITH "WEST VALLEY CITY"
CAST INTO BASE AS SHOWN
(15 YEAR STRUCTURAL WARRANTY)



DECORATIVE BASE
ENLARGED DETAIL

STINGER W/HARDWARE:
DIRECT BURIAL SHAFT ZINC COATED

WIRE ENTRY
2 @ 180 DEGREE 24" BELOW GRADE

SHEET NO. 7

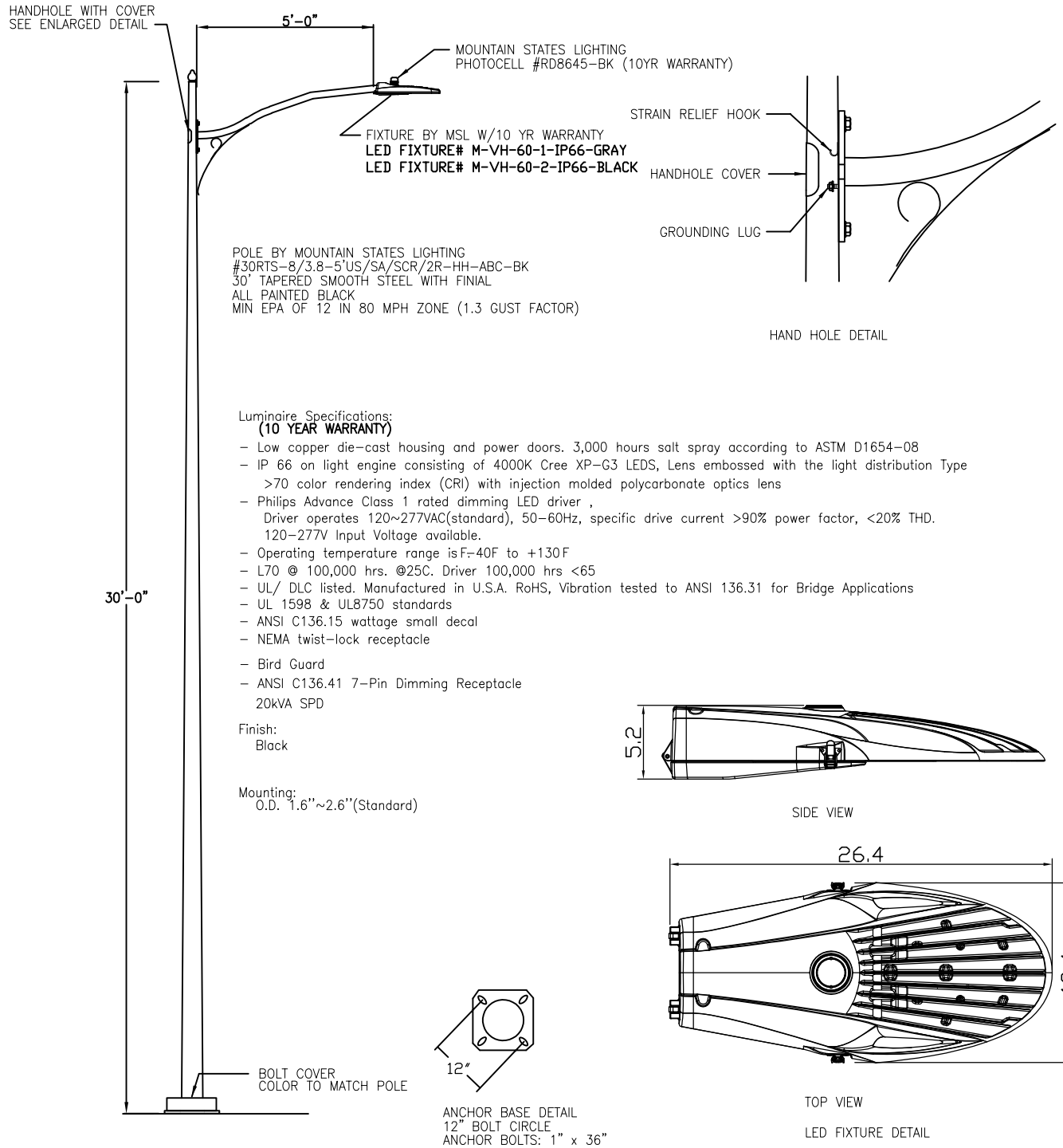
STANDARD DRAWING
LP-06
DOUBLE SIDEWALK STREET LIGHT
PROJECT NUMBER WVC STREET LIGHTING

WEST VALLEY CITY PUBLIC WORKS DEPARTMENT
TRANSPORTATION DIVISION
3600 CONSTITUTION BOULEVARD
WEST VALLEY CITY, UTAH 84119-3720

DESIGN FTM 10-09-2019
DATE

REMARKS	DATE	NO.	BY
REVISIONS			

ASSEMBLY COLOR: BLACK



Luminaire Specifications:
(10 YEAR WARRANTY)

- Low copper die-cast housing and power doors. 3,000 hours salt spray according to ASTM D1654-08
- IP 66 on light engine consisting of 4000K Cree XP-G3 LEDS, Lens embossed with the light distribution Type >70 color rendering index (CRI) with injection molded polycarbonate optics lens
- Philips Advance Class 1 rated dimming LED driver , Driver operates 120~277VAC(standard), 50-60Hz, specific drive current >90% power factor, <20% THD. 120-277V Input Voltage available.
- Operating temperature range is F:-40F to +130 F
- L70 @ 100,000 hrs. @25C. Driver 100,000 hrs <65
- UL/ DLC listed. Manufactured in U.S.A. RoHS, Vibration tested to ANSI 136.31 for Bridge Applications
- UL 1598 & UL8750 standards
- ANSI C136.15 wattage small decal
- NEMA twist-lock receptacle
- Bird Guard
- ANSI C136.41 7-Pin Dimming Receptacle 20kVA SPD

Finish:
Black

Mounting:
O.D. 1.6"~2.6"(Standard)

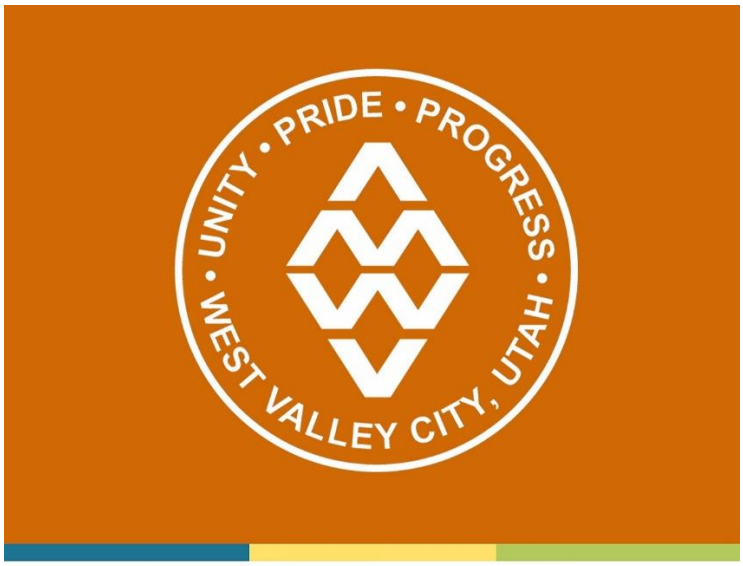
SIDE VIEW

TOP VIEW

LED FIXTURE DETAIL

ANCHOR BASE DETAIL
12" BOLT CIRCLE
ANCHOR BOLTS: 1" x 36"

SHEET NO. 8	STANDARD DRAWING	WEST VALLEY CITY PUBLIC WORKS DEPARTMENT TRANSPORTATION DIVISION 3600 CONSTITUTION BOULEVARD WEST VALLEY CITY, UTAH 84119-3720	REMARKS / DATE / NO. / BY REVISIONS
	LP-07		
	INDUSTRIAL STREET LIGHT		
	PROJECT NUMBER WVC STREET LIGHTING	DESIGN FTM 10-09-2019 DATE	



WEST VALLEY CITY

WEST VALLEY CITY
2020 ENGINEERING STANDARDS
8.3 - APPENDIX

WEST VALLEY CITY SPECIAL PROVISIONS
MODIFICATIONS TO APWA STANDARD SPECIFICATIONS

APPLICABLE FOR WORK IN THE PUBLIC RIGHT OF WAY AND ON PUBLIC INFRASTRUCTURE AND APPURTENANCES

SECTION 01 45 00-M

QUALITY CONTROL

This specification changes a portion of the 2017 Edition APWA Standard Specification No. 32 12 13.13. All other provisions of the Section remain in full force and effect.

Add the following to Part 1:

1.7 MINIMUM SAMPLING AND TESTING

A. The West Valley City Minimum Sampling and Testing Requirements provided in the bid documents shall be used to determine the frequency of verification sampling and testing on all public improvements constructed within the city right-of-way.

END OF SECTION 01 45 00-M

SECTION 26 56 19-S
ROADWAY LIGHTING

This specification replaces APWA Standard Specification Section 26 56 19 in its entirety.

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Materials and procedures for installing roadway lighting system.
B. Testing, painting, restoration, salvage.

1.2 REFERENCES

A.. **ASTM Standards:**

B3 Soft or Annealed Copper Wire.

B8 Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

D2301 Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape.

B. **NEMA Standards:**

250 Enclosures for Electrical Equipment (1000 Volts Maximum).

C. **NFPA Standards:**

70 National Electric Code.

D. **SSPC Standards:**

25 BCS Zinc Oxide Alkyld, Linseed Oil Primer for.

1.3 SUBMITTALS

A. Shop Drawings and Product Data: Complete, bound, indexed, large enough for all items included. When requested, supplement the following list by such other data as may be required, including detailed scale drawings and wiring diagrams of any special equipment and of any proposed deviation from the Contract Documents:

1. Performance data for luminaires, including lighting contours on the roadway surface and average maintained level of light in foot-candles.
2. Shop Drawings for luminaires showing pertinent physical characteristics, type of light source, and wattage.
3. Shop Drawings of ornamental poles.
4. Luminaire supports.
5. Pole bases.
6. Wiring schematic.
7. Fixture mounting height.
8. Drawing showing location of poles and underground power conduit.

B. Warranties and instruction sheets.

C. Testing results of this section article 3.9.

1.4 MAINTAINING EXISTING AND TEMPORARY ELECTRICAL SYSTEMS

A. Notify ENGINEER before performing any work on existing systems.

B. Allow 20 feet minimum overhead clearance across thoroughfares and 12 feet minimum clearance above sidewalk areas. Do not run temporary conductor on top of the ground or across any sidewalk area unless protected in an electrical raceway and barricaded.

C. Maintain existing electrical systems or approved temporary replacements, in effective operation for the benefit of the traveling public during the progress of the Work, except when shutdown is permitted to allow for alteration or removal of the systems. Do not interfere with the regular lighting schedule.

1.5 GENERAL ITEMS

A. Components of the street lighting system shall be in compliance with the standards, specifications and styles currently adopted by West Valley City for use in the municipal right-of-way.

B. Contractor shall be responsible to inspect poles and fixtures upon delivery to the job site and to protect the same from damage until installation is complete and lighting system is accepted by West Valley City.

C. Contractor shall be responsible to coordinate construction of lighting system with Rocky Mountain Power and West Valley City. Confirm final location of Rocky Mountain Power transformers or secondary boxes before starting construction.

D. All Light poles, fixtures, junction boxes, transformers or secondary boxes, underground conduit and wiring shall be placed only within the public street right-of-way and/or designated public utility easement. All underground work shall be completed and inspected prior to construction of permanent roadway, sidewalk, and curb and gutter.

1.6 INSPECTION

A. Two inspections shall be required. Call West Valley City Transportation Division at (801-955-3726) at least 24 hours in advance to schedule the required inspections.
   1. Underground system including but not limited to conduit, wiring, boxes, compaction and pole installation.
   2. Final inspection after system installation for a complete and operable system.

1.7 IN THE EVENT THAT MATERIALS ARE FURNISHED BY WEST VALLEY CITY

A. Contractor shall be responsible to inspect poles and fixtures upon receiving material. Material furnished by West Valley City to the contractor shall be the responsibility of the contractor until final approval of the system at which time the City will take ownership and the one-year contractor warranty for labor and underground will begin.

B. Anticipate 12-14 weeks for delivery of streetlight assemblies from manufacturer.

PART 2 PRODUCTS

2.1 EXISTING MATERIALS

A. Where existing systems are to be modified, incorporate existing material in revised system, salvage, or abandon.

2.2 Materials

A. The Contractor shall provide two #6RHH copper conductors or equivalent copper burial wires for wiring streetlights (the ground must be green color insulation or bare copper).

B. Permanently label the voltage that the wires are carrying inside the junction box (to be approved by WVC). Install dual fuse holder (set screw type only with rubber boots), two 10-amp fuses, and 3-outlet rubberized aluminum bar connector in each junction box.

1. No wire nuts allowed.

C. All wires shall be placed within a 2-inch conduit a minimum of 24 inches below finished grade. Conduit shall be installed under park strip or within the public utility easement behind integral sidewalk except where crossing streets. Conduit under park strips shall be Schedule 40 PVC and conduit under streets shall be Schedule 80 PVC or rigid steel. Conduit entering junction box shall be 6 inches above pea gravel at bottom of junction box.

D. Seal all conduits in each junction box with duct seal. Polywater FST duct sealant or approved equal.

E. Complete all connections and work per current NEC requirements.

2.3 POLES AND LUMINAIRE SUPPORTS

A. Per WVC standard drawings.

2.4 JUNCTION BOXES

A. Junction/Splice boxes shall be pre-cast polymer concrete, 25” x 16” x 24”. See Street Light Details drawing.

B. Manufacture lids with “STREET LIGHTING” in the logo area, in 1-inch recessed letters.

C. Lid Access Points: recessed reinforced steel pull slots to allow removal of cover with a hook or lever. Replace lid if damage occurs to the pulling point.

D. Bolts: stainless steel recessed penta head bolts with washer.

E. Place 6 inches of pea gravel on top 12 inches of free draining granular backfill borrow under junction boxes.

F. Level the top of junction box and grade accordingly.

G. Install concrete collars around junction boxes in all locations except where junction boxes are in concrete paved surfaces. See Street Light Details drawing.

1. Secure ½ inch expansion joint material around the junction box before placing concrete collar.
2. In certain areas as determined by the Engineer, junction boxes may be required to be recessed 4-inches and covered by a 4-inch thick concrete slab as a wire theft deterrent.

2.5 **INSULATING TAPE**

A. Type 1 vinyl chloride, ASTM D2301.

2.6 **LUMINAIRE**

A. Per WVC standard drawings.

2.7 **POLYSULFIDE BASE, SINGLE COMPONENT SEALANT**

A. Chemical curing; capable of being continuously immersed in water, withstand movement up to 20 percent of joint width, and satisfactorily applied throughout a temperature range to 40 to 80 deg F, Shore A hardness of 15 minimum and 50 maximum; non-staining and non-bleeding; color as selected by ENGINEER.

2.8 **CONCRETE AND GROUT**

A. Concrete: Class 4000 minimum cast-in-place, Section 03 30 04.
B. Grout: Cement, Section 03 61 00.

PART 3 EXECUTION

3.1 **PREPARATION**

A. Locate and preserve utilities, Section 31 23 16.
B. Excavate; Section 31 23 16 and backfill; Section 33 05 20.
C. Do not disturb roadway surface, sidewalk, curb, gutter, or other obstructions without approval.
D. Do not block or restrict pedestrian traffic, vehicle traffic, drainage or utilities.
E. Barricade all Excavations in traveled ways.
F. Compact excavated Trench material; Section 33 05 20 to the requirements of the adjacent areas.
G. After backfilling excavations, maintain smooth and well-drained surfaces until permanent repairs are effected.
H. Legally dispose of all excess or waste material.

3.2 **POLE FOUNDATION**

A. Construct foundation per details indicated and Section 34 41 13.
B. Locations:
    1. 18 inches clear from pull box.
    2. Not in pedestrian access way.
    3. Unless specified otherwise:
        a. 5 feet from new tree.
        b. 10 feet from existing tree, driveway, or hydrant.
        c. Center of park strip or 24 inches clear from top back of curb on wide park strips.
C. Pole Installation:
    1. Contractor is responsible for any damage to underground utilities or structures. Contractor shall contact Blue Stakes (800-662-4111) prior to any excavation.

2. Contractor is responsible for verification of streetlight location and restoration of environment compromised by installation.
3. All concrete shall be class 4000 per APWA 03 30 04. Placement shall be compliant with APWA Section 03 30 04.
4. Pole shall be plumb and secure.
5. Locate light pole behind signs when there is conflict.
6. All poles located in park strips shall be centered in park strip.
7. Pole shall be cleaned of dirt and debris after installation.
8. On direct burial poles install 24-inch diameter 4-inch thick concrete ring centered on pole and cast-in-place, (**NO Pre-cast is allowed)**.

3.3 CONDUIT INSTALLATION

A. In structural applications, use rigid steel conduit in areas subject to vehicular load, on the surface of structures, inside of structures and foundations, between structures, and the adjacent pull boxes located next to structures.

B. In buried utility applications, place conduit as follows.

Location	Depth of Burial, inches
In front of curb faces	36 to 60
Back of the back of curb	24 to 36
Railroad tracks	36 to 60
Primary power cables	40 minimum

C. Use sizes of conduit indicated or use larger sizes for any run at no additional cost to OWNER. No expanding or reducing fittings will be permitted.

D. Make field cuts square and true so that the ends will come together for full circumference. Paint threads on all rigid steel conduit with rust preventive paint before couplings are made. Repair damaged coating on galvanized steel conduit.

E. Cap all conduit ends with standard pipe caps until wiring is installed. When caps are removed from metallic conduit, provide threaded ends and approved conduit bushings.

F. Clean all existing underground conduit to be incorporated into new system with a mandrel and blow out with compressed air. Where existing rigid steel conduit systems are to be modified or extended, install rigid steel conduit.

G. Make changes in direction by bending the conduit to a radius which will meet code or, preferable, by the use of standard bends or elbows.

H. Install a No. 12 AWG pull wire or equivalent strength cord in all conduits which are to receive future conductors. Leave at least two (2) feet of pull wire extending beyond each end of the conduit run and secure.

I. Center conduit ends within the bolt circle of traffic signal poles or pedestals.

J. Pack conduit ends with sealant after conductors are installed.

K. Cap all conduit terminated without a pull box and identify its location by monumenting.

3.4 CONDUCTOR INSTALLATION

A. Install wiring per the appropriate articles of NFPA 70. Neatly arrange wiring within cabinets, junction boxes, etc.

B. Splice only at junction boxes, transformer leads, in pole bases, or at control equipment. Splice conductors as per manufacturer's recommendations and codes.

Provide a fused connector between the line and the ballast, accessible at the hand holes located in the poles.

C. Provide conduit to separate low-voltage conductors from high-voltage conductors in the same raceway (i.e. poles).

D. Splice insulation shall consist of layers of vinyl chloride electrical insulating tape applied to a thickness equal to and well lapped over the original insulation to provide uninterrupted underwater operation.

E. Leave two (2) feet of slack at each pole. Leave 18 inches of slack above top of pull box grade.

F. Mark termination of each conductor. Where circuit and phase are clearly indicated by conductor insulation, bands need not be used, otherwise use bands.

3.5 GROUNDING INSTALLATION

A. Effectively ground metallic cable sheaths, metal conduit, nonmetallic conduit grounding wire, ballast and transformer cases, service equipment, anchor bolts, metal poles, and pedestals, and make mechanically and electrically secure to form a continuous system. Use a copper wire strap for bonding and grounding jumpers of the same cross-sectional area as No. 6 AWG for all lighting systems.

B. Ground one side of the secondary circuit of series-multiple and step-down transformers. Ground metal conduit, service equipment, and neutral conductor at service point as required by NEC and electricity company with grounding conductor No. 6 AWG or larger.

C. In all nonmetallic (PVC) type conduit, provide a No. 8 AWG bare copper wire continuously and ground at each junction box.

D. At each multiple service point, unless otherwise indicated, furnish a ground electrode. Use copper coated ground electrodes of steel or iron in one piece lengths at least 3/4 inch in diameter. Do not use electrodes of nonferrous materials less than 1/2 inch in diameter.

E. Bond metal poles by means of a No. 8 AWG bonding wire attached from a grounding bushing to a foundation bolt or to a 3/16 inch or larger brass or bronze bolt installed in the lower portion of the pole.

F. On wood poles, ground all equipment mounted less than eight (8) feet above the ground surface.

G. Ground metallic conduit or bonding conductor system at intervals less than 500 feet to one of the following:
   1. 1-inch galvanized pipe driven eight (8) feet deep.
   2. 1/2-inch copper rod driven eight (8) feet deep.
   3. Metal water main with the approval of the water company. Clean water main thoroughly before connection.

H. Use galvanized grounding bushings and bonding jumpers for bonding metallic conduit in a concrete pull box. Use lock nuts for bonding metallic conduit in steel pull boxes, one inside and one outside of the box.

I. Pull Boxes: Install 3/4-inch x 10 feet copper clad ground rods at each pull box, six (6) inches above bottom. Ground all metal parts, neutral and ground wire with #6 B.C. Use exothermic weld or hammerlock connection.

3.6 JUNCTION AND PULL BOX INSTALLATION

A. Install at locations indicated, and at additional points when conduit runs are more than 200 feet. Without additional cost to OWNER and at CONTRACTOR's convenience add such additional boxes as may be desired to facilitate the work.
B. Rest bottom of pull box firmly on 12 inches thick bed of 1-inch crushed rock extending a minimum of six (6) inches beyond the outside edge of box.
C. Establish grade of top of boxes as for foundations.
D. Place long side of box parallel to curb unless indicated.
E. Use box extensions if ballasts or transformers are installed in box.
F. Do not install boxes in Driveway aprons.

3.7 LUMINAIRE AND BALLAST INSTALLATION

A. Immediately before installation, clean all light control surfaces, refractors, and reflectors to provide the maximum lumen output possible. Clean per luminaire manufacturer's recommendations.
B. Mount at height indicated.
C. Adjust luminaires individually to give the optimum light distribution.

3.8 SALVAGE

A. Terminate all conduit abandoned in place at least five (5) inches below finished grade.
B. Exercise care in removing equipment to be reused or salvaged so that it will remain in the condition existing before its removal.

3.9 RESTORATION

A. Replace damaged equipment, concrete work or other fixtures or features disturbed or damaged by the installation.
B. Restore paved surfaces, Section 33 05 25.
C. Finish landscaped surfaces to match existing with grass, Section 32 92 00 or with other ground cover, Section 32 93 13.

3.10 POINTS OF CONNECTION

A. All points of connection to Rocky Mountain Power facilities shall comply with the current release of the Electric Service Requirements Manual published by Rocky Mountain Power and available at;

http://www.rockymountainpower.net/esr

END OF SECTION 26 56 19-S

SECTION 31 05 13-M

COMMON FILL

This specification changes a portion of 2017 Edition APWA Standard Specification No. 31 05 13. All other provisions of the Section remain in full force and effect.

PART 1 GENERAL

Delete Article 1.5 in its entirety.

PART 2 PRODUCTS

Replace Article 2.1 with the following:

2.12 FREE DRAINING GRANULAR BACKFILL

A. Meet the following gradation:

Free Draining Granular Backfill Gradation	
Sieve Size	**Percent Passing**
1 ½ inch	100
1 inch	95 to 100
½ inch	25 to 60
No. 4	0 to 10
No. 200	0 to 5

END OF SECTION 31 05 13-M

SECTION 31 23 23-M

BACKFILLING FOR STRUCTURES

This specification changes a portion of 2017 Edition APWA Standard Specification No. 31 23 23. All other provisions of the Section remain in full force and effect.

PART 1 GENERAL

Replace Article 1.7 with the following:

1.7 ACCEPTANCE

A. **Materials:** For material acceptance refer to:
   1. Common Fill, Section 31 05 13
   2. Aggregate Base Course, Section 32 11 23
   3. Cement Treated Fill, Section 31 05 15

B. **Compaction Requirements**: One test per lift on each lot as defined in Table 1.

Table 1 - Lot Sizes for Backfilling Structures	
Structure Type	**Lot Size**
Strip Footings	40 Linear Feet
Structure Footing excluding strip footings	225 Square Feet
Embankments	625 Square Feet
Interior Slab on Grade	625 Square Feet
Side of Foundation Walls and Retaining Walls	New lot every time wall changes direction or exceeds 40 linear feet
Misc. small structures (e.g. manholes, drainage boxes, etc.)	**Each structure.**

PART 2 PRODUCTS

Replace Article 2.1 with the following:

2.1 BACKFILL MATERIALS

A. Foundation Stabilization (as required)
   1. Granular Backfill Borrow per APWA Section 31 05 13.
   2. Free Draining Granular Backfill per WVC Special Provision Section 31 05 13-M. Material must be completely enclosed with an appropriate separation geotextile per APWA Section 31 05 19 and is to be worked with compaction equipment to consolidate rock and minimize voids.

B. Bedding
   1. Bedding Options
      a. Untreated Base Course per APWA Section 32 11 23 unless required otherwise by pipe manufacturer.
      b. Free Draining Granular Backfill per WVC Special Provision Section 31 05 13-M. Material must be completely enclosed with an appropriate separation geotextile per APWA Section 31 05 19 and is to be worked with compaction equipment to consolidate rock and minimize voids.
   2. Material for other pipe types to be per manufacturer's recommendation.

C. Structure Backfill
   1. Backfill Options
      a. Untreated Base Course per APWA Section 32 11 23.
      b. Granular Backfill Borrow per APWA Section 31 05 13.
      c. Free Draining Granular Backfill per WVC Special Provision Section 31 05 13-M. Material must be completely enclosed with an appropriate separation geotextile per APWA Section 31 05 19 and is to be worked with compaction equipment to consolidate rock and minimize voids.

D. Use a flowable fill (Cement Treated Fill) when vibration is not allowed, or when specified. See APWA Section 31 05 15. Other uses of flowable fill are to be approved by the Engineer.

E. Materials excavated on site will not be allowed for use on project without written approval from Engineer. All backfill materials must meet specifications.

F. Slag or recycled asphalt material is NOT ALLOWED in the backfill

.

PART 3 EXECUTION

Replace or add the following articles:

3.7 TOLERANCES

A. Compaction: 95 percent or greater relative to a standard or modified proctor density, APWA Section 31 23 26,

B. Lift thickness (before compaction) shall be a maximum of 8 inches when using riding equipment or 6-inches when using handheld equipment.

C. Cement Treated Fill: Compressive strength targets are 60 psi in 28 days and 90 psi maximum in 28 days.

END OF SECTION 33 05 20-M

SECTION 32 12 05-M

BITUMINOUS CONCRETE

This specification changes a portion of the 2017 Edition APWA Standard Specification No. 32 12 05. All other provisions of the Section remain in full force and effect.

Add or Replace the following:

1.2 REFERENCES

D. **UDOT Standards:**
UDOT Standard Specifications for Road and Bridge Construction (Latest Ed.)
UDOT Materials Manual of Instruction
UDOT Quality Management Plans

1.3 DEFINITIONS

H. Road Class
   a. Class I: See Section 32 01 31 for definition
   b. Class II: **Minor Roads**: WVC Minor Streets and Minor Collectors - See WVC Standards and Section 32 01 31 for additional definition
   c. Class III: **Major Roads**: WVC Arterials and Collector – See WVC Standards and Section 32 01 31 for additional definition

I. Effective Binder Content, by volume (Vbe): Volume of Asphalt Binder incorporated into the mix but not absorbed into the aggregate. Calculated as the volume difference between Voids in the Mineral Aggregate (VMA) and Air Voids (Va):

$$Vbe = VMA - Va$$

1.4 SUBMITTALS

A. Paragraph A, **General**, remains in full force and effect.

B. **Quality Assurance**
   1. HMA Mixing Plant: Use UDOT 514 QMP certified Asphalt Mix Plant.
      a. Submit plant certification and lab accreditation documentation with mix design.
   2. Obtain materials from same source throughout or submit new mix design.
   3. Use AMRL certified laboratories and WAQTC/UDOT TTQP certified technicians.
      a. Submit lab accreditation documentation with mix design
      b. Submit field technician certification documentation at least 5 working days before paving
   4. Contractor to submit daily plant production records and quality control data to the Engineer prior to start of paving subsequent lots. Plant production record must include the following:
      - Plant Location

- Production Date and Times
- Mix Designation
- Total Mix Tonnage
- Virgin Aggregate Tonnage
- Virgin Asphalt Tonnage
- RAP Aggregate Tonnage
- Lime Tonnage (if used)
- Water Tonnage (if lime used)

1.5 QUALITY CONTROL

A. Quality Control is performed by Contractor or their representative. Each bid schedule is treated independently regarding lots. Perform QC sampling and testing in accordance with the adopted West Valley City Minimum Sampling & Testing requirements.

B. Provide split sample to the Engineer for each sample taken.

C. The Engineer may sample any portion of the HMA that exhibits a non-uniform appearance.
   a. The contractor will repair subjectively sampled portions found to be out of specification at no cost to the Owner.
   b. Subjective sample results will not be included in the pay factor calculations.

D. Submit QC data and plant daily production summary to the Engineer prior to the start of paving subsequent lots.

E. Failure to obtain and provide all required testing will automatically result in test results being deemed out of specification for that lot.

1.6 ACCEPTANCE

A. Observation of Contractor's field quality control testing does not constitute acceptance. Such testing, however, may be used by ENGINEER for acceptance at the discretion of the Engineer.

B. A lot equals the number of tons of HMA placed during each production day.

C. Gradation and asphalt binder content
   1. The Engineer informs the Contractor of the time and place of sampling not more than 15 minutes before the sampling.
   2. Contractor obtains the sample from behind the paver and field splits the sample, and Engineer takes immediate possession of the sample.
   3. Lot Acceptance for Gradation/Asphalt Binder according to Table 1 and Table 2. (See standard specification for tables)

D. Failure to Notify or Wait for Test: Lots that are not tested by the owner due to the contractor failing to notify the Engineer or failing to wait for testing personnel to be present automatically result in Owner test results being deemed out of specification.

E. Small Lots: The Engineer may elect to accept material on visual inspection for work such as utility work, traffic signals, detours, lane leveling, driveways, etc., or small projects with plan quantities less than 1,000 tons.
   1. The Engineer reserves the option of conducting any acceptance tests necessary to determine that the material and workmanship meets the project requirements.
   2. At the Engineer's discretion, acceptance for density may be based on establishing and maintaining a roller pattern to obtain maximum density without over-stressing the pavement.

2.3 ADDITIVES

D. RAP or ROSP: Free of detrimental quantities of deleterious materials.
   1. Do not incorporate more than 15% RAP or RAP binder.
   2. No binder grade adjustments are to be used to account for any binder stiffness caused by RAP.
   3. Determine RAP binder content by chemical extraction.

2.4 MIX DESIGN

A. Preparation
   1. Mix Designator
      a. Minor Roads: **DM-1/2, PG58-28, 50 Blow**
      b. Major Roads: **SP-1/2, PG64-28, 75 Nd**
   2. Use Paragraph 1.4C to determine submittal requirements.

3.3 CEASE PRODUCTION

A. Cease production when any two out of three consecutive lots meet one of the following criteria:
   1. Air voids averaged for each lot are less than 2.5 or greater than 4.75 percent.
   2. VMA averaged for each lot are not within Target Value +/- 1.25%.

B. Submit a corrective action plan for approval before production continues indicating the changes in production procedures that will be implemented to correct the deficiencies
   1. Address the specific issues contributing to the cease production.
   2. Obtain approval of the revised plan before production continues.

C. The Engineer may require a new mix design.

D. The Engineer may require Hamburg Wheel-Track testing up to 5 lots after the cease production order.
   1. Sample randomly from behind the paver for up to 5 lots after the cease production order.
   2. Failure to meet the requirements of Table 6 will result in rejection of the lot.

3.3 LABORATORY CORRELATION

A. Perform split-sample, paired t-testing with City designated lab based on project quality control testing.
   1. Perform split-sample, paired t analysis on all mix acceptance tests and tests related to volumetric properties.

2. Perform paired t analysis as defined in the UDOT Materials Manual of Instruction.
3. Continue paired t-testing until at least two consecutive production days meet $\alpha = 0.05$ for a two tailed distribution.
4. Resolve discrepancies in lab results within the first five production days.
    a. Cease production if the requirements for two consecutive days of the first five days cannot be met.
    b. Submit a corrective action plan to the Engineer before production continues indicating the changes in procedures that will be implemented to correct the deficiencies.
    c. Both Contractor and City designated lab must make paired t test results available within 24 hours of sampling.

END OF SECTION 32 12 05-M

SECTION 32 12 13.13-M

TACK COAT

This specification changes a portion of the 2017 Edition APWA Standard Specification No. 32 12 13.13. All other provisions of the Section remain in full force and effect.

Replace the following:

3.2 APPLICATION

B. **Application Rate:**

1. Emulsions - Concentrate shall be diluted at a rate of 2:1 (2 parts concentrate to 1-part water)
    a. Smooth Surfaces: shall be applied at a rate of 0.06 to 0.08 gallons per SY.
    b. Rotomilled Surfaces: 0.08 to 0.1 gallons per SY.
    c. Coverage shall be 95% or better.
2. Cutback, Contractor's choice.

END OF SECTION 32 12 16.13-M

SECTION 32 12 16.13-M

PLANT-MIX BITUMINOUS PAVING

This specification changes a portion of the 2017 Edition APWA Standard Specification No. 32 12 16.13. All other provisions of the Section remain in full force and effect.

Replace the following:

1.8 ACCEPTANCE

A. Paragraph A, **General**, remains in full force and effect.

B. Paragraph B, **Mix Material**, remains in full force and effect.

C. **Mix Temperature at Site**:
1. Reject mixes if transport material exceeds the following temperatures:
   a. Hot Mix, 325°

D. Paragraph B, **Grade, Cross Slope**, remains in full force and effect.

E. **Compaction**: Acceptance is based on core density unless specified otherwise. A lot is acceptable if density tests are within pay factor 1.00 limits. At ENGINEER's discretion, a Lot with deficient sub-lot density tests may be accepted if pay is adjusted using an applicable pay factor in the following table or accepted at 50 percent pay if a sub-lot is in Reject. Use the average of the Maximum Specific Gravity tests for each lot when determining in-place density.

Table 1 - Compaction Pay Factors

	Density, in Percent Relative to ASTM D 2041	
Pay Factor	**Average**	**Lowest Test**
0.70	More than 96	
1.00	**93.5 to 96**	**90 or greater**
0.90	93.5 to 96	Less than 90
0.80	Less than 92	90 or greater
Reject	Less than 92	Less than 90

1. Core Density:
   a. Lot Size: One (1) day production with 1,000 square yard sub lots or part thereof.

b. Contractor obtains cores within two days after the pavement is placed. Obtain two samples at each test location
c. Engineer marks coring location for in-place density cores.
d. Move transversely to a point 1 ft from the edge of the pavement for In-place density if the random location for coring falls within 1 ft of the edge of the overall pavement section (outer part of shoulders).
e. Fill core holes with HMA or high AC content cold mix and compact with mechanical impact means using multiple lifts. Do not fill hole by loose filling of hole and compacting through constant pressure of foot, tool or tire.
f. The Engineer witnesses the coring operation, takes possession of the cores immediately, and begins testing the cores within 24 hours for density acceptance.

2. At the discretion of the Engineer, perform randomly located nuclear density tests, divided into 1,000 square yard sublots (2 tests each) in lieu of coring, using an average of two (2) 30 second counts at 90 degree or 180 degree offsets, for each nuclear density test. ASTM D 2950.

3. Delete paragraph 3.

4. Paragraph 4, **Compaction Dispute Resolution**, remains in full force and effect.

F. Paragraph F, **Thickness**, remains in full force and effect.

G. **Profile Roughness and Profile Deviation**:
1. Profilograph and any necessary corrective action per Section 32 01 31 will be required on all streets with a Major Road Mix Design.

2. Profilograph and any necessary corrective action per Section 32 01 31 may be required on streets with a Minor Mix design at the Engineers discretion.

3. No additional payment is made for smoothness verification procedures.

3.8 TOLERANCES

A. Compaction: Target is 94 percent of ASTM D2041(Rice Density). See pay factors in Table 1.

B. Paragraph B remains in full force and effect.

C. Paragraph C remains in full force and effect.

END OF SECTION 32 12 16.13-M

SECTION 32 16 14-S

CURB CUT ASSEMBLY

This specification replaces APWA Standard Specification Section 32 16 13 in its entirety.

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Americans with Disabilities Act (ADA) pedestrian access ramps.

1.2 REFERENCES

A. UDOT 2017 Standard Specification Section 02771.
B. UDOT PA Series Standard Drawings.
C. UDOT Pedestrian Access Evaluation Form C-170.

1.3 DEFINITIONS

A. **ADA Pedestrian Access Ramp:** Includes pedestrian access elements as contained on the UDOT PA Series Standard Drawings.
B. **Certified Installer** The contractor or subcontractor who has successfully completed UDOT's ADA Pedestrian Ramp Training Course. Refer to https://www.udot.utah.gov/go/standardsreferences.
C. **Crosswalk (or Pedestrian Street Crossing):**
   1. Unmarked: That part of a roadway at an intersection included within the connections of the lateral lines of the sidewalks on opposite sides of the roadway measured from the curbs or in the absence of curbs, from the edges of the traversable roadway. In the absence of a sidewalk on one side of the roadway, that part of a roadway included within the extension of the lateral lines of the sidewalk at right angles to the center line;
   2. Marked: Any portion of a roadway at an intersection or elsewhere distinctly indicated as a pedestrian crossing by pavement marking lines on the surface, which might be supplemented by contrasting pavement texture, style, or color.

1.4 SUBMITTALS

A. Certificate of completion of UDOT ADA Pedestrian Access Ramp Evaluation Training Course for information.
B. Manufacturer's product data sheet and recommended installation instructions for detectable warning surface.
C. Provide copy of current certificate for the Certified Installer.
D. Traffic Control Plan, Section 01 55 26.
E. Concrete mix design, Section 03 30 04.
F. Batch ticket, Section 03 30 10.
G. UDOT Pedestrian Access Evaluation Form C-170

1.5 OWNER'S INSTRUCTIONS

A. **Alterations:** If the direction of water flow in an existing curb and gutter system is not apparent, proceed as follows:
   1. Flood curb and gutter system to determine extent of replacement.
   2. Flood curb and gutter system after installation to verify drainage.

B. **Steep Slopes:** Prior to placing concrete, allow ENGINEER time to check slopes and dimensions of construction forms.

1.6 ACCEPTANCE

A. Passing all necessary criteria found on UDOT's Pedestrian Access Evaluation Form C-170.

PART 2 PRODUCTS

2.1 CONCRETE

A. Class 4000, Section 03 30 04.

2.2 UNTREATED BASE COURSE

A. Refer to Section 32 11 23.

2.3 DETECTABLE WARNING SURFACE

A. Use In-line truncated dome pattern that meets the requirements of UDOT PA Series Standard Drawings.
B. Minimize number of panels used.
C. Acceptable products for installation:
   1. Detectable warning surface shall be **fluorescent yellow** Vitrified Polymer Composite (VPC) Cast-in-Place Tiles embedded in concrete.
   2. Tiles shall be 24"x 48" or 24"x 60"
      a. If tile must be cut, minimum tile cut length is 3/4 tile. Do not cut tiles longitudinally. Remove domes that were cut. Seal cuts to prevent water intrusion.

PART 3 EXECUTION

3.1 GENERAL

A. A certified ADA Pedestrian Access installer must always be on site when ramps are being formed and installed.
B. Construct as shown in UDOT PA Series Standard Drawings and project plans.

3.2 PREPARATION

A. Implement notification and traffic control plan requirements, Section 01 55 26. Provide safe passage for pedestrians and vehicles.
B. Construct subgrade to required elevation
C. Place and compact Untreated Base Course per Section 32 11 23
D. Forms:
   1. Use wood, metal, reinforced fiberglass, or plastic forms free of warps or bends and of sufficient strength to prevent deflection during the placement of concrete

2. Transition smoothly from curves to straight section. keep forms in curves free of flat sections and sharp bends.
3. Anchor securely in place.
4. Clean the inside surface of all dirt, concrete, and foreign material before concrete placement.

3.3 INSTALLATION

A. Verify forms meet requirements per UDOT C-170 Evaluation form prior to concrete placement
B. Place and finish concrete, Section 03 30 10
C. Install Detectable Warning Surface
   1. Tiles shall be installed per manufacturer's recommendations.
   2. Use an 8-foot minimum curb cut for Bi-directional crosswalks. A 4-foot minimum curb cut width and detectable warning surface is allowed for two unmarked crossings on streets with less than 66 feet of right-of-way. Approval from the City Engineer is required to use a 4-foot curb cut width on streets with 66 feet of right-of-way or larger and for locations with marked crosswalks.
   3. The tiles shall be installed so that the maximum difference between the tile surface and the adjacent concrete surface is 1/16". Tiles shall be placed in accordance with the slopes shown in the pedestrian access ramp standard drawing.
   4. Tiles shall be placed in a manner to eliminate air voids between the tile surface and the concrete surface.
   5. Tiles shall be placed with plastic coating intact to protect the tile color. After ramp has been poured, clean any remaining concrete residue from tiles.
D. Place contraction joints according to Section 32 16 13.
E. Cure concrete according to Section 03 39 00.

3.4 FIELD QUALITY CONTROL

A. Evaluate ramp using the UDOT Pedestrian Access Evaluation Form C-170 to verify that the curb cut assembly complies with layout requirements.
B. Contractor to replace any deficiency found using the evaluation form at no cost to owner.

3.5 CLEANING AND REPAIR

A. Remove all debris and concrete dust.
B. Clean surrounding handrails, sidewalks, driveways approaches, landscaping, and other objects in vicinity of work.
C. Repair surfaces damaged by saw cutting, grinding, or removal operations at no additional cost to OWNER.

END OF SECTION 32 16 14-S

SECTION 32 16 24-S

STAMPED CONCRETE PAVING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Furnish materials and construct stamped portland cement concrete paving in park strips and median islands.

1.2 SUBMITTALS

A. Provide Section 03 30 04 submittals.

B. Submit color chart with specified color sample, and patterns.

C. Manufacturer's recommendations for placement.

1.3 ACCEPTANCE

A. Acceptance is by sub-lot. One sub-lot is 50 cubic yards. One lot is one day's production.

B. All sampling and testing to be performed per WVC Minimum Sampling and Testing Requirements.

C. Refer to Section 03 30 10 for compressive strength pay factors.

PART 2 PRODUCTS

2.1 MATERIALS

A. Portland Cement Concrete: Class 4000 minimum per Section 03 30 04.

B. Coarse Aggregate: Grade 57 (1") per Section 03 30 04.

C. Color: Two-part shake color compound; base color with color release. Scofield UV resistant.

1. Base Color shall be Yosemite Brown (Per Davis Colors or equal approved by West Valley City Engineering Division).

2. Color release shall be Dark Gray (Per Brickform Standard Color Selector Brochure (or equal approved by West Valley City Engineering Division).

D. Forms: Wood, metal, reinforced fiberglass, or plastic per Section 03 11 00. Use approved concrete forms on all curves that transition smoothly from curves to straight section. Keep forms free of flat sections and sharp bends.

E. Expansion Joint Filler: Per Section 32 13 73.

F. Pattern:
1. Pattern shall be "Ashlar Slate" or equal approved by ENGINEER.

G. Sealant Compound: Liquid membrane per Section 03 39 00. Sealant compound used on stamped concrete paving shall be clear liquid, or clear when dry.

PART 3 EXECUTION

3.1 PREPARATION

A. General:
1. Examine surfaces scheduled to receive concrete form work for defects.
2. Do not start work until defects are corrected.
3. Curb, gutter and sidewalk work shall be placed and cured a minimum of seven days prior to placing stamped concrete.

B. Form Construction: Place forms per Section 03 11 00. Obtain ENGINEER's review of forms before placing concrete.

3.2 CONCRETE PLACEMENT

A. Place concrete per section 03 30 10.

B. Do not place concrete until sub-base course and forms have been checked for line and grade. Moisten sub-base if required to provide uniform dampened condition at time of placement.

C. Place concrete using methods which prevent segregation of mix. Consolidate concrete with external screen vibrator or other acceptable methods. Do not use mechanical vibrators.

D. Provide 5-foot test strip.

E. Add concrete base color to mix at the batch plant. Allow concrete to set prior to application of color release compound. Apply stamped pattern. Wash off unstamped color release compound after concrete has set. Follow manufacturer's instruction.

C. Stamp pattern into fresh concrete in accordance with manufacturer's recommendations.

3.3 CONTRACTION AND EXPANSION JOINTS

A. Additional contraction and expansion joint requirements per Section 32 13 73.

3.4 FINISHES

A. Tool edges as required to remove sharp or jagged edges.

B. Remove form marks or irregularities from finish surfaces.

3.5 CURING

A. Seal concrete surface using only clear sealer.

3.6 FIELD QUALITY CONTROL

A. Line and grade per Section 32 16 13.

3.7 PROTECTION AND REPAIRS

A. Protect concrete work from deicing operations during the 28-day cure period.

END OF SECTION 32 16 24-S

SECTION 33 05 20-M

BACKFILLING TRENCHES

This specification changes a portion of 2017 Edition APWA Standard Specification No. 33 05 20. All other provisions of the Section remain in full force and effect.

PART 1 GENERAL

Replace Article 1.9 with the following:

1.9 ACCEPTANCE

A. **Materials:** For material acceptance refer to:
   1. Common Fill, Section 31 05 13
   2. Aggregate Base Course, Section 32 11 23
   3. Cement Treated Fill, Section 31 05 15

B. **Compaction Requirements**: One test per lift on every lot for all bedding, pipe zone backfill, and trench backfill material using nuclear density tests, ASTM D2922.
   1. Lot Size: Not more than one pipe, pipe culvert, or box culvert and not more than 40 linear feet along a pipe, pipe culvert, or box culvert.

PART 2 PRODUCTS

Replace Article 2.1 with the following:

2.1 BACKFILL MATERIALS

A. Foundation Stabilization (as required)
   1. Granular Backfill Borrow per APWA Section 31 05 13.
   2. Free Draining Granular Backfill per WVC Special Provision Section 31 05 13-M. Material must be completely enclosed with an appropriate separation geotextile per APWA Section 31 05 19 and is to be worked with compaction equipment to consolidate rock and minimize voids.

B. Pipe Bedding
   1. Rigid Pipe Options
      a. Untreated Base Course per APWA Section 32 11 23 unless required otherwise by pipe manufacturer.
      b. Free Draining Granular Backfill per WVC Special Provision Section 31 05 13-M. Material must be completely enclosed with an appropriate

separation geotextile per APWA Section 31 05 19 and is to be worked with compaction equipment to consolidate rock and minimize voids.

2. Material for other pipe types to be per manufacturer's recommendation.

C. Pipe Zone Backfill
   1. Rigid Pipe Options
      a. Untreated Base Course per APWA Section 32 11 23.
      b. Granular Backfill Borrow per APWA Section 31 05 13.
      c. Free Draining Granular Backfill per WVC Special Provision Section 31 05 13-M. Material must be completely enclosed with an appropriate separation geotextile per APWA Section 31 05 19 and is to be worked with compaction equipment to consolidate rock and minimize voids.
   2. Material for other pipe types to be per manufacturer's recommendation.

D. Trench Backfill
   1. Rigid Pipe Options
      a. Untreated Base Course per APWA Section 32 11 23.
      b. Granular Backfill Borrow per APWA Section 31 05 13.
      c. Granular Borrow per APWA Section 31 05 13 with a maximum particle size of 3-inches.
      d. Free Draining Granular Backfill per WVC Special Provision Section 31 05 13-M. Material must be completely enclosed with an appropriate separation geotextile per APWA Section 31 05 19 and is to be worked with compaction equipment to consolidate rock and minimize voids.
   2. Material for other pipe types to be per manufacturer's recommendation.

E. Use a flowable fill (Cement Treated Fill) when vibration is not allowed, or when specified. See APWA Section 31 05 15. Other uses of flowable fill are to be approved by the Engineer.

F. Materials excavated on site will not be allowed for use on project without written approval from Engineer. All backfill materials must meet specifications.

G. Pea gravel, slag or recycled asphalt material is NOT ALLOWED in the trench.

PART 3 EXECUTION

Replace or add the following articles:

3.5 PIPE ZONE

A. Pipe zone backfill to be installed per APWA Plan 382 unless specified otherwise in this section. The pipe zone backfill extends from the bedding material to a height of at least 1foot above the crown of the pipe and extends over the entire width of the trench.

B. Placement of the pipe zone materials should be at approximately the same rate on each side of the pipe. The difference in elevation of backfill soils on each side of the pipe should not exceed 6 inches.

C. Slice and tamp to ensure proper placement of pipe zone material under and around the pipe haunch.

D. Don't not permit free fall of backfill material that may damage pipe, pipe finish or pipe alignment.

E. Except where piping must remain exposed for tests, fill pipe zone as soon as possible.

F. Pipe zone materials shall be placed and compacted in lifts with a maximum loose (uncompacted) thickness of 8 inches of thickness when using riding equipment or 6-inches when using hand held equipment.

G. Compact pipe backfill materials to a minimum of 95 percent or greater relative to a modified proctor density, APWA Section 31 23 26, unless pipe manufacturer requires more stringent installation.

3.6 TRENCH ABOVE PIPE ZONE

A. Follow APWA Plan 381 unless specified otherwise in this section.

B. Pipe zone materials shall be placed and compacted in lifts with a maximum loose (uncompacted) thickness of 8 inches of thickness when using riding equipment or 6-inches when using hand held equipment.

C. Fill unauthorized excavations with material acceptable to Engineer at no additional cost to Owner.

D. Do not damage adjacent structures or service lines.

E. Install continuous identification tape directly over buried lines 18 inches below finished grade.

F. Compact pipe backfill materials to a minimum of 95 percent or greater relative to a standard or modified proctor density, APWA Section 31 23 26, unless pipe manufacturer requires more stringent installation.

3.12 PIPE BEDDING

A. Pipe bedding to be installed per APWA Plan 382 unless specified otherwise in this section.

B. Pipe bedding materials shall be compacted in loose (uncompacted) lifts of not more than 8 inches of thickness when using riding equipment or 6-inches when using hand held equipment.

B. Compact pipe bedding materials to a minimum of 95 percent or greater relative to a modified proctor density, APWA Section 31 23 26.

C. Minimum thickness of the bedding layer as shown in APWA Plan 382.

D. The surface of the bedding layer should be graded so that the final grade of the layer meets the specified pipeline grade requirements.

E. The bedding layer should be shaped to support the full length of the pipe section and deleterious materials, e.g., boulders, angular rocks and gravel should be removed to prevent damage to the pipe. Maintain uniform foundation along barrel of pipe with sufficient relief for joint connections.

END OF SECTION 33 05 20-M

SECTION 33 41 00-M

STORM DRAINAGE SYSTEMS

This specification changes a portion of 2017 Edition APWA Standard Specification Section 33 41 00. All other provisions of the section remain in full force and effect.

PART 1 GENERAL

Replace the following:

1.2 REFERENCES

A. APWA (Utah Standards)
- Plan 315 Catch basin (single or double grate)
- Plan 323 Pipe outfall
- Plan 341 Precast manhole (where specified)
- Plan 381 Trench backfill
- Plan 382 Pipe zone backfill

B. WVC Standard Drawings
- WVC 255 Asphalt Concrete T-Patch
- WVC 316 Combination Catch Basin and Cleanout Box
- WVC 331 Cleanout Box

PART 3 EXECUTION

Replace the following:

3.6 INSTALLATION – INLETS, CATCH BASINS, CLEANOUTS

A. Install facilities per APWA 315, WVC 316 and WVC 331 (WVC Cleanout Box)

END OF SECTION 33 41 00-M

WEST VALLEY CITY
ENGINEERING DIVISION

CONTRACTOR'S SUBMITTAL TRANSMITTAL FORM

For contractor submittals (including shop drawings, calculations, data or other product information)

Project Name:		**Project #:**	
Contractor:		**Date:**	
Submitted By:		**Submittal #:** (Sequential order starting at 1)	

Description of Item Submitted:	
Bid Item Number(s): (All that apply)	
Contract Document Reference: (Specification No. or Drawing No.)	
Material Certification (check one)	
☐	We certify that the material or equipment contained in this submittal meets all requirements specified or shown (no exceptions).
☐	We certify that the material or equipment contained in this submittal meets all the requirements specified or shown, except for the following deviations:
Request for Deviation from Specification:	

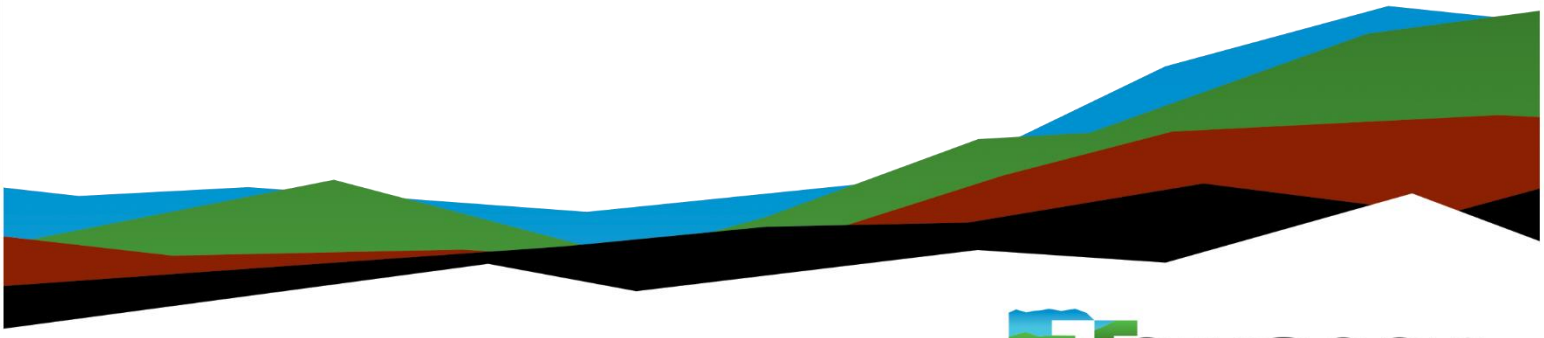
GHID — Anderson WTP

Geotechnical Engineering Report — Revision 1

April 15, 2024 | Terracon Project No. 61235197

Prepared for:

J-U-B Engineers, Inc.
392 East Winchester Street, Ste. 300
Salt Lake City, Utah 84107



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April 15, 2024

J-U-B Engineers, Inc.
392 East Winchester Street, Ste. 300
Salt Lake City, Utah 84107

Attn: Christina Osborn, P.E.
P: (801) 886-9052
E: cosborn@jub.com

Re: Geotechnical Engineering Report — Revision 1
GHID — Anderson WTP
1629 West 2320 South
West Valley City, Utah
Terracon Project No. 61235197

Dear Ms. Osborn:

We have completed the scope of Geotechnical Engineering services for the above-referenced project in general accordance with Terracon Proposal No. P61235197 dated September 12, 2023. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations and floor slabs for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,

Terracon

Virginia G. Puljan

Assistant Project Manager

PROFESSIONAL ENGINEER
No. 9665888-2202
CHARLES V. MOLTHEN
STATE OF UTAH
4/15/2024

Charles V. Molthen, P.E.

Department Manager II

Table of Contents

Figures

Attachments

Exploration and Testing Procedures
Site Location and Exploration Plans
Exploration and Laboratory Results
Supporting Information

Note: This report was originally delivered in a web-based format. **Blue Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks that direct the reader to that section and clicking on the Terracon logo will bring you back to this page. For more interactive features, please view your project online at **client.terracon.com**.

Refer to each individual Attachment for a listing of contents.

Introduction

This report presents the results of our subsurface exploration and Geotechnical Engineering services performed for the proposed Water Treatment Plant (WTP) to be located at 1629 West 2320 South in West Valley City, Utah. The purpose of these services was to provide information and geotechnical engineering recommendations relative to:

- subsurface soil conditions
- groundwater conditions
- Seismic Site Class per IBC and liquefaction potential
- site preparation and earthwork
- dewatering considerations
- foundation design and construction
- floor slab design and construction
- below grade structures
- lateral earth pressure
- subsurface drainage for below-grade walls

The geotechnical engineering Scope of Services for this project included the advancement of test borings, cone penetration test (CPT), percolation testing, laboratory testing, engineering analysis, and preparation of this report.

Drawings showing the site and boring locations are shown in the **Site Location** and **Exploration Plan**, respectively. The results of the laboratory testing performed on soil samples obtained from the site during our field exploration are included in the boring and CPT logs in the **Exploration Results** section.

Project Description

Our initial understanding of the project was provided in our proposal and was discussed during project planning. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

Item	Description
Information provided	Email received on September 1, 2023, with site location, preliminary layout, and a general description for proposed WTP. An additional email with updated site plan was provided on January 16, 2024, from J-U-B Engineers (J-U-B).

Item	Description
Project description	The project includes construction of a WTP building, two 40,000-gallon RFP tanks, detention tank and associated pipelines.
Proposed structure	Structures associated with the project include a 60 foot by 60 foot single-story building with tow (2) 10 feet (diameter) x 40 feet (horizontal) pressure filters.The building will be slab-on-grade. And two (2) 10 feet (diameter) x approximately 70 feet long cylindrical FRP underground water storage tanks, offset 10 feet from the north side of the building.
Finished floor elevation	Not provided; boring depths have assumed that finished floor is not more than 2 feet of existing grade.
Maximum loads	Anticipated structural loads were not provided. In the absence of information provided by the design team, we will use the following loads in estimated settlement based on our experience with similar projects. WTP Building: ▪ Columns: 50 kips ▪ Walls: 5.5 kips per linear foot (klf) ▪ Slabs: 250 pounds per square foot (psf) ▪ Filter Tank Footings: 1200 psf
Grading/slopes	Less than 2 feet of cut and fill will be required to develop final grade.
Below-grade structures	Detention tanks are expected to require between 12 to 15 feet of excavation. Expected weights of the tanks are 12,100 lbs (empty) and up to 354,000 lbs (full) over approximately 700 square feet.
Free-standing retaining walls	None
Pavements	None
Building code	2021 IBC

Terracon should be notified if any of the above information is inconsistent with the planned construction, especially the grading limits, as modifications to our recommendations may be necessary.

Site Conditions

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel information	The project is located at 1629 West 2320 South in West Valley City. Size of the property is approximately 0.9 acres. Coordinates of the center of the property are Latitude: 40.72036°N, Longitude: 111.93735°W (approximate) See **Site Location**
Existing improvements	Portions of the site are occupied by an existing well house.
Current ground cover	Mainly landscape within new WTP building and tanks
Existing topography	Relatively level

Geotechnical Characterization

We have developed a general characterization of the subsurface conditions based on our review of the subsurface exploration, laboratory data, geologic setting, and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of the site. Conditions observed at each exploration point are indicated in the individual logs. The individual logs can be found in the **Exploration Results** and the GeoModel can be found in the **Figures** attachment of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model layer	Layer name	General description
1	**Topsoil**	Topsoil i.e., vegetation encountered in all borings, approximately 6 inches thick
2	**Fine-grained soils**	Very stiff to soft lean clay and silt with varying amounts of sand

Model layer	Layer name	General description
3	Coarse-grained soils	Loose to medium dense sand with varying amounts of silt

Groundwater Conditions

The borings were observed during the field exploration for the presence and level of groundwater. Groundwater was encountered in a series of borings at various depths during field exploration. These levels are presented in the table below and noted in the boring and CPT logs in **Exploration Results**. These observations and interpretations represent groundwater conditions at the time of the field exploration and may not be indicative of other times or other locations.

Boring number	Depth to groundwater (feet)
B-01	8
CPT-01	7.91
P-01	Not encountered
P-02	8.5
P-03	9

It should be recognized that fluctuations of the groundwater table will occur due to seasonal variations in the amount of rainfall, runoff, and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the future may be higher or lower than the levels indicated on the boring logs and should be considered when developing design and construction plans for the project.

The groundwater table could affect overexcavation efforts, especially for overexcavation and replacement of lower strength soils. A temporary dewatering system consisting of sumps with pumps may be necessary to achieve the recommended depth of overexcavation depending on groundwater conditions at the time of construction

Percolation Test

Field infiltration testing was performed at the site location labeled P-01, P-02, and P-03 in **Exploration Plan**. Boring logs can be found in **Exploration and Laboratory Results.** Samples were obtained in the upper 10 feet in P-02 and P-03 and the upper 5 feet in P-01 before performing the percolation test. Due to the indicated water table above 10 feet, we reinstalled P-02 and P-03 to 5 feet to correctly perform the percolation test.

Following drilling, a thin layer of sand or gravel of approximately 6 inches was placed at the bottom of the boring up to or extending above the ground surface. Approximately 12 inches of sand was then placed in the annulus between the outside of the pipe and the edge of the boring wall. Following placement of the sand, approximately 12 inches of bentonite chips was placed in the annulus on top of the sand and hydrated with approximately 5 gallons of water. Water was then added inside the pipe to presoak the soils exposed at the bottom of the pipe and to saturate the sand used to backfill the bottom 12 inches of the pipe and boring wall annulus. After saturation, the test pipe was refilled with water, and the time required for the water level to drop incrementally was measured until a stabilized rate was achieved. Rates were considered to be stable when the rate of percolation appeared to be relatively constant.

Test location	Infiltration rate (inches/hour)
P-01	14
P-02	35
P-03	14

Seismic Site Class

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Class is required to determine the Seismic Design Category for a structure. The Site Class is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7 and the International Building Code (IBC). Based on the soil properties observed at the site and as described in the exploration logs and results, our professional opinion is that a **Seismic Site Class of F** be considered for the project. Subsurface explorations at this site were extended to a maximum depth of 51.5 feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth.

Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth. The values presented below must be verified by the structural engineer.

Description	Value
Risk Category	III
2021 International Building Code Site Classification (IBC) [1]	D,F [2]

Description	Value
Site Latitude	40.7204
Site Longitude	-111.9374
S_S MCE_R [3]	1.77g
S_1 MCE_R [3]	0.59g
S_{DS} [3]	1.12
S_{D1} [3]	0.84
S_{MS} [3]	1.68
S_{M1} [3,4]	1.01
PGA_M [3]	0.7g
F_v [2,4]	1.71
F_a [2]	1.0

1. Seismic site classification in general accordance with the 2021 International Building Code, which refers to ASCE 7-10.
2. F_v and F_a were obtained using ASCE 7-16, Supplement 1 dated December 12, 2018 assuming the structures will meet the exception.
3. These values were obtained using online seismic design maps and tools provided by the ASCE Hazards Report.
4. These values were provided by J-U-B engineers on April 4, 2024.

Liquefaction Potential

The proposed Water Treatment Plant facility location is in an area mapped as having high liquefaction potential.[1] Soils vulnerable to potential liquefaction were encountered in CPT-01 and in boring B-01. Accordingly, a liquefaction analysis was performed using ground motions (design event with 2% probability of exceedance in 50 years) for Site Class D, SPT, and CPT data. The liquefaction analysis results based on the CPT and boring data are summarized below.

[1] Christenson, G. E., & Shaw, L. M. (2008). *Liquefaction special study areas, Wasatch Front and nearby areas, Utah.* Supplement Map to Utah Geologic Survey Circular 106.

Exploration location	Liquefiable soil layer depths, feet	Total liquefaction induced vertical settlement, inches	Lateral spread, inches
CPT-01	Various[1]	1.4[2]	18
B-01	Various[1]	1.54	15.7

1. Based on CPT Soil Behavior Type (SBT).
2. Lower limit based on Robertson (2009) and upper limit based on Boulanger and Idriss (2014).

The liquefaction analysis was performed based on evaluation of soil boring data collected at periodic sampling intervals in the soil borings, as well as the CPT sounding. Based on the depth of the liquefiable layers, vertical movement is not anticipated to be realized at the ground surface.

Liquefaction potential was evaluated at boring B-01 using methods by Youd and Idriss, 2001.[2] Cone Penetrometer Test (CPT) data was evaluated for liquefaction potential using the computer programs CPeT-IT v.1.5.5.42 (data presentation and interpretation software) and Cliq v.1.2.0.30 (CPT liquefaction assessment software). The CpeT-IT software program was used to analyze raw CPT data and to generate soil profile properties and subsurface soil profile logs. Cliq calculates soil resistance against liquefaction in general accordance with Robertson and Wride (1998) and procedures outlined in NCEER-97-0022.

Corrosivity

The table below lists the results of laboratory soluble sulfate, soluble chloride, electrical resistivity, and pH testing. The values may be used to estimate potential corrosive characteristics of the on-site soils with respect to contact with the various underground materials which will be used for project construction.

[2] Youd, T. L., & Idriss, I. M. (2001). *Liquefaction resistance of soils: summary report from the 1996 NCEER and 1998 NCEER/NSF workshops on evaluation of liquefaction resistance of soils.* Journal of Geotechnical and GeoEnvironmental Engineering, Vol. 127, No. 4.

Corrosivity Test Results Summary

Boring	Sample depth (feet)	Soil description	Soluble sulfate (mg/kg)	Soluble chloride (mg/kg)	Electrical resistivity (Ω-cm)	pH
B-01	2.5	Silty sand	1	94	1,342	8.9

Results of soluble sulfate testing can be classified in accordance with ACI 318 — Building Code Requirements for Structural Concrete. Numerous sources are available to characterize corrosion potential to buried metals using the parameters above. ANSI/AWWA is commonly used for ductile iron, while threshold values for evaluating the effect on steel can be specific to the buried feature (piling, culverts, welded wire reinforcement, etc.) or agency for which the work is performed. Imported fill materials may have significantly different properties than the site materials noted above and should be evaluated if expected to be in contact with metals used for construction. Consultation with a NACE certified corrosion professional is recommended for buried metals on the site.

Mapping by the NRCS includes qualitative severity of corrosion to concrete and steel. Based on this source, the near-surface materials are rated "Low" for corrosion to concrete and "Negligible" for corrosion of steel.

Geotechnical Overview

The site appears suitable for the proposed construction based on geotechnical conditions encountered in the test borings, provided that the recommendations provided in this report are implemented in the design and construction phases of this project.

Soils encountered in CPT-01 and B-01, located in the water tank and building area, are loose sand and soft sandy lean clay that have a high liquefaction potential. As discussed in **Liquefaction Potential**, liquefaction-induced settlement of 1.4 to 1.5 inches is anticipated with 16 to 18 inches of lateral spread is anticipated.

Soil conditions at the site are best represented by a Seismic Site Class F, based on ASCE 7-16, Chapter 20. Some of the soil layers are liquefiable and have the potential to cause settlement during a high seismic event in the range of 1.5 inches.

The subsurface materials generally consisted of sand with varying amounts of silt overlain with lean clay with varying amounts of sand extending to the maximum depth of the borings. Groundwater was encountered in B-01, P-02, P-03, and CPT-01 at an average depth around 8 feet below grade.

Based on the conditions encountered and estimated load-settlement relationships, the proposed structures can be supported on conventional shallow foundations.

Due to the low bearing capacity of near-surface soils and anticipated seismic settlements, the foundations should be supported on a minimum of 24 inches of Structural Fill. Grading for the proposed foundations should incorporate the limits of the foundations plus a lateral distance beyond the outside edge of footings, where space is available. On-site soils are not considered suitable to be used as engineered fill materials.

The near-surface, soft to medium stiff plasticity lean clay could become unstable with typical earthwork and construction traffic, especially after precipitation events. Effective drainage should be completed early in the construction sequence and maintained after construction to avoid potential issues. If possible, the grading should be performed during the warmer and drier times of the year. If grading is performed during the winter months, an increased risk for possible undercutting and replacement of unstable subgrade will persist. Additional site preparation recommendations, including subgrade improvement and fill placement, are provided in the **Earthwork** section.

The soils that form the bearing stratum for shallow foundations are plastic and exhibit potential for shrink-swell movements with changes in moisture. Maintaining a minimum dead load pressure on footings should reduce the anticipated swell movements to tolerable levels. The **Shallow Foundations** section addresses support of the building directly bearing on Structural Fill. We do not expect significant dead load on the floors and recommend either overexcavation of near-surface high plasticity clays to reduce the heave potential or use of suspended slabs to accommodate potential ground heave. The **Floor Slabs** section addresses slab-on-grade support of the building using overexcavation techniques.

The recommendations contained in this report are based on the results of field and laboratory testing (presented in the **Exploration Results**), engineering analyses, and our current understanding of the proposed project. The **General Comments** section provides an understanding of the report's limitations.

Earthwork

Earthwork is anticipated to include clearing and grubbing, excavations, and engineered fill placement. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for foundations and floor slabs.

Site Preparation

Prior to placing fill, any existing vegetation, topsoil, and root mats should be removed. Complete stripping of the topsoil should be performed in the proposed building.

Mature trees are located within or near the footprint of some of the proposed buildings and tank structures, which will require removal at the onset of construction. Tree root systems can remove substantial moisture from surrounding soils. Where trees are removed, the full root ball and all associated dry and desiccated soils should be removed. The soil materials that contain less than 5 percent organics can be reused as engineered fill provided the material is moisture conditioned and properly compacted.

Where fill is placed on existing slopes steeper than 5H:1V, benches should be cut into the existing slopes prior to fill placement. The benches should have a minimum vertical face height of 1 foot and a maximum vertical face height of 3 feet and should be cut wide enough to accommodate the compaction equipment. This benching will help provide a positive bond between the fill and natural soils and reduce the possibility of failure along the fill/natural soil interface.

Although no evidence of fill or underground facilities (such as septic tanks, cesspools, basements, and utilities) was observed during the exploration and site reconnaissance, such features could be encountered during construction. If unexpected fills or underground facilities are encountered, such features should be removed and the excavation thoroughly cleaned prior to backfill placement and/or construction.

Subgrade Preparation

We recommend that the soils within the footprint of the proposed structures be removed to a minimum depth of 2 feet below the bottom of footings. Structural Fill placed beneath the entire footprint of the foundations should extend horizontally a minimum distance of 5 feet beyond the outside edge of footings. Portions of the near-surface materials anticipated to be developed as excavation spoils are not considered suitable for use as Structural Fill.

The subgrade should be proofrolled with an adequately loaded vehicle such as a fully loaded tandem-axle dump truck. The proofrolling should be performed under the observation of the Geotechnical Engineer or representative. Areas excessively deflecting under the proofroll should be delineated and subsequently addressed by the Geotechnical Engineer. Excessively wet or dry material should either be removed or moisture conditioned and recompacted.

All exposed areas that will receive fill, once properly cleared and benched where necessary, should be scarified to a minimum depth of 10 inches, moisture conditioned as necessary, and compacted per the compaction requirements in this report. Compacted

Structural Fill soils should then be placed to the proposed design grade and the moisture content and compaction of subgrade soils should be maintained until foundation construction.

Based on the subsurface conditions determined from the geotechnical exploration, subgrade soils exposed during construction are anticipated to be relatively workable; however, the workability of the subgrade may be affected by precipitation, repetitive construction traffic, or other factors. If unworkable conditions develop, workability may be improved by scarifying and drying.

Excavation

It is anticipated that shallow trenches and excavations for the project can be made with conventional earth moving equipment. Near surface site soils include mainly fine-grained soils (Occupational Safety and Health Association (OSHA) C). Cut slopes should not be constructed steeper than 1½ horizontal to 1 vertical. Some excavations less than 4 feet deep in cohesive soil may stand at, or near vertical. However, at any of these slopes, some raveling or caving may occur and should be expected, especially if the slope dries or becomes wet. Flatter slopes or the use of shoring may be required if excessive raveling occurs or if seepage is encountered. The bottom of excavations should be thoroughly cleaned of loose soils and disturbed materials prior to backfill placement and/or construction.

Soil Stabilization

Methods of subgrade improvement, as described below, could include scarification, moisture conditioning and recompaction, removal of unstable materials and replacement with granular fill (with or without geosynthetics), and chemical stabilization. The appropriate method of improvement, if required, would be dependent on factors such as schedule, weather, the size of area to be stabilized, and the nature of the instability. More detailed recommendations can be provided during construction as the need for subgrade stabilization occurs. Performing site grading operations during warm seasons and dry periods would help reduce the amount of subgrade stabilization required.

If the exposed subgrade is unstable during proofrolling operations, it could be stabilized using one of the methods outlined below.

- **Scarification and Recompaction** — It may be feasible to scarify, dry, and recompact the exposed soils. The success of this procedure would depend primarily upon favorable weather and sufficient time to dry the soils. Stable subgrades likely would not be achievable if the thickness of the unstable soil is greater than about 1 foot, if the unstable soil is at or near groundwater levels, or

if construction is performed during a period of wet or cool weather when drying is difficult.

- **Crushed Stone** — The use of crushed stone or crushed gravel is a common procedure to improve subgrade stability. Typical undercut depths would be expected to range from about 18 to 24 inches below finished subgrade elevation. The use of high modulus geotextiles (i.e., engineering fabric or geogrid) could also be considered after underground work, such as utility construction, is completed. Prior to placing the fabric or geogrid, we recommend that all below-grade construction, such as utility line installation, be completed to avoid damaging the fabric or geogrid. Equipment should not be operated above the fabric or geogrid until one full lift of crushed stone fill is placed above it. The maximum particle size of granular material placed over geotextile fabric or geogrid should not exceed 1½ inches.
- **Chemical Modification** — Improvement of subgrades with Portland cement or class C fly ash could be considered for improving unstable soils. Chemical modification should be performed by a prequalified contractor experienced with successfully stabilizing subgrades in the project area on similar sized projects with similar soil conditions. Results of chemical analysis of the additive materials should be provided to the geotechnical engineer prior to use. The hazards of chemicals blowing across the site or onto adjacent property should also be considered. Additional testing would be needed to develop specific recommendations to improve subgrade stability by blending chemicals with the site soils. Additional testing could include, but not be limited to, determining the most suitable stabilizing agent, the optimum amounts required, the presence of sulfates in the soil, and freeze-thaw durability of the subgrade.

Further evaluation of the need and recommendations for subgrade stabilization can be provided during construction as the geotechnical conditions are exposed.

Fill Material Types

Fill required to achieve design grade should be classified as Structural Fill and General Fill. Structural Fill is material used below or within 10 feet of structures and constructed slopes. General Fill is material used to achieve grade outside of these areas.

Reuse of On-Site Soil: Excavated on-site soil is not suitable for reuse as Structural Fill and should not be placed beneath settlement sensitive structures and within foundation bearing zones. Portions of the on-site soil have an elevated fines content and will be sensitive to moisture conditions (particularly during seasonally wet periods) and may not be suitable for reuse when above optimum moisture content.

Material property requirements for on-site soil for use as General Fill and Structural Fill are noted in the table below:

Fill Type[1]	Application	Material specifications		
		Gradation		Plasticity
		Size	Percent finer by weight	
Structural Fill	Below foundations, concrete slabs, or other structural areas	3 inches No. 4 Sieve No. 200 Sieve	100 30–80 <20	Liquid Limit 20 max Plasticity Index 5 max
General Fill	Fill in nonstructural areas	4 inches No. 200 sieve	100 <50	Liquid Limit 35 max Plasticity Index 15 max
Stabilization Fill	Fill used to stabilize soft, potentially pumping subgrade	6 inches No. 200 Sieve	100 5 max	--

1. All fills should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to the geotechnical engineer for evaluation.

Fill Placement and Compaction Requirements

Structural and General Fill should meet the following compaction requirements.

Item	Structural Fill	General Fill
Maximum lift thickness	8 inches or less in loose thickness when heavy, self-propelled compaction equipment is used 4 to 6 inches in loose thickness when hand-guided equipment (i.e., jumping jack or plate compactor) is used	Same as Structural Fill
Minimum compaction requirements[1,2,3]	98% of max below foundations 95% of max above foundations and below floor slabs	92% of max

Item	Structural Fill	General Fill
Water content range[1]	Low plasticity cohesive: -2% to +3% of optimum High plasticity cohesive: 0 to +4% of optimum Granular: -3% to +3% of optimum	As required to achieve minimum compaction requirements

1. Maximum density and optimum water content as determined by the standard Proctor test (ASTM D 698).
2. High plasticity cohesive fill should not be compacted to more than 100% of standard Proctor maximum dry density.
3. If the granular material is a coarse sand or gravel, of a uniform size, or has a low fines content, compaction comparison to relative density may be more appropriate. In this case, granular materials should be compacted to at least 70% relative density (ASTM D 4253 and D 4254). Materials not amenable to density testing should be placed and compacted to a stable condition observed by the Geotechnical Engineer or representative.

Utility Trench Backfill

Any soft or unsuitable materials encountered at the bottom of utility trench excavations should be removed and replaced with Structural Fill or bedding material in accordance with public works specifications for the utility to be supported. This recommendation is particularly applicable to utility work requiring grade control and/or in areas where subsequent grade raising could cause settlement in the subgrade supporting the utility. Trench excavation should not be conducted below a downward 1:1 projection from existing foundations without engineering review of shoring requirements and geotechnical observation during construction.

On-site materials are considered suitable for backfill of utility and pipe trenches from 1 foot above the top of the pipe to the final ground surface, provided the material is free of organic matter and deleterious substances.

Trench backfill should be mechanically placed and compacted as discussed earlier in this report. Compaction of initial lifts should be accomplished with hand-operated tampers or other lightweight compactors. Where trenches are placed beneath slabs or footings, the backfill should satisfy the gradation and expansion index requirements of engineered fill discussed in this report. Flooding or jetting for placement and compaction of backfill is not recommended.

For low permeability subgrades, utility trenches are a common source of water infiltration and migration. Utility trenches penetrating beneath the building should be effectively sealed to restrict water intrusion and flow through the trenches, which could migrate below the building. The trench should provide an effective trench plug that

extends at least 5 feet from the face of the building exterior. The plug material should consist of cementitious flowable fill or low permeability clay. The trench plug material should be placed to surround the utility line. If used, the clay trench plug material should be placed and compacted to comply with the water content and compaction recommendations for Structural Fill stated previously in this report.

Grading and Drainage

All grades must provide effective drainage away from the building during and after construction and should be maintained throughout the life of the structure. Water retained next to the building can result in soil movements greater than those discussed in this report. Greater movements can result in unacceptable differential floor slab and/or foundation movements, cracked slabs and walls, and roof leaks. The roof should have gutters/drains with downspouts that discharge onto splash blocks at a distance of at least 10 feet from the building.

Exposed ground should be sloped and maintained at a minimum of 5% away from the building for at least 10 feet beyond the perimeter of the building. Locally, flatter grades may be necessary to transition ADA access requirements for flatwork. After building construction and landscaping have been completed, final grades should be verified to document that effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted, as necessary, as part of the structure's maintenance program. Where paving or flatwork abuts the structure, a maintenance program should be established to effectively seal and maintain joints and prevent surface water infiltration.

Earthwork Construction Considerations

Shallow excavations for the proposed structure are anticipated to be accomplished with conventional construction equipment. Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of grade-supported improvements such as floor slabs. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Water collecting over or adjacent to construction areas should be removed. If the subgrade freezes, desiccates, saturates, or is disturbed, the affected material should be removed, or the materials should be scarified, moisture conditioned, and recompacted prior to floor slab construction.

The groundwater table could affect overexcavation efforts, especially for overexcavation and replacement of lower strength soils. A temporary dewatering system consisting of sumps with pumps may be necessary to achieve the recommended depth of overexcavation depending on groundwater conditions at the time of construction.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices and in accordance with any applicable local and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety or the contractor's activities; such responsibility shall neither be implied nor inferred.

Excavations or other activities resulting in ground disturbance have the potential to affect adjoining properties and structures. Our scope of services does not include review of available final grading information or consider potential temporary grading performed by the contractor for potential effects such as ground movement beyond the project limits. A preconstruction/precondition survey should be conducted to document nearby property/infrastructure prior to any site development activity. Excavation or ground disturbance activities adjacent to or near property lines should be monitored or instrumented for potential ground movements that could negatively affect adjoining property and/or structures.

Construction Observation and Testing

The earthwork efforts should be observed by the Geotechnical Engineer (or others under their direction). Observation should include documentation of adequate removal of surficial materials (vegetation, topsoil, and pavements), evaluation and remediation of existing fill materials, as well as proofrolling and mitigation of unsuitable areas delineated by the proofroll.

Each lift of compacted fill should be tested, evaluated, and reworked, as necessary, as recommended by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least one test for every 2,500 square feet of compacted fill in the building areas. Where not specified by local ordinance, one density and water content test should be performed for every 100 linear feet of compacted utility trench backfill, and a minimum of one test should be performed for every 12 vertical inches of compacted backfill.

In areas of foundation excavations, the bearing subgrade should be evaluated by the Geotechnical Engineer. If unanticipated conditions are observed, the Geotechnical Engineer should prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer's presence into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

Shallow Foundations

If the site has been prepared in accordance with the requirements noted in **Earthwork**, the following design parameters are applicable for shallow foundations.

Design Parameters — Compressive Loads

Item	Description
Maximum net allowable bearing pressure[1, 2]	2,000 psf
Required bearing stratum[3]	A minimum of 24 inches of properly placed and compacted Structural Fill
Maximum foundation dimensions	Column: 9 feet x 9 feet Wall: 3.5 feet x 100 feet
Ultimate passive resistance[4] **(equivalent fluid pressures)**	460 pcf (granular backfill) – unsaturated 302 pcf (granular backfill) - saturated
Sliding resistance[5]	0.45 allowable coefficient of friction — granular material
Minimum embedment below finished grade[6]	Exterior footings in heated areas: 30 inches Interior footings in heated areas: 12 inches
Estimated total settlement from structural loads[2]	Less than about 1 inch
Estimated differential settlement[2, 7]	About ½ of total settlement

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. Values assume that exterior grades are no steeper than 20% within 10 feet of the structure.
2. Values provided are for maximum loads noted in **Project Description**. Additional geotechnical consultation will be necessary if higher loads are anticipated.
3. Unsuitable or soft soils should be overexcavated and replaced per the recommendations presented in **Earthwork**.
4. Use of passive earth pressures requires the sides of the excavation for the spread footing foundation to be nearly vertical and the concrete placed neat against these vertical faces or that the footing forms be removed and compacted Structural Fill be placed against the vertical footing face. Assumes no hydrostatic pressure.
5. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Frictional resistance for granular materials is dependent on the bearing pressure, which may vary due to load combinations. For fine-grained materials, lateral resistance using cohesion should not exceed ½ the dead load.
6. Embedment necessary to minimize the effects of frost and/or seasonal water content variations. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure.

Item	Description

7. Differential settlements are noted for equivalent-loaded foundations and bearing elevation as measured over a span of 50 feet.

Design Parameters — Overturning and Uplift Loads

Shallow foundations subjected to overturning loads should be proportioned such that the resultant eccentricity is maintained in the center third of the foundation (e.g., $e < b/6$, where b is the foundation width). This requirement is intended to keep the entire foundation area in compression during the extreme lateral/overturning load event. Foundation oversizing may be required to satisfy this condition.

Uplift resistance of spread footings can be developed from the effective weight of the footing and the overlying soils with consideration to the IBC basic load combinations.

Item	Description
Soil moist unit weight	121 pcf
Soil effective unit weight[1]	58.6 pcf
Soil weight included in uplift resistance	Soil included within the prism extending up from the top perimeter of the footing at an angle of 20 degrees from vertical to ground surface

1. Effective (or buoyant) unit weight should be used for soil above the foundation level and below a water level. The high groundwater level should be used in uplift design as applicable.

Construction Adjacent to Existing Building

Differential settlement between the additions and the existing building is expected to approach the magnitude of the total settlement of the addition. Expansion joints should be provided between the existing building and the proposed addition to accommodate differential movements between the two structures. Underground piping between the two structures should be designed with flexible couplings and utility knockouts in foundation walls should be oversized so minor deflections in alignment do not result in breakage or distress. Care should be taken during excavation adjacent to existing foundations to avoid disturbing existing foundation bearing soils.

New footings should bear at or near the bearing elevation of immediately adjacent existing foundations. Depending on their locations and current loads on the existing footings, footings for the new addition could cause settlement of adjacent walls. To reduce this concern and risk, clear distances at least equal to the new footing widths

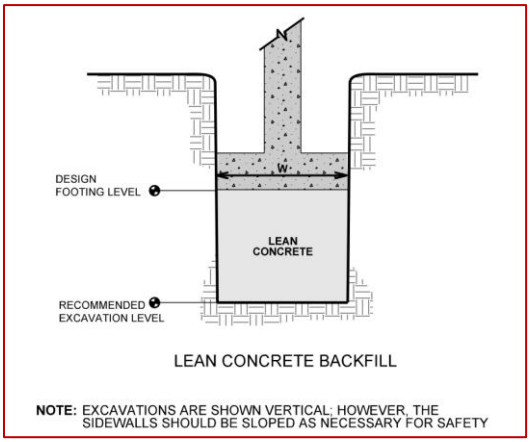
should be maintained between the addition's footings and footings supporting the existing building.

We understand existing foundations may support additional load from the walls of the new additions. Based on our understanding of the **Project Description**, the additional loads should be limited to about 2 klf. Additional loads on the existing foundations could cause other building settlements to occur. The structural capacity of existing foundations should be evaluated by a licensed structural engineer where increases in loading are planned.

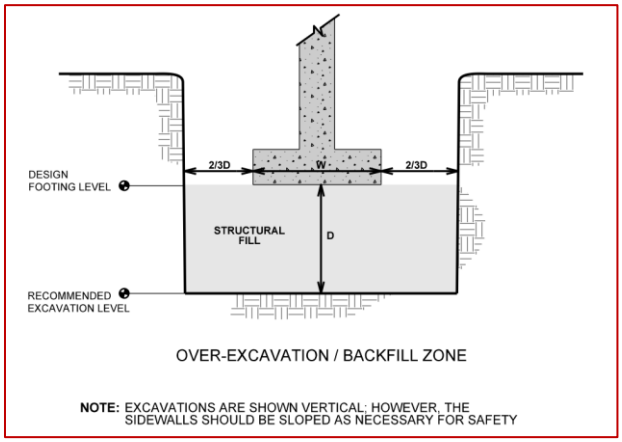
Foundation Construction Considerations

As noted in **Earthwork**, the footing excavations should be evaluated under the observation of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed.

If unsuitable bearing soils are observed at the base of the planned footing excavation, the excavation should be extended deeper to suitable soils, and the footings could bear directly on these soils at the lower level or on lean concrete backfill placed in the excavations. The lean concrete replacement zone is illustrated in the sketch below.



Overexcavation for Structural Fill placement below footings should be conducted as shown below. The overexcavation should be backfilled up to the footing base elevation, with Structural Fill placed, as recommended in the **Earthwork** section.



Floor Slabs

Design parameters for floor slabs assume the requirements for **Earthwork** have been followed. Specific attention should be given to positive drainage away from the structure and positive drainage of the aggregate base beneath the floor slab.

Depending on the finished floor elevation, soft to medium stiff soils may be observed at the floor slab subgrade level. These soils should be replaced with Structural Fill so the floor slab is supported on at least 12 inches of compacted Structural Fill.

Floor Slab Design Parameters

Item	Description
Floor slab support[1]	Use 6 inches of base course meeting material specifications of ACI 302 underlain by 12 inches of properly placed and compacted Structural Fill. Subgrade to be prepared in accordance with recommendations in **Earthwork**
Estimated modulus of subgrade reaction[2]	90 pounds per square inch per inch (psi/in.) for point loads

1. Floor slabs should be structurally independent of building footings or walls to reduce the possibility of floor slab cracking caused by differential movements between the slab and foundation.
2. Modulus of subgrade reaction is an estimated value based on our experience with the subgrade condition, the requirements noted in **Earthwork**, and the floor slab support as noted in this table. It is provided for point loads. For large area loads, the modulus of subgrade reaction would be lower.

The use of a vapor retarder should be considered beneath concrete slabs on grade covered with wood, tile, carpet, or other moisture sensitive or impervious coverings; when the project includes humidity-controlled areas; or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

Saw-cut contraction joints should be placed in the slab to help control the location and extent of cracking. For additional recommendations, refer to the ACI Design Manual. Joints or cracks should be sealed with a waterproof, nonextruding compressible compound specifically recommended for heavy duty concrete pavement and wet environments.

Where floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks beyond the length of the structural dowels. The Structural Engineer should account for potential differential settlement through the use of sufficient control joints, appropriate reinforcing, or other means.

Settlement of floor slabs supported on existing fill materials cannot be accurately predicted but could be larger than normal and result in some cracking. Mitigation measures, as noted within **Earthwork**, are critical to the performance of floor slabs. In addition to the mitigation measures, the floor slab can be stiffened by adding steel reinforcement, grade beams, and/or post-tensioned elements.

Floor Slab Construction Considerations

Finished subgrade, within and for at least 10 feet beyond the floor slab, should be protected from traffic, rutting, or other disturbance and maintained in a relatively moist condition until floor slabs are constructed. If the subgrade should become damaged or desiccated prior to construction of floor slabs, the affected material should be removed, and Structural Fill should be added to replace the resulting excavation. Final conditioning of the finished subgrade should be performed immediately prior to placement of the floor slab support course.

The Geotechnical Engineer should observe the condition of the floor slab subgrades immediately prior to placement of the floor slab support course, reinforcing steel, and concrete. Attention should be paid to high traffic areas that were rutted and disturbed earlier, and to areas where backfilled trenches are located.

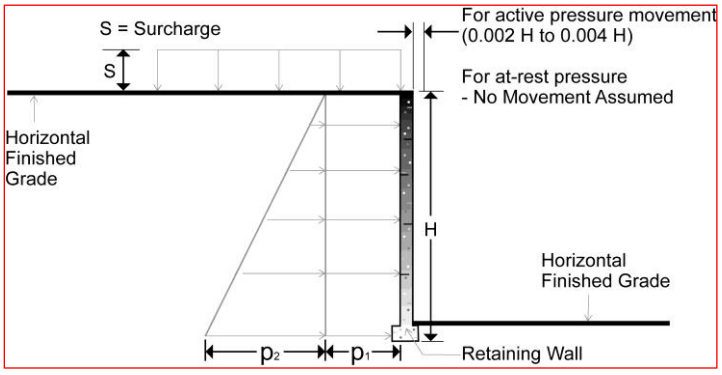
Below-Grade Structures

Groundwater was encountered at depths ranging from about 8 to 9 feet below existing grades. Excavations extending near or below the groundwater will require benching or shoring and dewatering. Excavations for the planned underground water tank, which may be up to 15 feet deep, will require shoring and dewatering designed and constructed by an experienced tank installation contractor. Additionally, buoyant forces on underground tanks will need to be taken into consideration.

Lateral Earth Pressures

Design Parameters

Structures with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to values indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction, and/or compaction and the strength of the materials being restrained. Two wall restraint conditions are shown in the diagram below. Active earth pressure is commonly used for design of free-standing cantilever retaining walls and assumes wall movement. The "at-rest" condition assumes no wall movement and is commonly used for basement walls, loading dock walls, or other walls restrained at the top. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls (unless stated).



Lateral Earth Pressure Design Parameters

Earth pressure condition[1]	Coefficient for backfill type[2]	Surcharge pressure[3] p_1 (psf)	Equivalent fluid pressures (psf)[2,4]	
			Unsaturated[5]	Submerged[5]
Active (K_a)	Granular: 0.28	(0.28)S	(37)H	(82)H
At-rest (K_o)	Granular: 0.44	(0.44)S	(57)H	(92)H

1. For active earth pressure, wall must rotate about base, with top lateral movements 0.002 H to 0.004 H, where H is wall height. For passive earth pressure, wall must move horizontally to mobilize resistance. Fat clay or other expansive soils should not be used as backfill behind the wall.
2. Uniform, horizontal backfill, with a maximum unit weight 130 pcf for granular soils.
3. Uniform surcharge, where S is surcharge pressure.
4. Loading from heavy compaction equipment is not included.
5. To achieve "Unsaturated" conditions, follow guidelines in **Subsurface Drainage for Below-Grade Walls** below. "Submerged" conditions are recommended when drainage behind walls is not incorporated into the design.

Lateral Earth Pressure Design Parameters

Earth pressure condition[1]	Coefficient for backfill type[2]	Surcharge pressure[3] p_1 (psf)	Dynamic fluid pressures (psf)[2,4,6]	
			Unsaturated[5]	Submerged[5]
Active (K_a)	Granular: 0.54	(0.54)S	(70)H	(99)H
At-rest (K_o)	Granular: 2.81	(2.81)S	(366)H	(253)H

1. For active earth pressure, wall must rotate about base, with top lateral movements 0.002 H to 0.004 H, where H is wall height. For passive earth pressure, wall must move horizontally to mobilize resistance. Fat clay or other expansive soils should not be used as backfill behind the wall.
2. Uniform, horizontal backfill, with a maximum unit weight 130 pcf for granular soils.
3. Uniform surcharge, where S is surcharge pressure.
4. Loading from heavy compaction equipment is not included.
5. To achieve "Unsaturated" conditions, follow guidelines in **Subsurface Drainage for Below-Grade Walls** below. "Submerged" conditions are recommended when drainage behind walls is not incorporated into the design.
6. Dynamic fluid pressures based of a factored horizontal acceleration of 0.35g.

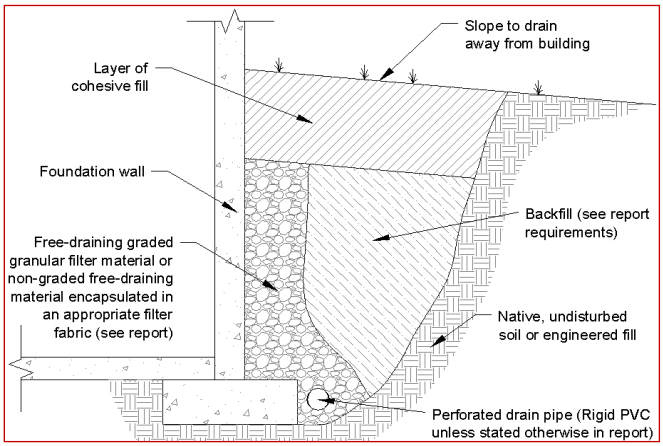
Backfill placed against structures should consist of granular soils or low plasticity cohesive soils. For the granular values to be valid, the granular backfill must extend out and up from the base of the wall at an angle of at least 45 degrees from vertical for the active case.

Footings, floor slabs, or other loads bearing on backfill behind walls may have a significant influence on the lateral earth pressure. Placing footings within wall backfill and in the zone of active soil influence on the wall should be avoided unless structural analyses indicate the wall can safely withstand the increased pressure.

The lateral earth pressure recommendations given in this section are applicable to the design of rigid retaining walls subject to slight rotation, such as cantilever or gravity type concrete walls. These recommendations are not applicable to the design of modular block geogrid reinforced backfill walls (also termed MSE walls). Recommendations covering these types of wall systems are beyond the scope of services for this assignment. However, we would be pleased to develop a proposal for evaluation and design of such wall systems upon request.

Subsurface Drainage for Below-Grade Walls

A perforated rigid plastic drain line installed behind the base of walls and extends below adjacent grade is recommended to prevent hydrostatic loading on the walls. The invert of a drain line around a below-grade building area or exterior retaining wall should be placed near foundation bearing level. The drain line should be sloped to provide positive gravity drainage to daylight or to a sump pit and pump. The drain line should be surrounded by clean, free-draining granular material having less than 5% passing the No. 200 sieve, such as No. 57 aggregate. The free-draining aggregate should be encapsulated in a filter fabric. The granular fill should extend to within 2 feet of final grade, where it should be capped with compacted cohesive fill to reduce infiltration of surface water into the drain system.



As an alternative to free-draining granular fill, a prefabricated drainage structure may be used. A prefabricated drainage structure is a plastic drainage core or mesh that is covered with filter fabric to prevent soil intrusion and is fastened to the wall prior to placing backfill.

General Comments

Our analysis and opinions are based on our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, or bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials, or hazardous conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client and is not

intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly affect excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety and cost estimating including excavation support and dewatering requirements/design are the responsibility of others. Construction and site development have the potential to affect adjacent properties. Such impacts can include damage due to vibration, modification of groundwater/surface water flow during construction, foundation movement due to undermining or subsidence from excavation, and noise or air quality concerns. Evaluation of these items on nearby properties is commonly associated with contractor means and methods and is not addressed in this report. The owner and contractor should consider a preconstruction/precondition survey of surrounding development. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

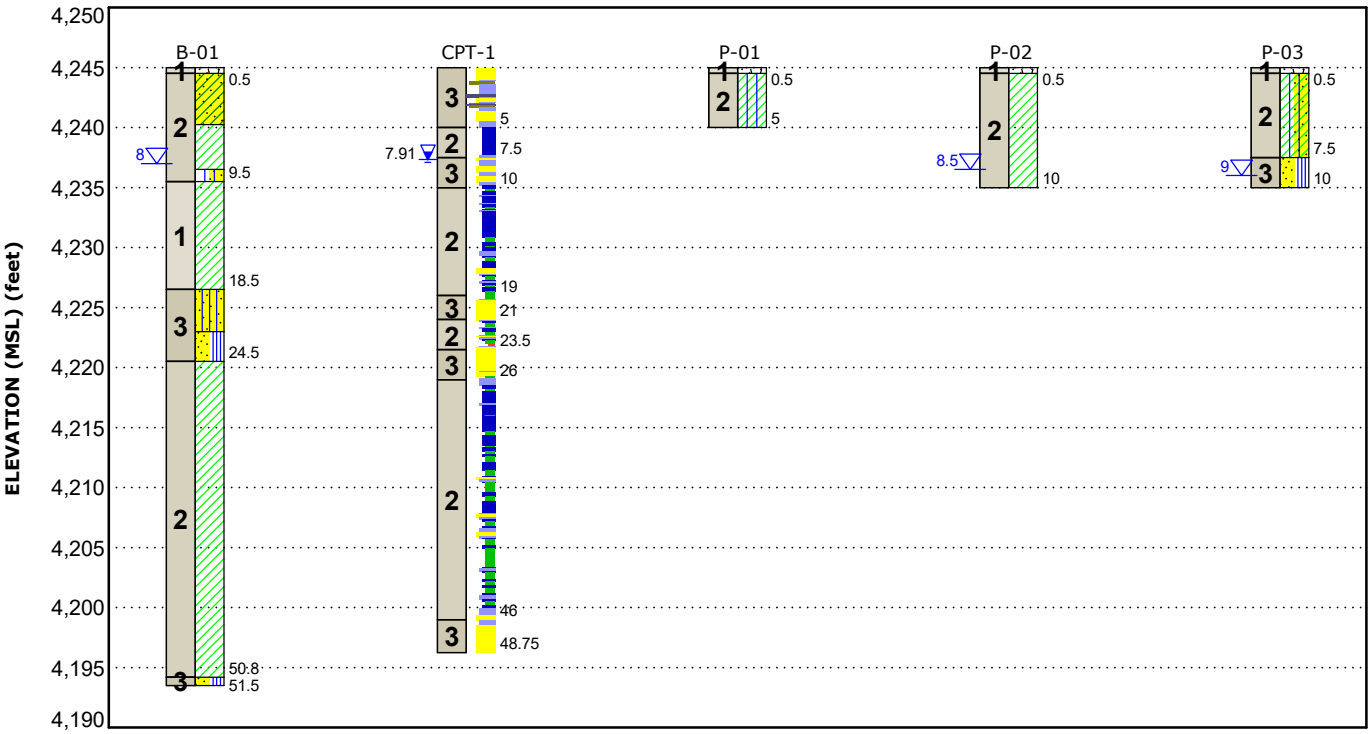
Figures

Contents:

JUB - GHID Anderson WTP
1600 West 2320 South | West Valley, Utah
Terracon Project No. 61235197

6952 S High Tech Dr, Ste B
Midvale, UT

GeoModel



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description
1	Topsoil	Topsoil (i.e. vegetation) encountered in all borings, approximately 6 inches thick
2	Fine Grained Soils	Soft to very stiff lean clay and silt with varying amounts of sand
3	Coarse Grained Soils	Loose to medium dense sand with varying amounts of silt

Legend

- Topsoil
- Lean Clay
- Silty Sand
- Silty Clay
- Sandy Lean Clay
- Silt with Sand
- Poorly-graded Sand with Silt
- Silty Clay with Sand

▽ First Water Observation

Groundwater levels are temporal. The levels shown are representative of the date and time of our exploration. Significant changes are possible over time.
Water levels shown are as measured during and/or after drilling. In some cases, boring advancement methods mask the presence/absence of groundwater. See individual logs for details.

NOTES:
Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project. Numbers adjacent to soil column indicate depth below ground surface.

Attachments

Exploration and Testing Procedures

Field Exploration

Number of explorations (type)	Approximate exploration depth (feet)	Location
1 Boring	51.5	WTP building
1 CPT	50	Water tank
2 Borings	10	Stormwater drainage basin
1 Boring	5	

Exploration Layout and Elevations: Terracon personnel provided the exploration layout using handheld GPS equipment (estimated horizontal accuracy of about ±10 feet) and referencing existing site features. Approximate ground surface elevations were estimated using Google Earth. If elevations and a more precise boring layout are desired, we recommend borings be surveyed.

Subsurface Exploration Procedures: We advanced the borings with a truck-mounted, rotary drill rig using continuous flight, hollow-stem, augers. Four samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. In the thin-walled tube sampling procedure, a thin-walled, seamless steel tube with a sharp cutting edge was pushed hydraulically into the soil to obtain a relatively undisturbed sample. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. A 3-inch O.D. split-barrel sampling spoon with 2.5-inch I.D. ring-lined sampler was used for sampling in the upper 10 feet. Ring-lined, split-barrel sampling procedures are similar to standard split-spoon sampling procedures; however, blow counts are typically recorded at 6-inch intervals for a total of 12 inches of penetration. We observed and recorded groundwater levels during drilling and sampling. For safety purposes, all borings were backfilled with auger cuttings after their completion.

The CPT test was performed using a truck-mounted rig to hydraulically push an instrumented cone through the soil while nearly continuous readings of soil strength and pore pressure which are recorded to a portable computer. No soil samples were gathered through this exploration technique.

The sampling depths, penetration distances, and other sampling information were recorded in the field boring logs. The samples were placed in appropriate containers and

taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials observed during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests. The laboratory testing program included the following types of tests:

- Moisture Content
- Dry Unit Weight
- Atterberg Limits
- Grain Size Analysis
- Consolidation
- Chemical Analyses — pH, sulfates, chloride ion, and electrical resistivity

The laboratory testing program often included examination of soil samples by an engineer. Based on the results of our field and laboratory programs, we described and classified the soil samples in accordance with the Unified Soil Classification System.

Site Location and Exploration Plans

Contents:

Site Location Plan
Exploration Plan

Note: All attachments are one page unless noted above.

Site Location

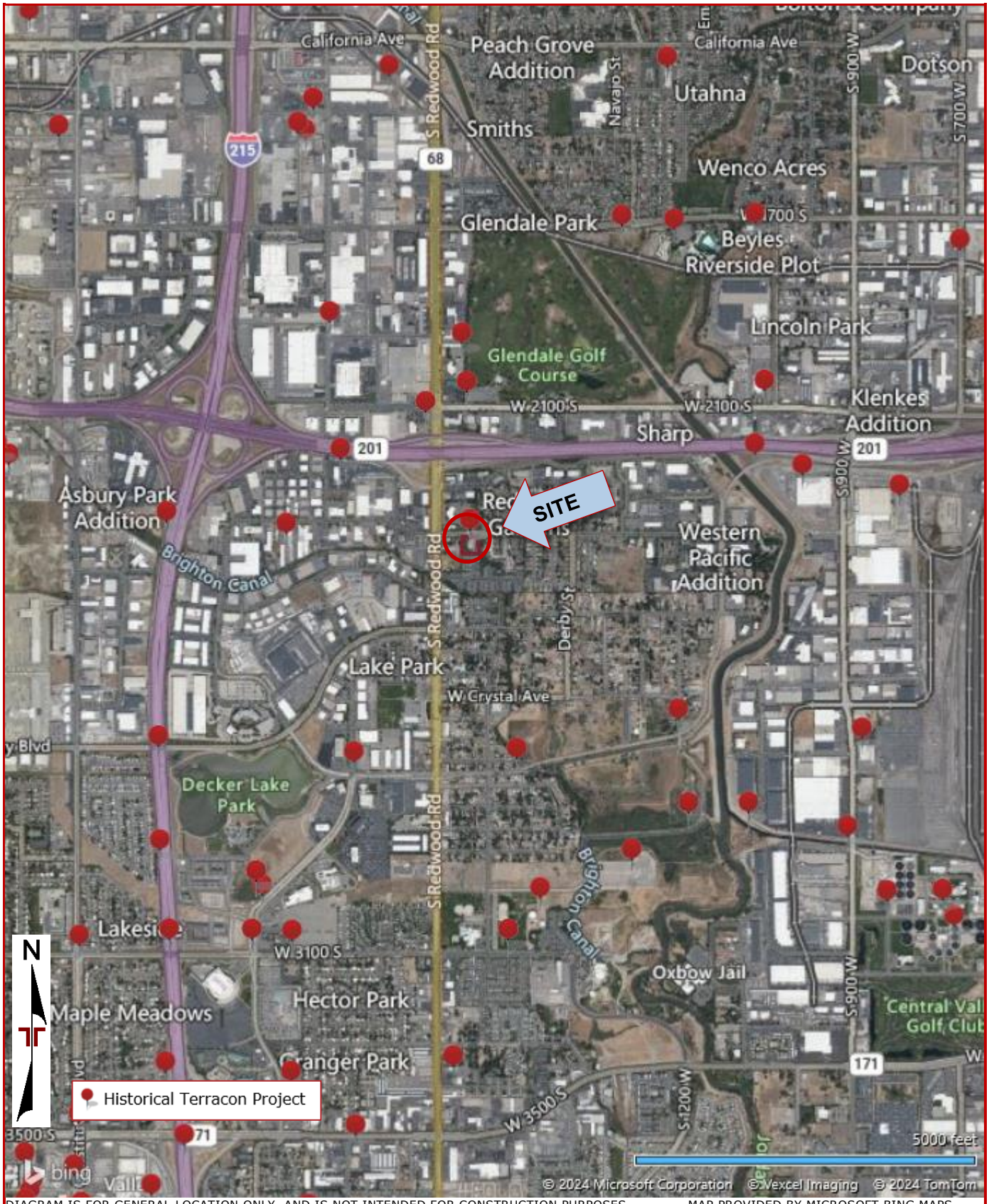


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES MAP PROVIDED BY MICROSOFT BING MAPS

Exploration Plan

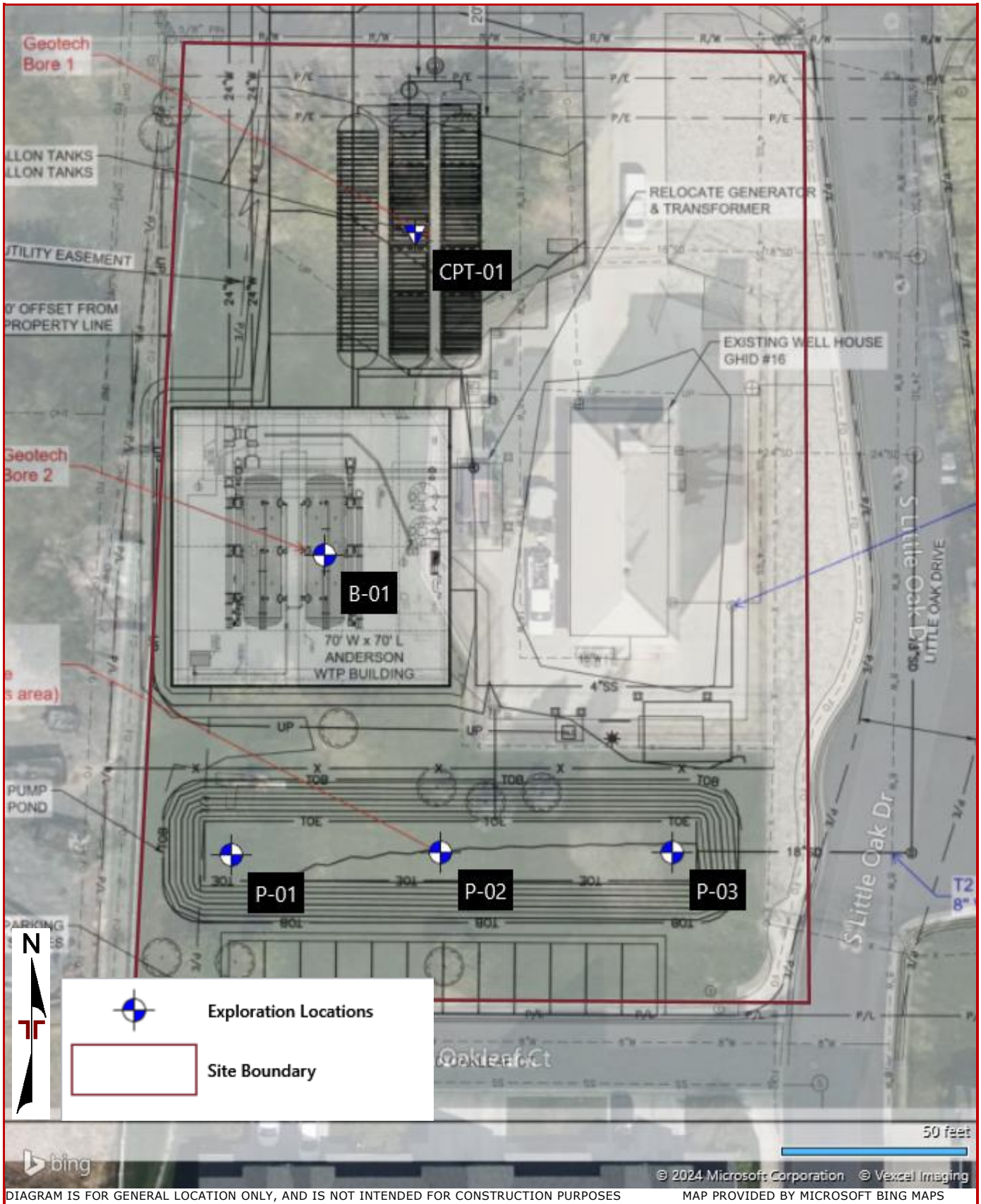


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Exploration and Laboratory Results

Contents:

Note: All attachments are one page unless noted above.

JUB - GHID Anderson WTP
1600 West 2320 South | West Valley, Utah
Terracon Project No. 61235197

6952 S High Tech Dr, Ste B
Midvale, UT

Boring Log No. B-01

Location: See Exploration Plan

Latitude: 40.7204° Longitude: -111.9374°

Model Layer	Depth (Ft.)	Elevation.: 4245 (Ft.)	Recovery (In.)	Field Test Results	OSHA Soil Type	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1	0.5	**TOPSOIL**, approximately 6 inches thick							
2	4.8	**SANDY LEAN CLAY (CL)**, brown, with oxidation staining and root holes	18		A	18.5		26-18-8	68
		LEAN CLAY (CL), light brown, soft, with oxidation staining	15	1-1-3 N=4	A	27.5			
	8.5		18		A C	23.1 24.7		28-16-12 NP	96 79
	9.5	**SILT WITH SAND (ML)**, light brown, with root holes							
1		**LEAN CLAY (CL)**, brown, medium stiff, with trace silt and root holes, with color mottling	16	1-2-4 N=6	C	28.3			
			14	1-4-4 N=8	C	30.6		32-19-13	90
	18.5								
3		**SILTY SAND (SM)**, gray, loose	18	4-2-2 N=4	C	28.5		NP	45
	22.0								
		POORLY GRADED SAND WITH SILT (SP-SM), gray, medium dense	18	4-13-11 N=24	C				
	24.5								
2		**LEAN CLAY (CL)**, dark gray to black, soft to very stiff, trace organic odor, with silt lenses throughout	12	0-0-3 N=3	C				

Depth (Ft.) 5 10 15 20 25 30

Water Level Observations: ▽ 8' while drilling

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes

Advancement Method
Hollow Stem Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Drill Rig
Geoprobe GT3100

Hammer Type
Automatic

Driller
Terracon

Logged by
EK

Boring Started
02-12-2024

Boring Completed
02-12-2024

6952 S High Tech Dr, Ste B
Midvale, UT

Boring Log No. B-01

Location: See Exploration Plan

Latitude: 40.7204° Longitude: -111.9374°

Depth (Ft.) Elevation.: 4245 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	OSHA Soil Type	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
2		**LEAN CLAY (CL)**, dark gray to black, soft to very stiff, trace organic odor, with silt lenses throughout *(continued)*									
					18	0-2-2 N=4	C	31.4		38-19-19	99
		35			18	0-2-3 N=5	C				
		40			18	1-2-4 N=6	C				
		45			18	0-3-5 N=8	C				
		50			18	8-10-18 N=28	C				
		50.8 4194.2									
3		51.5 **POORLY GRADED SAND WITH SILT (SP-SM)**, gray, medium dense 4193.5									
		Boring Terminated at 51.5 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
8' while drilling

Drill Rig
Geoprobe GT3100

Hammer Type
Automatic

Driller
Terracon

Notes

Advancement Method
Hollow Stem Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Logged by
EK

Boring Started
02-12-2024

Boring Completed
02-12-2024

JUB - GHID Anderson WTP
1600 West 2320 South | West Valley, Utah
Terracon Project No. 61235197

6952 S High Tech Dr, Ste B
Midvale, UT

Boring Log No. P-01

Location: See Exploration Plan

Latitude: 40.7201° Longitude: -111.9375°

Depth (Ft.) Elevation.: 4245 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	OSHA Soil Type	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		0.5 **TOPSOIL**, approximately 6 inches thick 4244.5									
2		**SILTY CLAY (CL-ML)**, light brown, medium stiff, with oxidation staining									
					16	5-3-3-4	A	29.4			
		5.0 noteable color change to dark brown, more silt present, with trace gravels 4240									
		5									
		Boring Terminated at 5 Feet									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations

Drill Rig
Geoprobe GT3100

Hammer Type
Automatic

Driller
Terracon

Notes

Advancement Method
Hollow Stem Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Logged by
EK

Boring Started
02-12-2024

Boring Completed
02-12-2024

JUB - GHID Anderson WTP
1600 West 2320 South | West Valley, Utah
Terracon Project No. 61235197

6952 S High Tech Dr, Ste B
Midvale, UT

Boring Log No. P-02

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 40.7202° Longitude: -111.9373° Depth (Ft.) Elevation.: 4245 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	OSHA Soil Type	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		0.5 **TOPSOIL**, approximately 6 inches thick 4244.5										
2		**LEAN CLAY (CL)**, light brown to gray, soft to medium stiff										
		with oxidation staining, trace root holes				8	0-1-1 N=2	A	18.3			
			5									
						10	1-2-2 N=4	A	26.6		28-16-12	95
		trace sand and silt										
				▽		14	2-2-5	C				
		10.0 4235	10									
		Boring Terminated at 10 Feet										

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
▽ 8.5' while drilling

Drill Rig
Geoprobe GT3100

Hammer Type
Automatic

Driller
Terracon

Notes

Advancement Method
Hollow Stem Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Logged by
EK

Boring Started
02-12-2024

Boring Completed
02-12-2024

JUB - GHID Anderson WTP
1600 West 2320 South | West Valley, Utah
Terracon Project No. 61235197

6952 S High Tech Dr, Ste B
Midvale, UT

Boring Log No. P-03

Location: See Exploration Plan

Latitude: 40.7202° Longitude: -111.9371°

Depth (Ft.) Elevation.: 4245 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	OSHA Soil Type	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		0.5 **TOPSOIL**, approximately 6 inches thick 4244.5									
2		**SILTY CLAY WITH SAND (CL-ML)**, light brown, soft, with oxidation staining, increasing silt content with depth			12	1-2-2 N=4	A	25.7		27-21-6	78
					8	0-1-2 N=3	A	27.8			
3		7.5 4237.5 **POORLY GRADED SAND WITH SILT (SP-SM)**, light brownish gray, loose	▽		12	2-4-5-6	C				
		10.0 4235 ***Boring Terminated at 10 Feet***									

5

10

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
▽ 9' while drilling

Drill Rig
Geoprobe GT3100

Hammer Type
Automatic

Driller
Terracon

Notes

Advancement Method
Hollow Stem Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Logged by
EK

Boring Started
02-12-2024

Boring Completed
02-12-2024

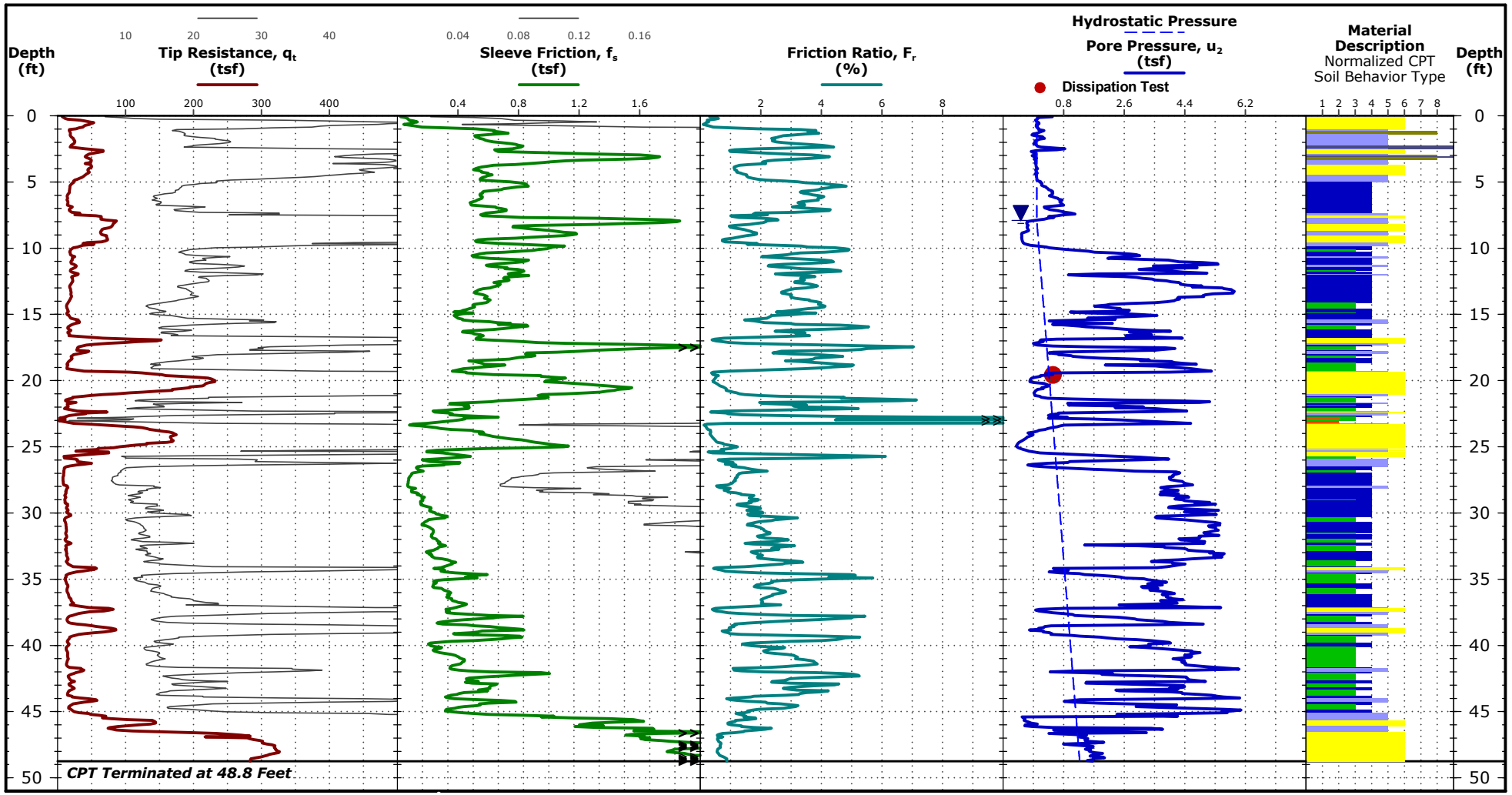
JUB - GHID Anderson WTP
1600 West 2320 South | West Valley, Utah
Terracon Project No. 61235197

CPT Sounding ID CPT-1

Latitude: 40.720605° Longitude: -111.937354°

Terracon
6949 S High Tech Dr Ste 100
Midvale, UT

CPT Started: 2/12/2024
CPT Completed: 2/12/2024



See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data, if any.

See Supporting Information for explanation of symbols and abbreviations.

Notes

Test Location: See Exploration Plan

CPT Equipment

CPT Rig: Geoprobe GT3100

Operator: CH

CPT sensor calibration reports available upon request

Probe No. 5501 with net area ratio of 0.86

Manufactured by Geoprobe Systems- Calibrated 5/19/2022

Water Level Observation

▼ 7.91 ft measured water depth

(used in normalizations and correlations)

Normalized Soil Behavior Type
(Robertson 1990)

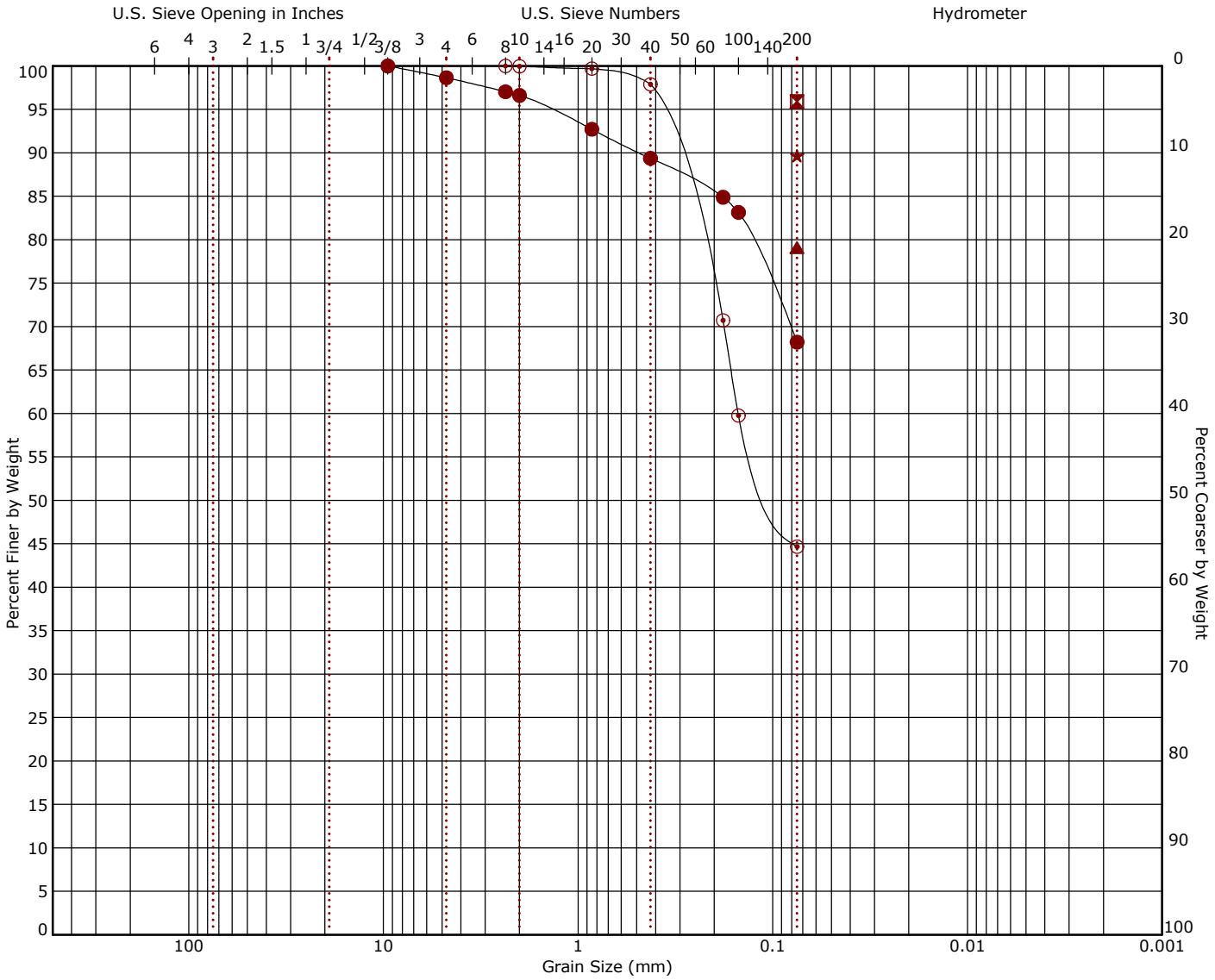
1 Sensitive, fine grained
2 Organic soils - clay
3 Clay - silty clay to clay
4 Silt mixtures - clayey silt to silty clay
5 Sand mixtures - silty sand to sandy silt
6 Sands - clean sand to silty sand
7 Gravelly sand to dense sand
8 Very stiff sand to clayey sand
9 Very stiff fine grained

JUB - GHID Anderson WTP
1600 West 2320 South | West Valley, Utah
Terracon Project No. 61235197

6949 S High Tech Dr Ste 100
Midvale, UT

Grain Size Distribution

ASTM D422 / ASTM C136



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID		Depth (Ft)	Description	USCS	LL	PL	PI	Cc	Cu
●	B-01	2.5 - 4.5	SANDY LEAN CLAY	CL	26	18	8		
⊠	B-01	7.5 - 9.5	LEAN CLAY	CL	28	16	12		
▲	B-01	8.5 - 9.5	SILT with SAND	ML	NP	NP	NP		
★	B-01	15 - 16.5	LEAN CLAY	CL	32	19	13		
⊙	B-01	20 - 21.5	SILTY SAND	SM	NP	NP	NP		

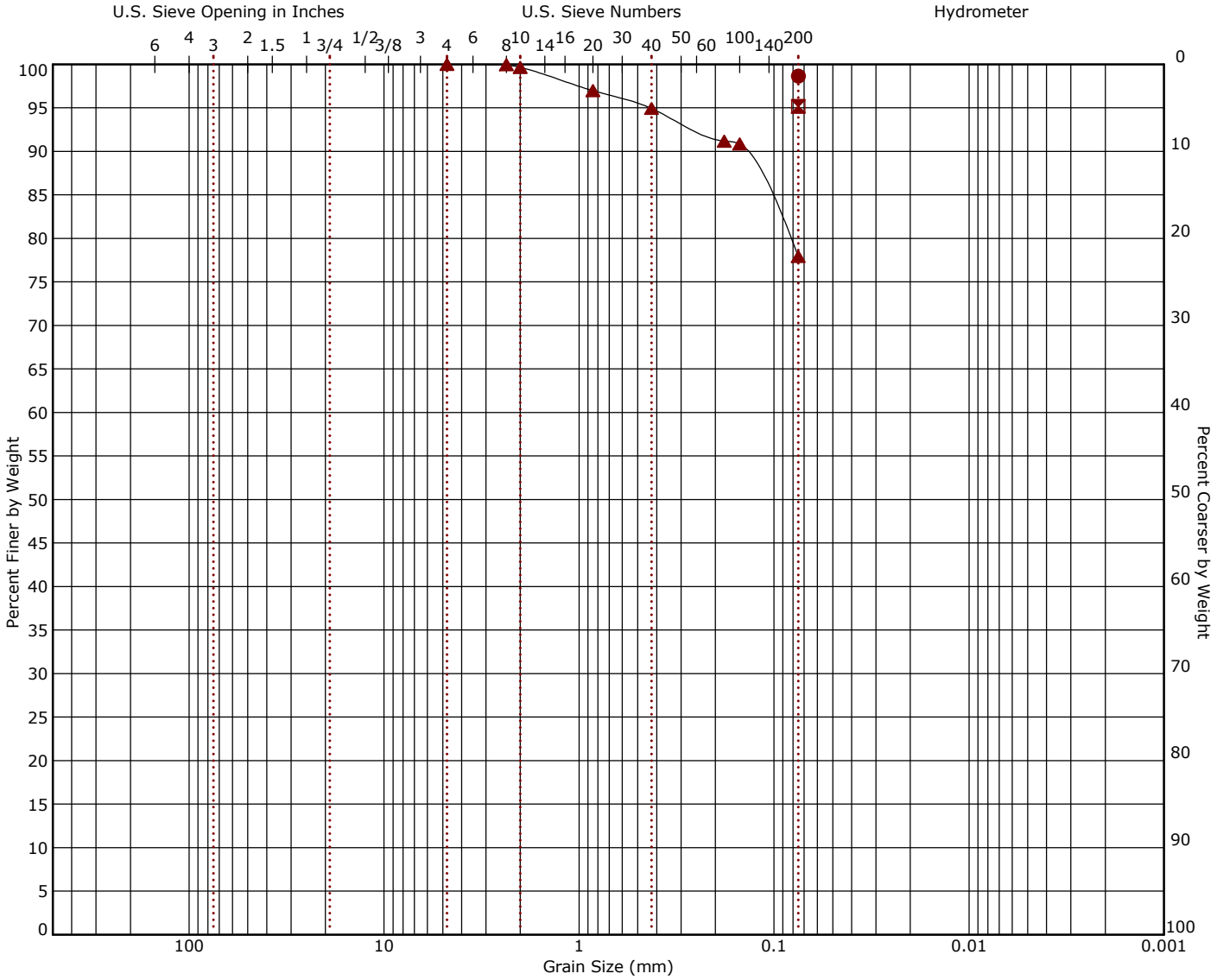
Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-01	2.5 - 4.5	9.5				0.0	1.4	30.4	68.2		
⊠	B-01	7.5 - 9.5	0.075							95.9		
▲	B-01	8.5 - 9.5	0.075							79.1		
★	B-01	15 - 16.5	0.075							89.7		
⊙	B-01	20 - 21.5	2.36	0.151			0.0	0.0	55.3	44.7		

JUB - GHID Anderson WTP
1600 West 2320 South | West Valley, Utah
Terracon Project No. 61235197

6949 S High Tech Dr Ste 100
Midvale, UT

Grain Size Distribution

ASTM D422 / ASTM C136

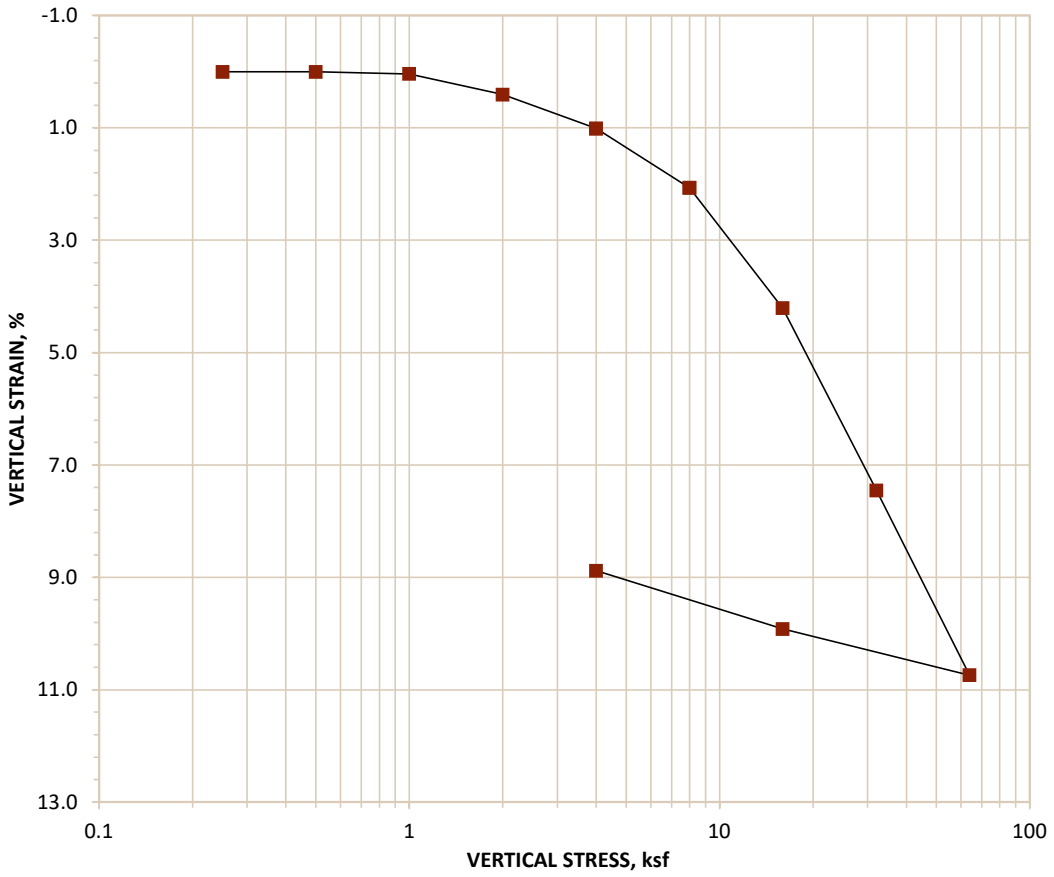


Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID		Depth (Ft)	Description	USCS	LL	PL	PI	Cc	Cu
●	B-01	30 - 31.5	LEAN CLAY	CL	38	19	19		
⊠	P-02	5 - 6.5	LEAN CLAY	CL	28	16	12		
▲	P-03	2.5 - 4	SILTY CLAY with SAND	CL-ML	27	21	6		

Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-01	30 - 31.5	0.075							98.7		
⊠	P-02	5 - 6.5	0.075							95.2		
▲	P-03	2.5 - 4	4.75				0.0	0.0	22.1	77.9		

CONSOLIDATION TEST DATA
ASTM D 2435-04

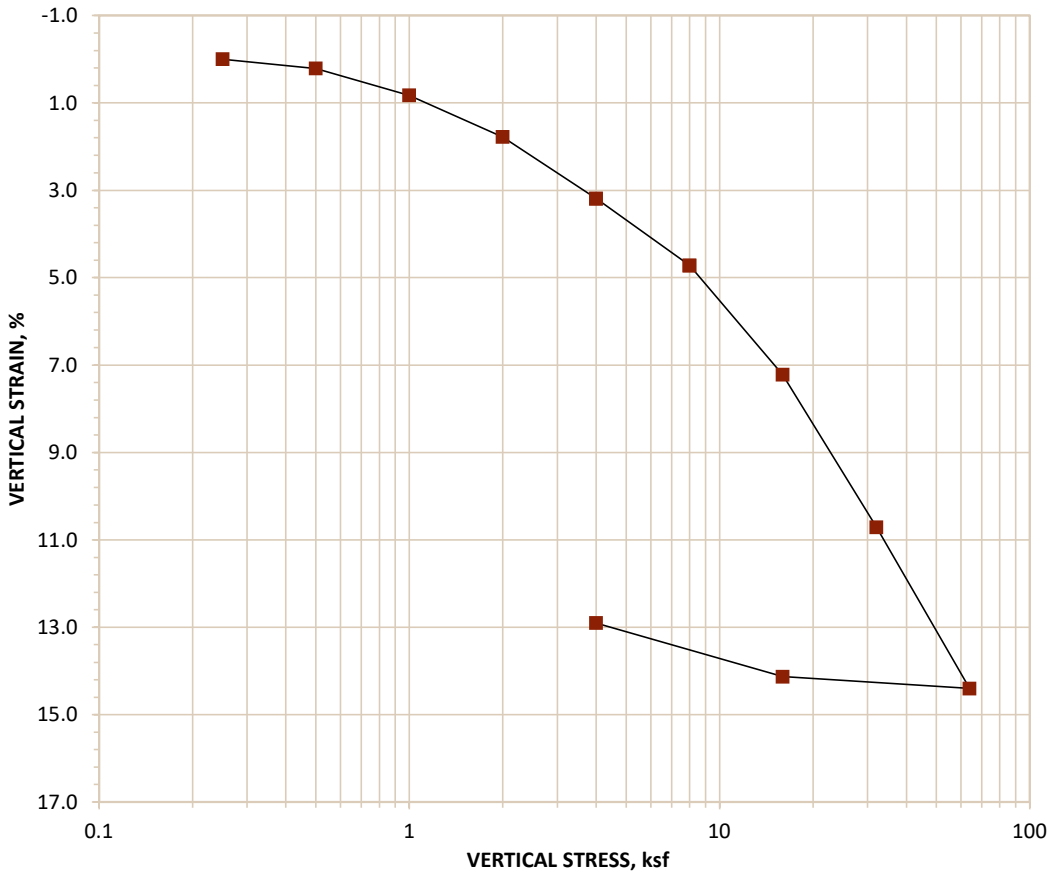


Before Consolidation			
Sample Diameter (in):	2.50	Moist Unit Weight (pcf):	117
Sample Height (in):	1.00	Moisture Content (%):	24
Sample Volume (cf):	0.0028	Dry Unit Weight (pcf):	94
After Consolidation			
Sample Diameter (in):	2.50	Moist Unit Weight (pcf):	123
Sample Height (in):	0.92	Moisture Content (%):	20
Sample Volume (cf):	0.0026	Dry Unit Weight (pcf):	102
Soil Properties			
Liquid Limit:	26	Percent Fines:	68
Plasticity Index:	8	Classification:	CL

Project: GHID Anderson WTP	Terracon	Project Number: 61235197
Location: West Valley, UT	6952 S High Tech Dr Suite B Midvale, Utah 84047	Sample: B-01 at 2.5 feet

CONSOLIDATION TEST DATA

ASTM D 2435-04



Before Consolidation			
Sample Diameter (in):	2.50	Moist Unit Weight (pcf):	121
Sample Height (in):	1.00	Moisture Content (%):	27
Sample Volume (cf):	0.0028	Dry Unit Weight (pcf):	95
After Consolidation			
Sample Diameter (in):	2.50	Moist Unit Weight (pcf):	131
Sample Height (in):	0.88	Moisture Content (%):	22
Sample Volume (cf):	0.0025	Dry Unit Weight (pcf):	108
Soil Properties			
Liquid Limit:	28	Percent Fines:	96
Plasticity Index:	12	Classification:	CL

Project: GHID Anderson WTP	Terracon	Project Number: 61235197
Location: West Valley, UT	6952 S High Tech Dr Suite B Midvale, Utah 84047	Sample: B-01 at 7.5 feet

CHEMICAL LABORATORY TEST REPORT

Project Number: 61235197
Service Date: 02/20/24
Report Date: 02/21/24

10400 State Highway 191
Midland, Texas 79707
432-684-9600

Client

J-U-B ENGINEERS, Inc.
392 East Winchester Street Suite 300
Salt Lake City, UT 84107

Project

JUB - GHID Anderson WTP
1600 West 2320 South
West Valley, UT

Sample Location	B-01
Sample Depth (ft.)	2.5
pH Analysis, ASTM G51-18	8.9
Water Soluble Sulfate (SO4), ASTM C1580 (mg/kg)	1
Sulfides, ASTM D4658-15, (mg/kg)	nil
Chlorides, ASTM D512, (mg/kg)	94
RedOx, ASTM D1498, (mV)	+558
Total Salts, ASTM D1125-14, (mg/kg)	831
Resistivity, ASTM G187, (ohm-cm)	1,342

Analyzed By: Zach Robertson

Zach Robertson
Laboratory Coordinator

Supporting Information

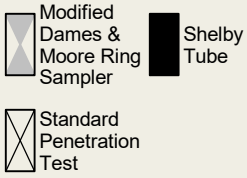
Contents:

Note: All attachments are one page unless noted above.

Terracon
6952 S High Tech Dr, Ste B
Midvale, UT

General Notes

Sampling



Water Level

Water Initially Encountered

Water Level After a Specified Period of Time

Water Level After a Specified Period of Time

Cave In Encountered

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

Field Tests

N	Standard Penetration Test Resistance (Blows/Ft.)
(HP)	Hand Penetrometer
(T)	Torvane
(DCP)	Dynamic Cone Penetrometer
UC	Unconfined Compressive Strength
(PID)	Photo-Ionization Detector
(OVA)	Organic Vapor Analyzer

Descriptive Soil Classification

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

Location And Elevation Notes

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

Strength Terms

Relative Density of Coarse-Grained Soils
(More than 50% retained on No. 200 sieve.)
Density determined by Standard Penetration Resistance

Relative Density	Standard Penetration or N-Value (Blows/Ft.)	Ring Sampler (Blows/Ft.)
Very Loose	0 - 3	0 - 6
Loose	4 - 9	7 - 18
Medium Dense	10 - 29	19 - 58
Dense	30 - 50	59 - 98
Very Dense	> 50	> 99

Consistency of Fine-Grained Soils
(50% or more passing the No. 200 sieve.)
Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance

Consistency	Unconfined Compressive Strength Qu (tsf)	Standard Penetration or N-Value (Blows/Ft.)	Ring Sampler (Blows/Ft.)
Very Soft	less than 0.25	0 - 1	< 3
Soft	0.25 to 0.50	2 - 4	3 - 4
Medium Stiff	0.50 to 1.00	4 - 8	5 - 9
Stiff	1.00 to 2.00	8 - 15	10 - 18
Very Stiff	2.00 to 4.00	15 - 30	19 - 42
Hard	> 4.00	> 30	> 42

Relevance of Exploration and Laboratory Test Results

Exploration/field results and/or laboratory test data contained within this document are intended for application to the project as described in this document. Use of such exploration/field results and/or laboratory test data should not be used independently of this document.

CPT GENERAL NOTES

DESCRIPTION OF MEASUREMENTS AND CALIBRATIONS

To be reported per ASTM D5778:

Uncorrected Tip Resistance, q_c
Measured force acting on the cone divided by the cone's projected area

Corrected Tip Resistance, q_t
Cone resistance corrected for porewater and net area ratio effects
$q_t = q_c + u_2(1 - a)$

Where a is the net area ratio, a lab calibration of the cone typically between 0.70 and 0.85

Pore Pressure, u
Pore pressure measured during penetration
u_1 - sensor on the face of the cone
u_2 - sensor on the shoulder (more common)

Sleeve Friction, f_s
Frictional force acting on the sleeve divided by its surface area

Normalized Friction Ratio, F_r
The ratio as a percentage of f_s to q_t, accounting for overburden pressure

To be reported per ASTM D7400, if collected:

Shear Wave Velocity, V_s
Measured in a Seismic CPT and provides direct measure of soil stiffness

DESCRIPTION OF GEOTECHNICAL CORRELATIONS

Normalized Tip Resistance, Q_{tn}
$Q_{tn} = ((q_t - \sigma_{v0})/P_a)(P_a/\sigma'_{v0})^n$
$n = 0.381(I_c) + 0.05(\sigma'_{v0}/P_a) - 0.15$

Over Consolidation Ratio, OCR
$OCR\ (1) = 0.25(Q_{tn})^{1.25}$
$OCR\ (2) = 0.33(Q_{tn})$

Undrained Shear Strength, S_u
$S_u = Q_{tn} \times \sigma'_{v0}/N_{kt}$
N_{kt} is a soil-specific factor (shown on S_u plot)

Sensitivity, S_t
$S_t = (q_t - \sigma_{v0}/N_{kt}) \times (1/f_s)$

Effective Friction Angle, ϕ'
$\phi'\ (1) = \tan^{-1}(0.373[\log(q_c/\sigma'_{v0}) + 0.29])$
$\phi'\ (2) = 17.6 + 11[\log(Q_{tn})]$

Unit Weight, γ
$\gamma = (0.27[\log(F_r)]+0.36[\log(q_t/atm)]+1.236) \times \gamma_{water}$
σ_{v0} is taken as the incremental sum of the unit weights

Small Strain Shear Modulus, G_0
$G_0\ (1) = \rho V_s^2$
$G_0\ (2) = 0.015 \times 10^{(0.55Ic + 1.68)}(q_t - \sigma_{v0})$

Soil Behavior Type Index, I_c
$I_c = [(3.47 - \log(Q_{tn}))^2 + (\log(F_r) + 1.22)^2]^{0.5}$

SPT N_{60}
$N_{60} = (q_t/atm) / 10^{(1.1268 - 0.2817Ic)}$

Elastic Modulus, E_s (assumes $q/q_{ultimate} \sim 0.3$, i.e. FS = 3)
$E_s\ (1) = 2.6\psi G_0$ where $\psi = 0.56 - 0.33\log Q_{tn,clean\ sand}$
$E_s\ (2) = G_0$
$E_s\ (3) = 0.015 \times 10^{(0.55Ic + 1.68)}(q_t - \sigma_{v0})$
$E_s\ (4) = 2.5q_t$

Constrained Modulus, M
$M = \alpha_M(q_t - \sigma_{v0})$
For $I_c > 2.2$ (fine-grained soils)
$\alpha_M = Q_{tn}$ with maximum of 14
For $I_c < 2.2$ (coarse-grained soils)
$\alpha_M = 0.0188 \times 10^{(0.55Ic + 1.68)}$

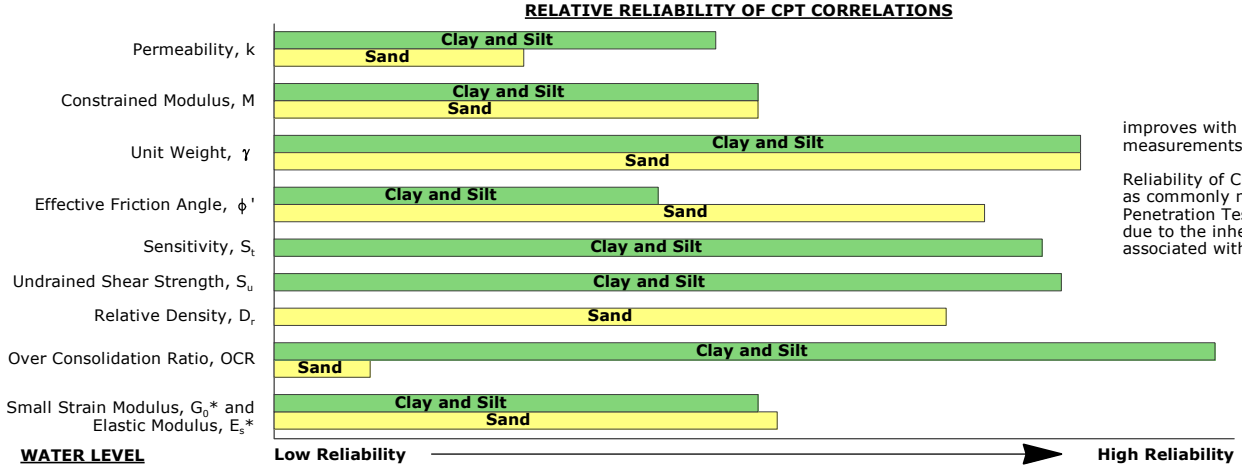
Hydraulic Conductivity, k
For $1.0 < I_c < 3.27$ $k = 10^{(0.952 - 3.04Ic)}$
For $3.27 < I_c < 4.0$ $k = 10^{(-4.52 - 1.37Ic)}$

Relative Density, D_r
$D_r = (Q_{tn} / 350)^{0.5} \times 100$

REPORTED PARAMETERS

CPT logs as provided, at a minimum, report the data as required by ASTM D5778 and ASTM D7400 (if applicable). This minimum data include q_t, f_s, and u. Other correlated parameters may also be provided. These other correlated parameters are interpretations of the measured data based upon published and reliable references, but they do not necessarily represent the actual values that would be derived from direct testing to determine the various parameters. To this end, more than one correlation to a given parameter may be provided. The following chart illustrates estimates of reliability associated with correlated parameters based upon the literature referenced below.

RELATIVE RELIABILITY OF CPT CORRELATIONS



improves with seismic V_s measurements

Reliability of CPT-predicted N_{60} values as commonly measured by the Standard Penetration Test (SPT) is not provided due to the inherent inaccuracy associated with the SPT test procedure.

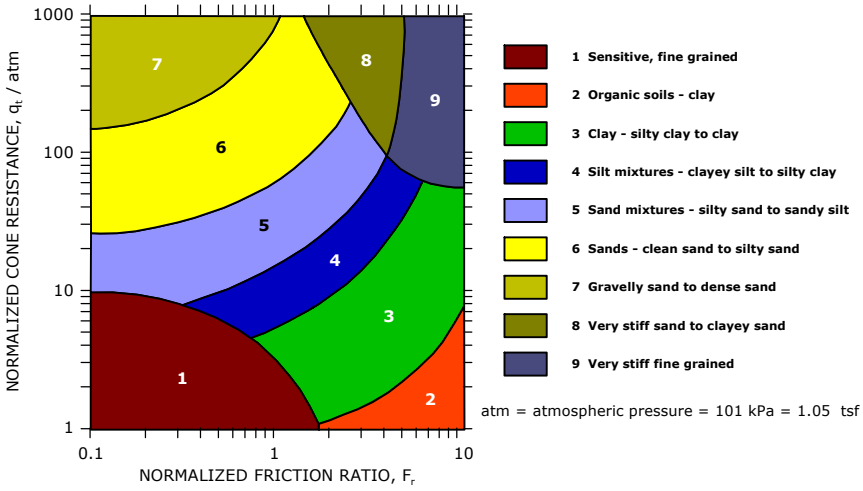
WATER LEVEL

The groundwater level at the CPT location is used to normalize the measurements for vertical overburden pressures and as a result influences the normalized soil behavior type classification and correlated soil parameters. The water level may either be "measured" or "estimated:"
Measured - Depth to water directly measured in the field
Estimated - Depth to water interpolated by the practitioner using pore pressure measurements in coarse grained soils and known site conditions
While groundwater levels displayed as "measured" more accurately represent site conditions at the time of testing than those "estimated," in either case the groundwater should be further defined prior to construction as groundwater level variations will occur over time.

CONE PENETRATION SOIL BEHAVIOR TYPE

The estimated stratigraphic profiles included in the CPT logs are based on relationships between corrected tip resistance (q_t), friction resistance (f_s), and porewater pressure (u_2). The normalized friction ratio (F_r) is used to classify the soil behavior type.

Typically, silts and clays have high F_r values and generate large excess penetration porewater pressures; sands have lower F_r's and do not generate excess penetration porewater pressures. The adjacent graph (Robertson *et al.*) presents the soil behavior type correlation used for the logs. This normalized SBT chart, generally considered the most reliable, does not use pore pressure to determine SBT due to its lack of repeatability in onshore CPTs.



atm = atmospheric pressure = 101 kPa = 1.05 tsf

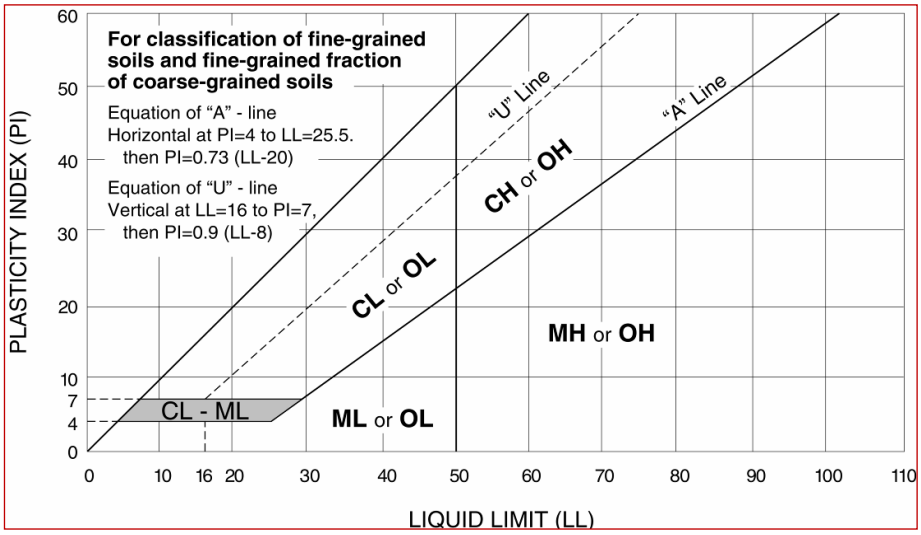
REFERENCES

Kulhawy, F.H., Mayne, P.W., (1997). "Manual on Estimating Soil Properties for Foundation Design," Electric Power Research Institute, Palo Alto, CA.
Mayne, P.W., (2013). "Geotechnical Site Exploration in the Year 2013," Georgia Institue of Technology, Atlanta, GA.
Robertson, P.K., Cabal, K.L. (2012). "Guide to Cone Penetration Testing for Geotechnical Engineering," Signal Hill, CA.
Schmertmann, J.H., (1970). "Static Cone to Compute Static Settlement over Sand,"*Journal of the Soil Mechanics and Foundations Division*,96(SM3), 1011-1043.

Unified Soil Classification System

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification	
				Group Symbol	Group Name [B]
Coarse-Grained Soils: More than 50% retained on No. 4 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	Cu≥4 and 1≤Cc≤3 [E]	GW	Well-graded gravel [F]
			Cu<4 and/or [Cc<1 or Cc>3.0] [E]	GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	Cu≥6 and 1≤Cc≤3 [E]	SW	Well-graded sand [I]
			Cu<6 and/or [Cc<1 or Cc>3.0] [E]	SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G, H, I]
			Fines classify as CL or CH	SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots above "A" line [J]	CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]	ML	Silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OL	Organic clay [K, L, M, N]
					Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line	CH	Fat clay [K, L, M]
			PI plots below "A" line	MH	Elastic silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OH	Organic clay [K, L, M, P]
					Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve.
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.
[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.
[E] $Cu = D_{60}/D_{10}$ $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
[F] If soil contains ≥ 15% sand, add "with sand" to group name.
[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[H] If fines are organic, add "with organic fines" to group name.
[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.
[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.
[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.
[N] PI ≥ 4 and plots on or above "A" line.
[O] PI < 4 or plots below "A" line.
[P] PI plots on or above "A" line.
[Q] PI plots below "A" line.



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Terracon Consultants, Inc.
Ran By: VGP
Approved By: CVM
March 1, 2024

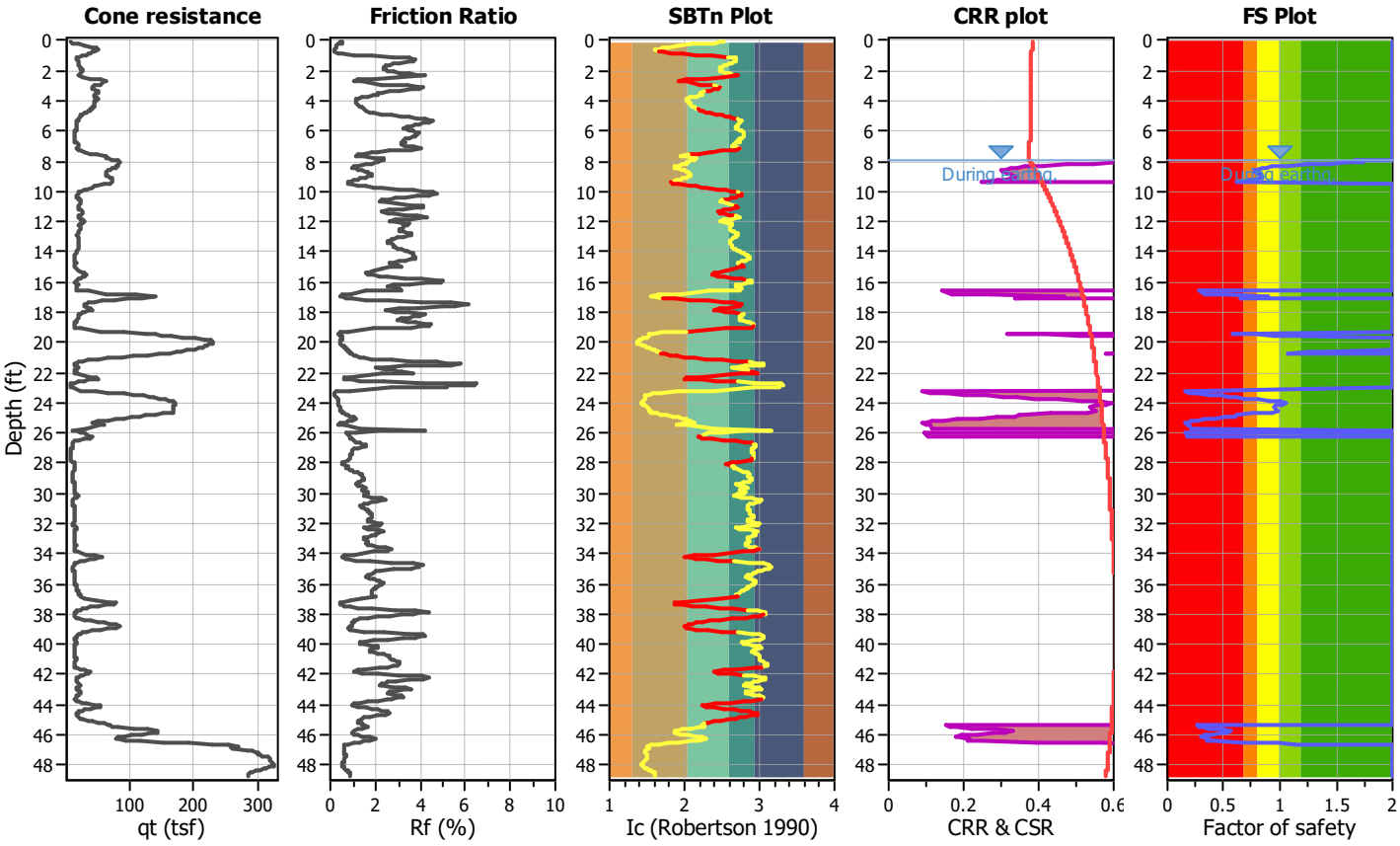
LIQUEFACTION ANALYSIS REPORT

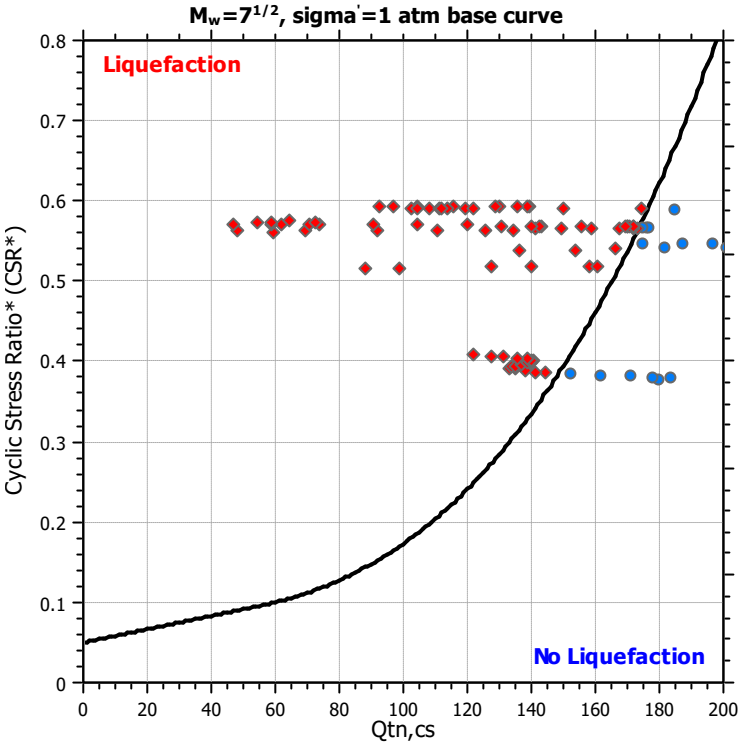
Project title : JUB - GHID Anderson WTP **Location : West Valley City, Utah**

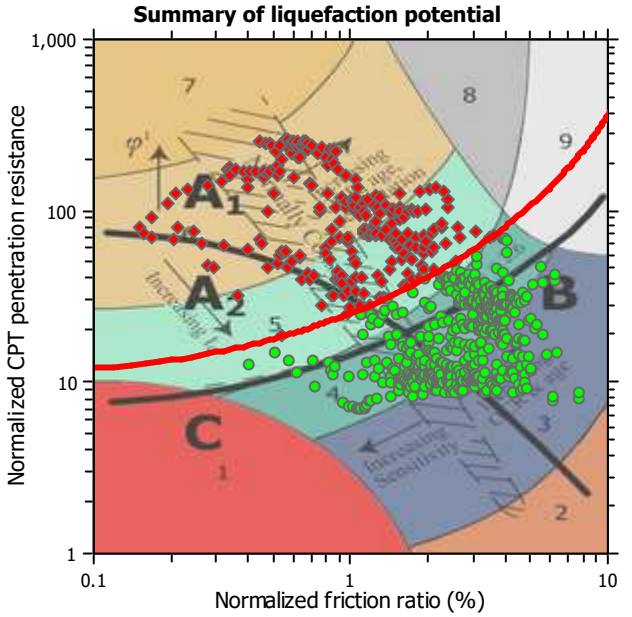
CPT file : CPT-1

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	7.91 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	7.91 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	50.00 ft
Earthquake magnitude M_w:	7.00	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.70	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

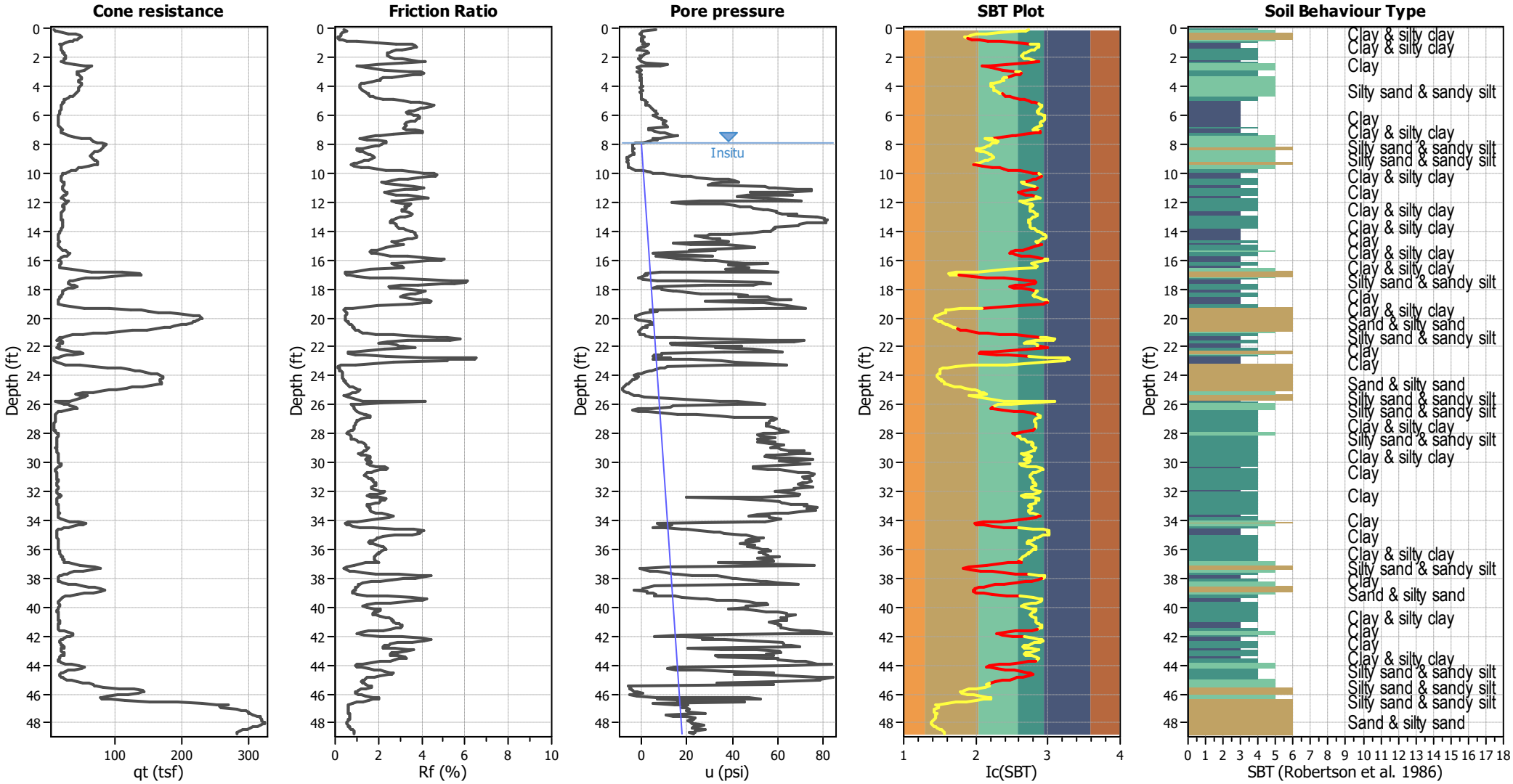






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



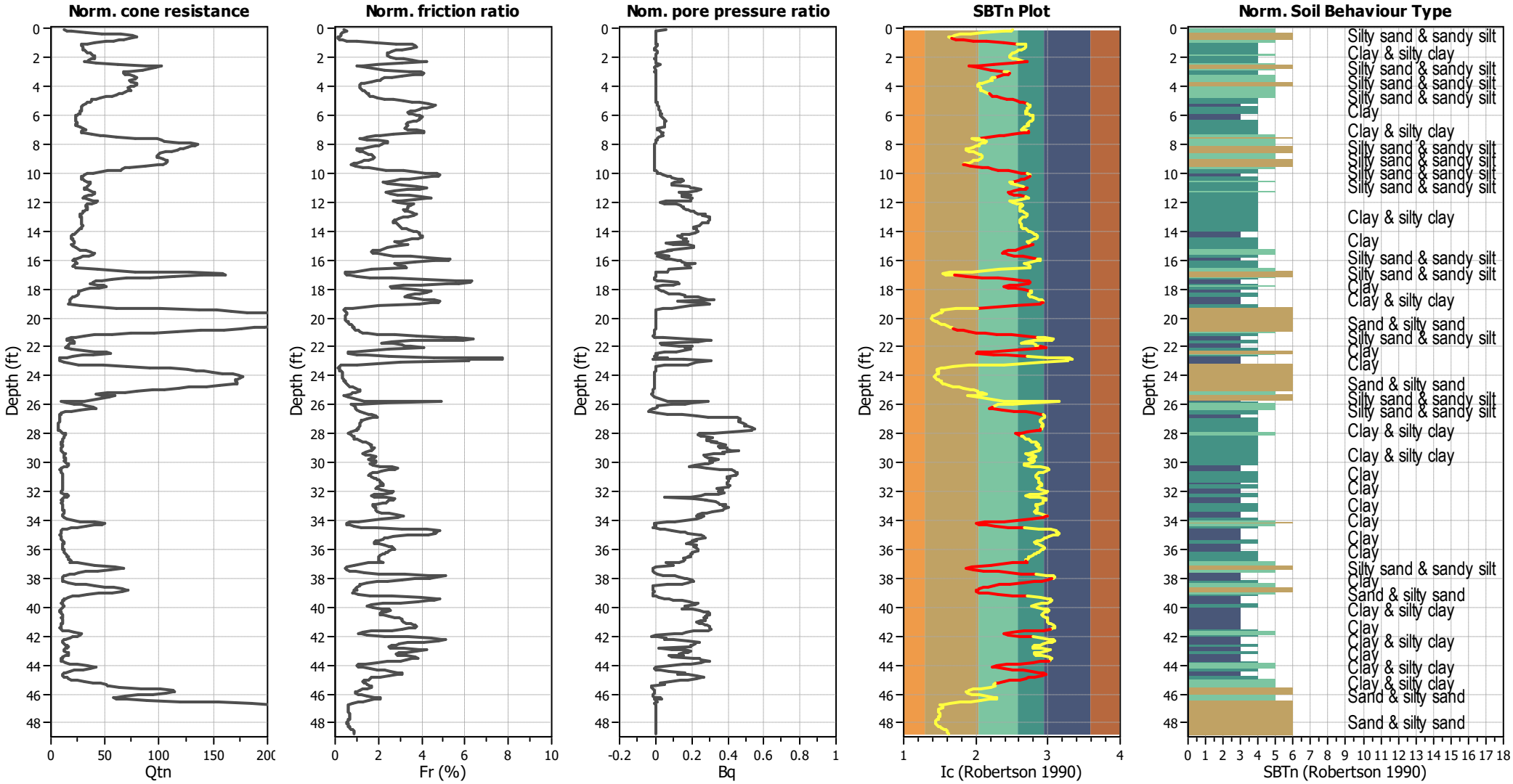
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	7.91 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.40	K_σ applied:	Yes
Earthquake magnitude M_w:	7.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	7.91 ft	Fill height:	N/A	Limit depth:	50.00 ft

SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

CPT basic interpretation plots (normalized)



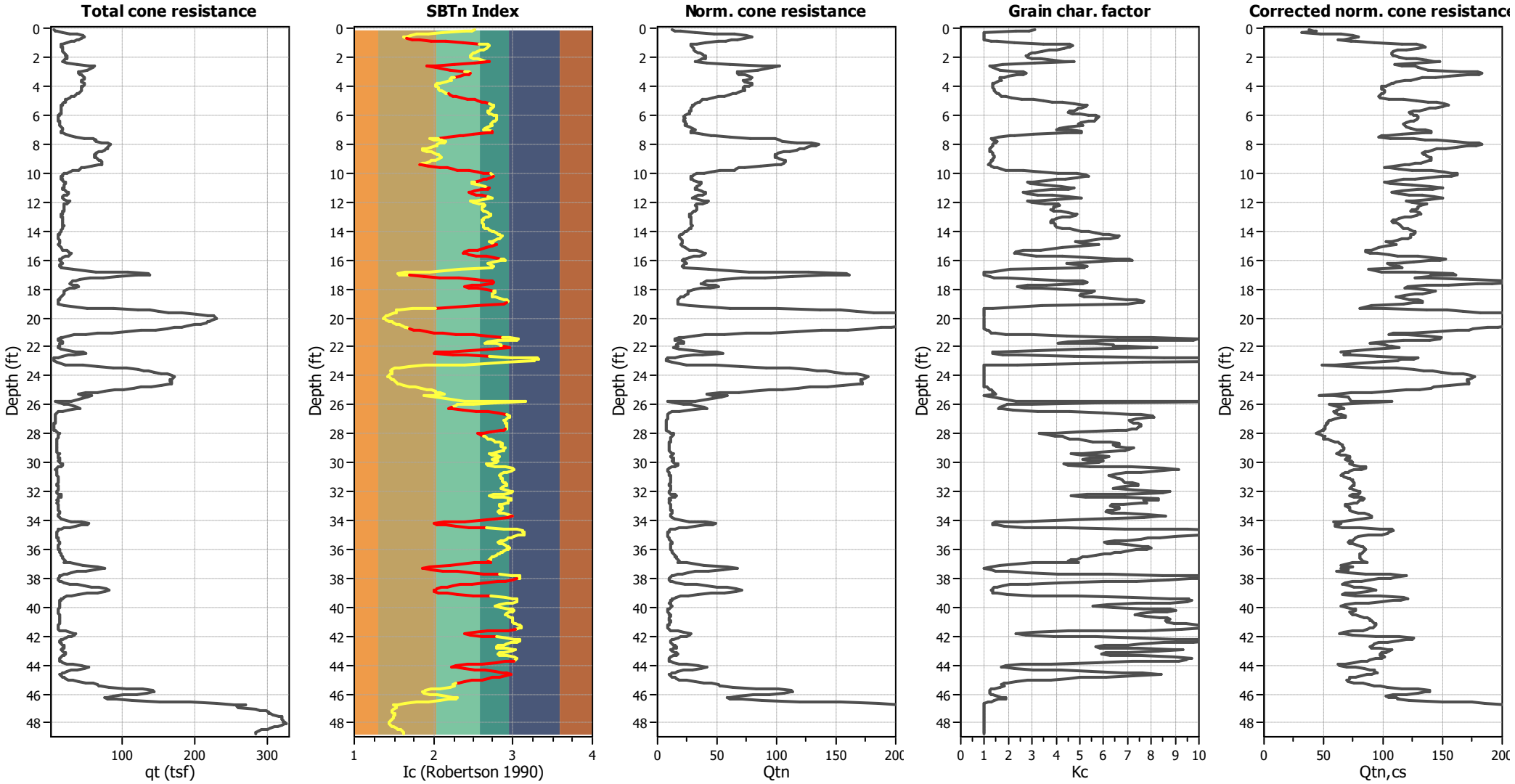
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	7.91 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.40	K_σ applied:	Yes
Earthquake magnitude M_w:	7.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	7.91 ft	Fill height:	N/A	Limit depth:	50.00 ft

SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

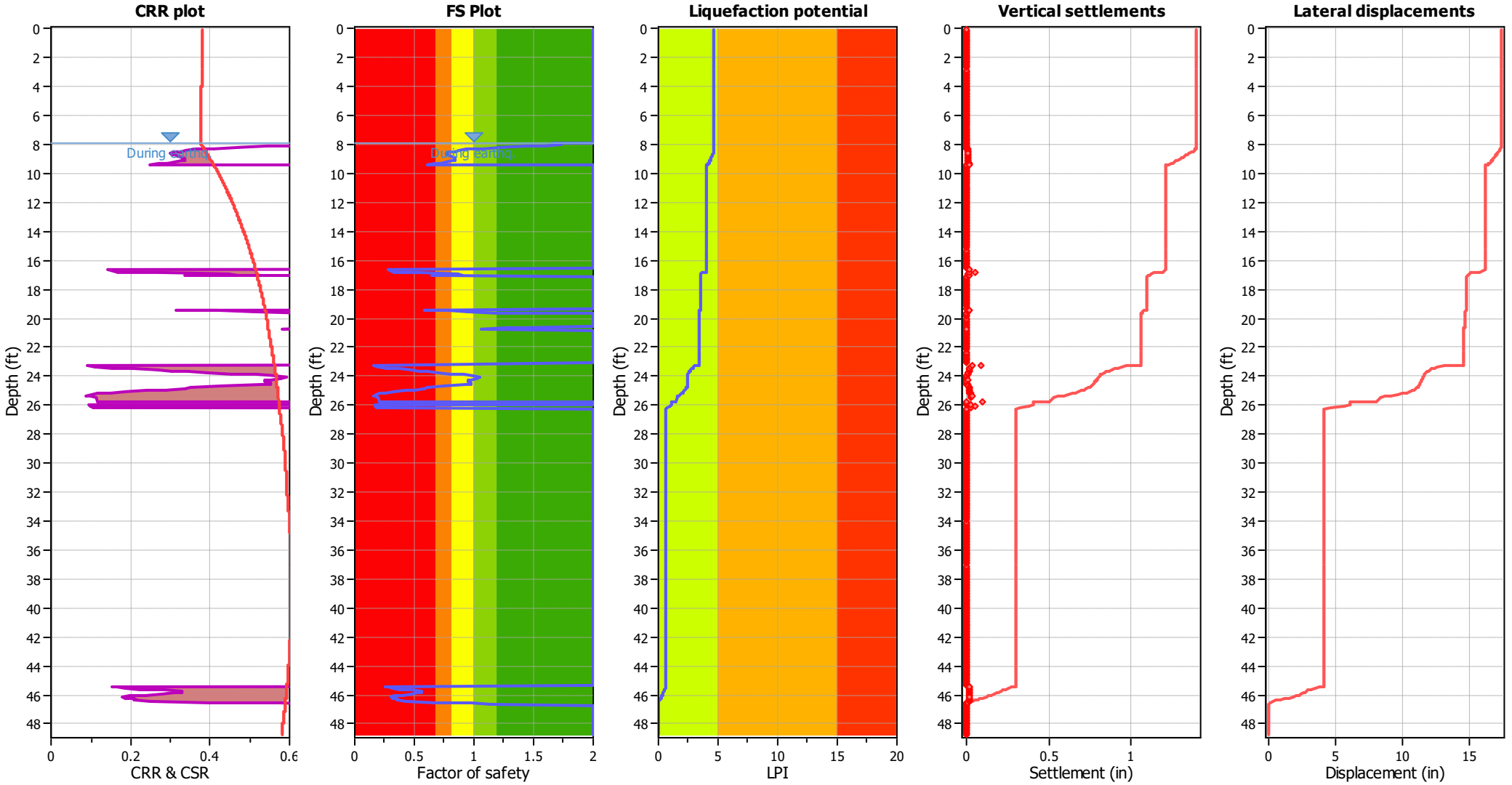
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	7.91 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.40	K_σ applied:	Yes
Earthquake magnitude M_w:	7.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	7.91 ft	Fill height:	N/A	Limit depth:	50.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	7.91 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.40	K_σ applied:	Yes
Earthquake magnitude M_w:	7.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	7.91 ft	Fill height:	N/A	Limit depth:	50.00 ft

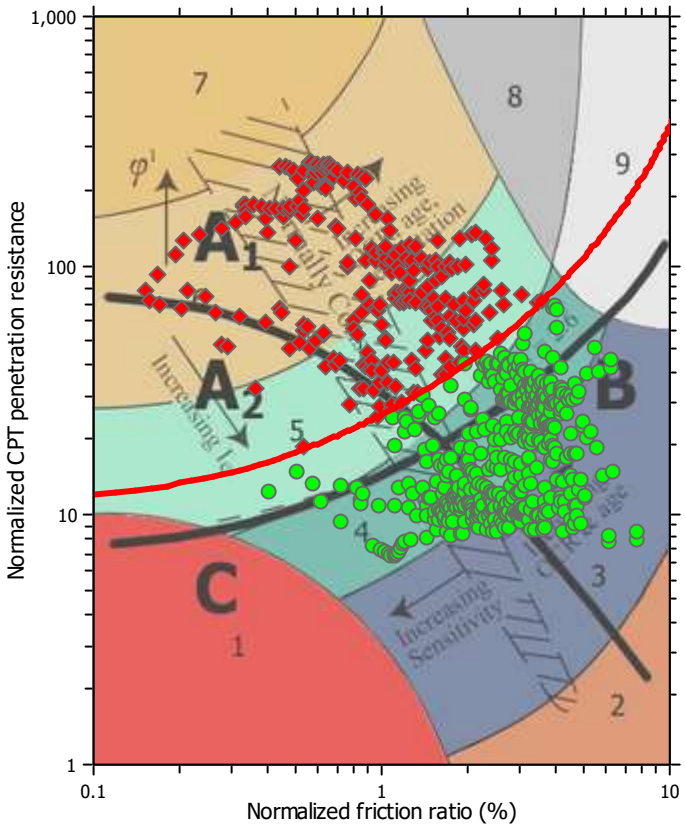
F.S. color scheme

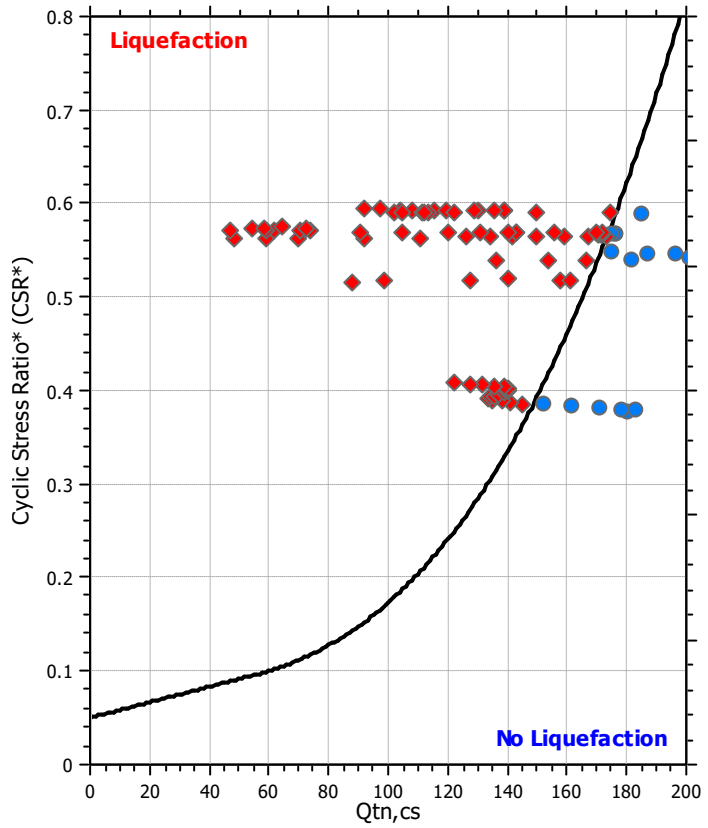
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

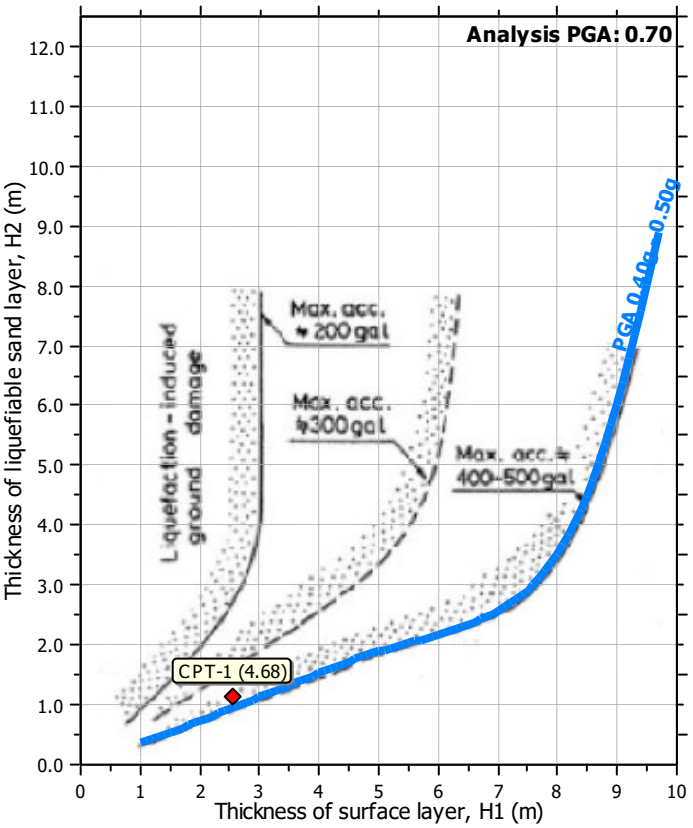
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



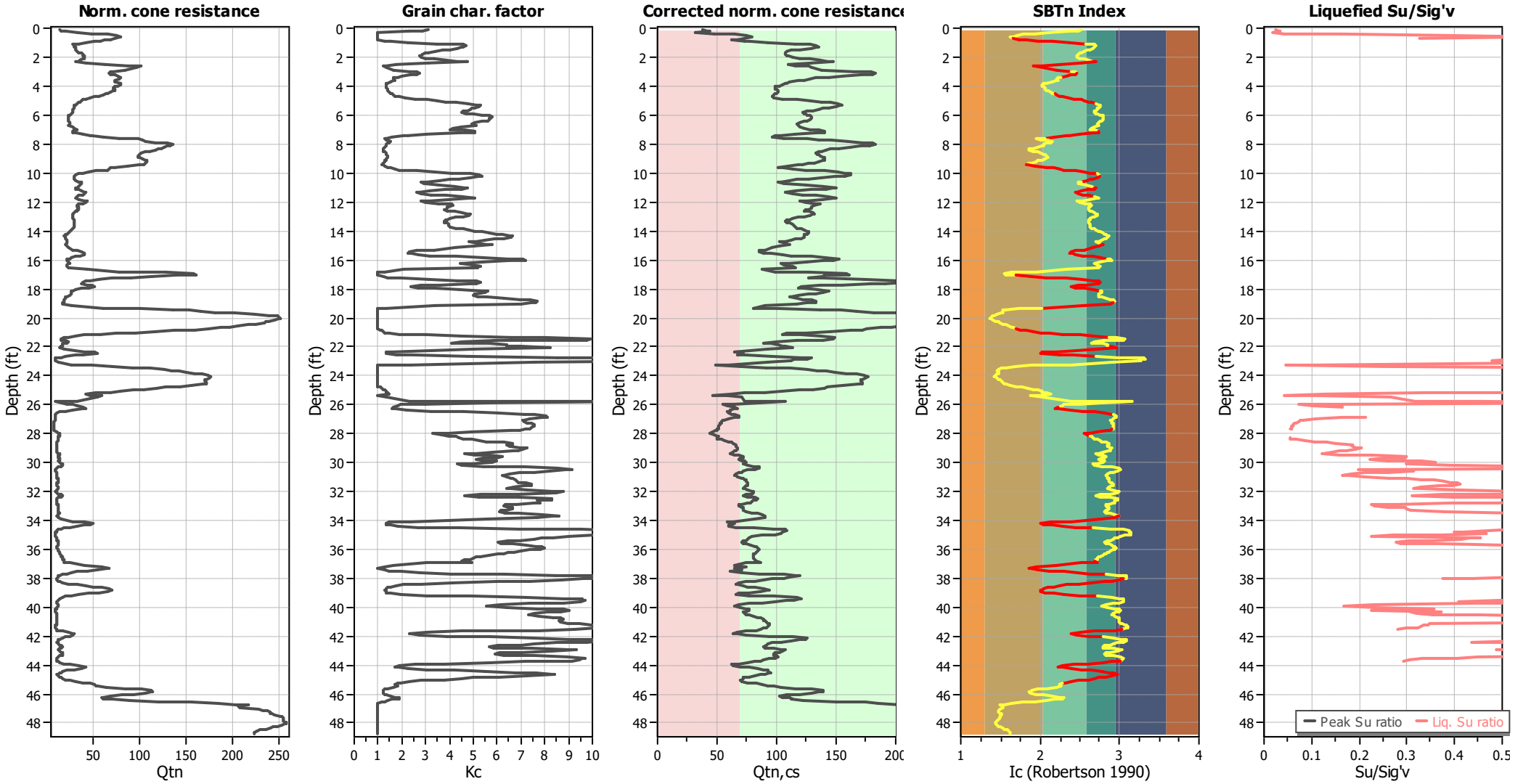




Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	7.91 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.40	K_σ applied:	Yes
Earthquake magnitude M_w:	7.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	7.91 ft	Fill height:	N/A	Limit depth:	50.00 ft

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

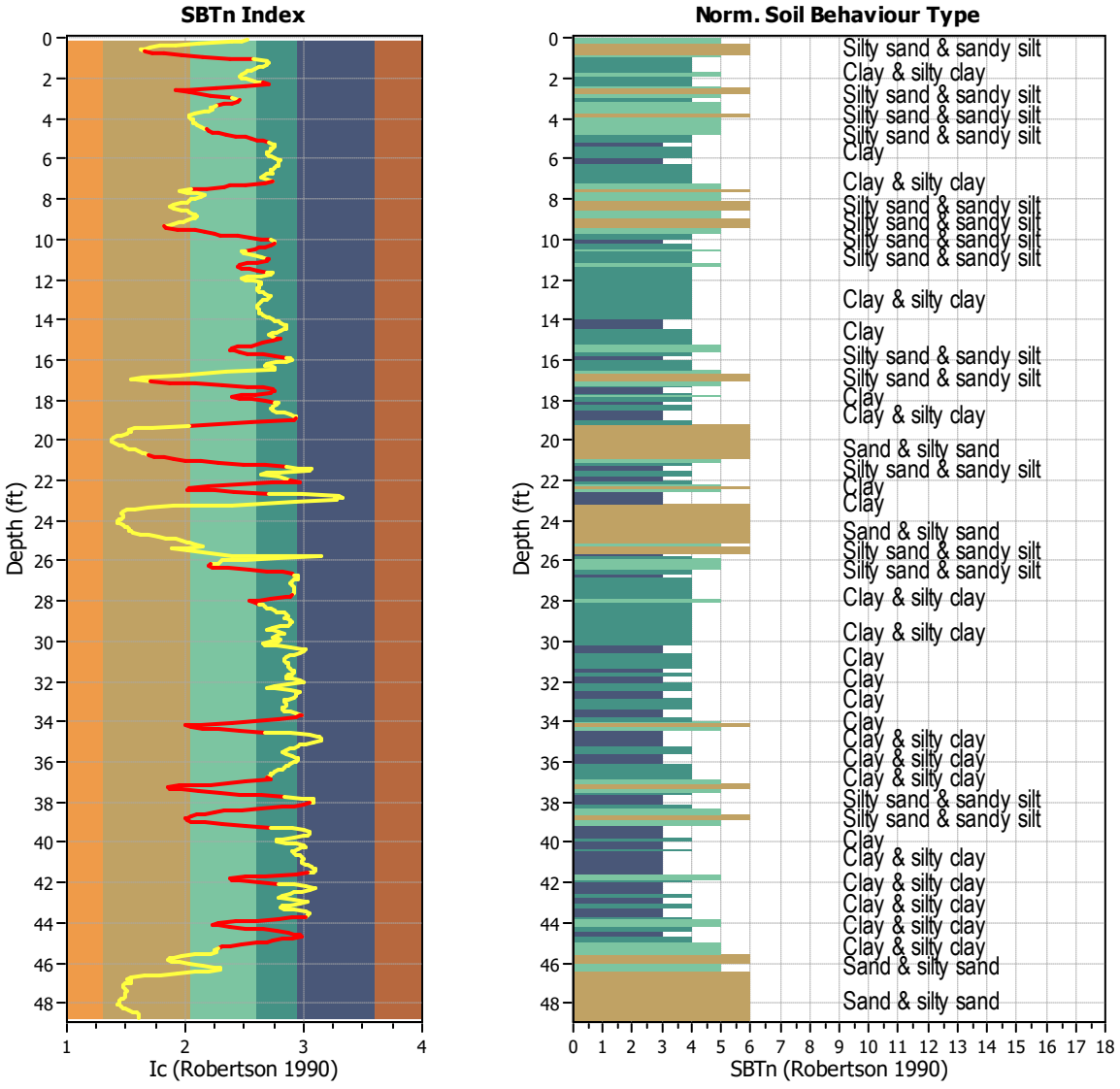
Analysis method:	NCEER (1998)	Depth to water table (erthq.):	7.91 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.40	K_σ applied:	Yes
Earthquake magnitude M_w:	7.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	7.91 ft	Fill height:	N/A	Limit depth:	50.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

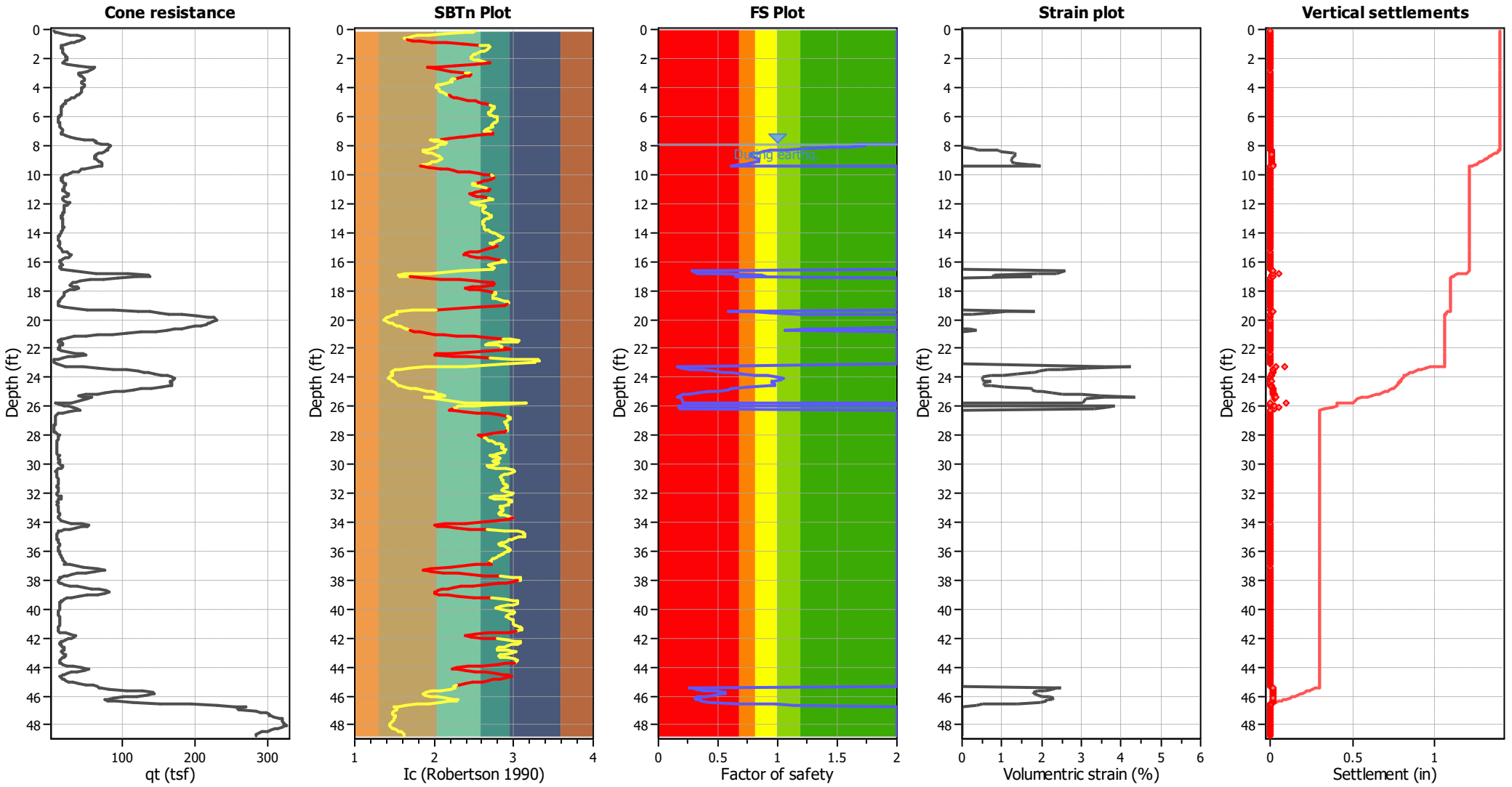
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.



Transition layer algorithm properties		General statistics	
I_c minimum check value:	1.70	Total points in CPT file:	719
I_c maximum check value:	3.00	Total points excluded:	224
I_c change ratio value:	0.0250	Exclusion percentage:	31.15%
Minimum number of points in layer:	4	Number of layers detected:	33

Estimation of post-earthquake settlements

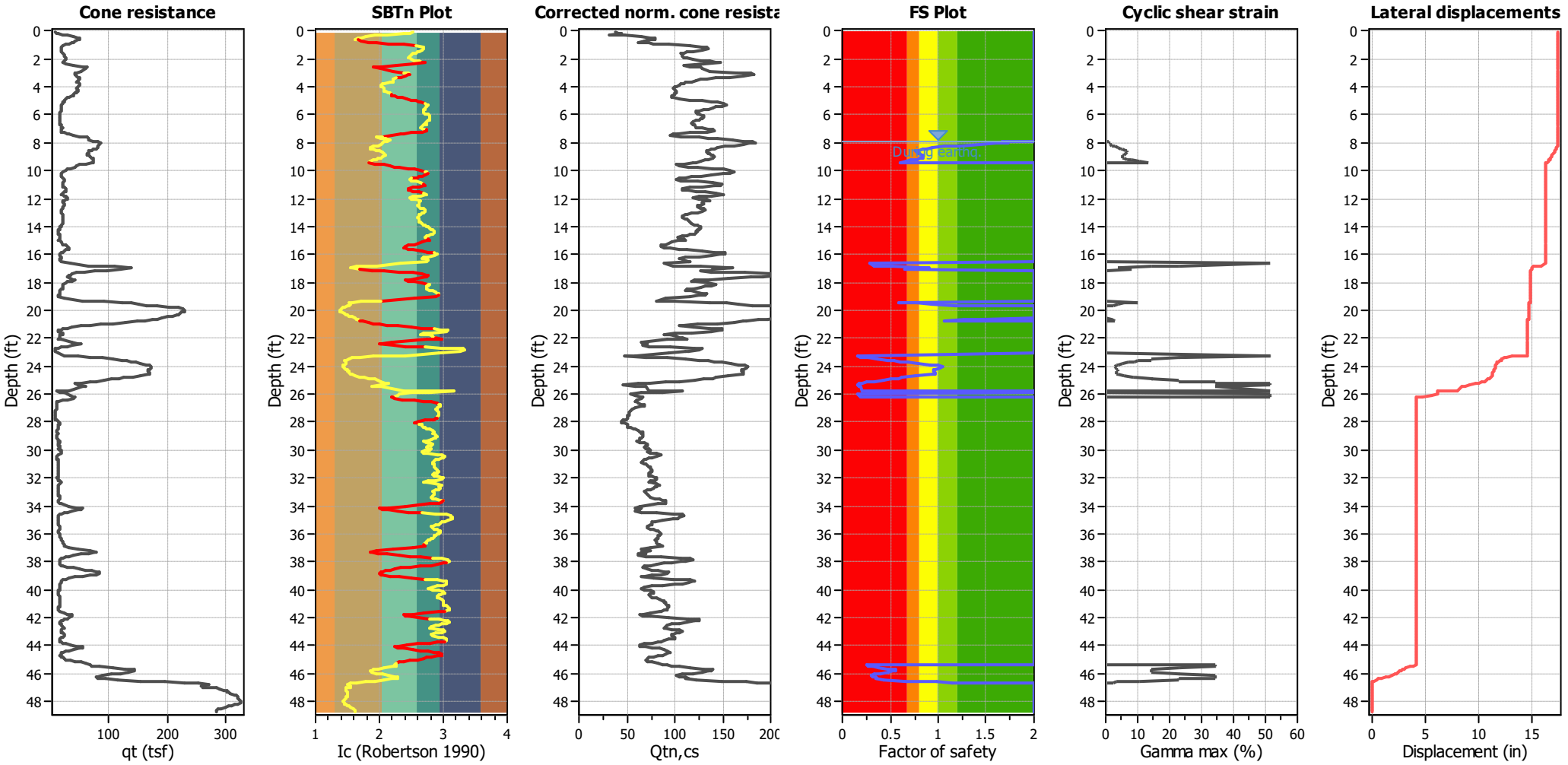


Abbreviations

q_t:	Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c:	Soil Behaviour Type Index
FS:	Calculated Factor of Safety against liquefaction
Volumentric strain:	Post-liquefaction volumentric strain

Estimation of post-earthquake lateral Displacements

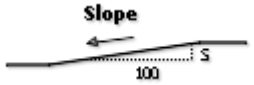
Geometric parameters: Gently sloping ground without free face (Slope 1.00 %)



Abbreviations

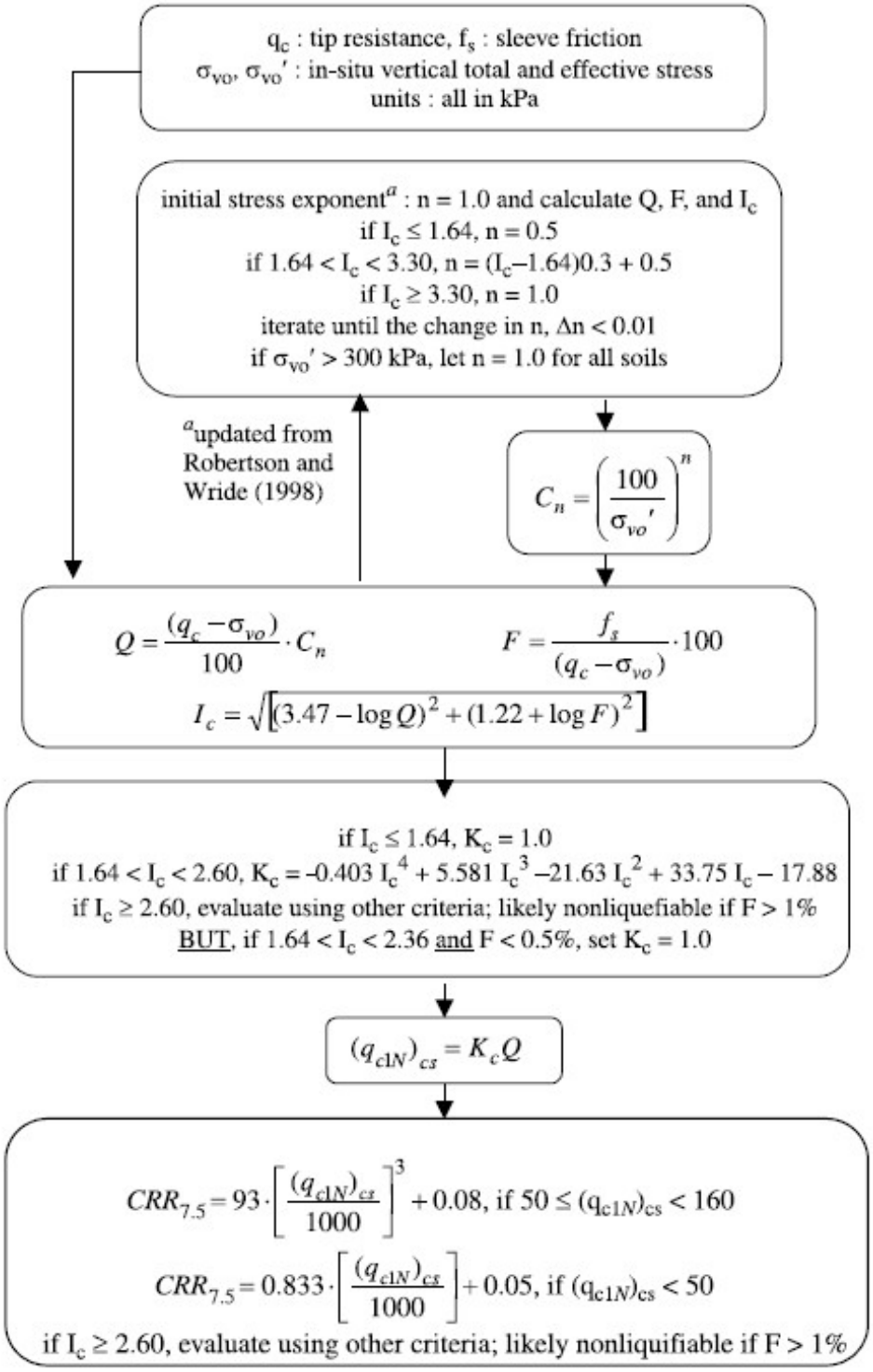
q_t: Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c: Soil Behaviour Type Index
$Q_{tn,cs}$: Equivalent clean sand normalized CPT total cone resistance
F.S.: Factor of safety
γ_{max}: Maximum cyclic shear strain
LDI: Lateral displacement index

Surface condition



Procedure for the evaluation of soil liquefaction resistance, NCEER (1998)

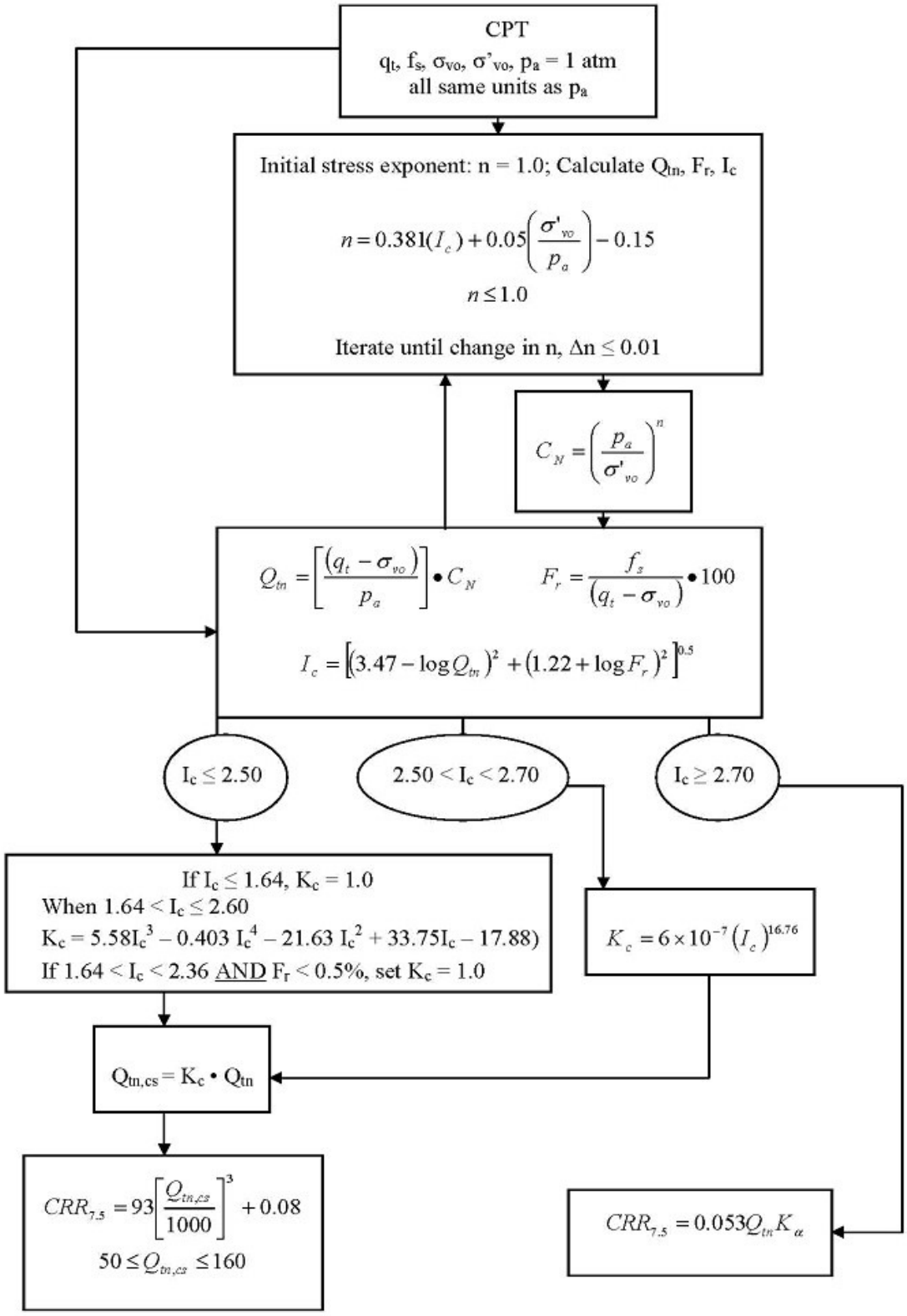
Calculation of soil resistance against liquefaction is performed according to the Robertson & Wride (1998) procedure. The procedure used in the software, slightly differs from the one originally published in NCEER-97-0022 (Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils). The revised procedure is presented below in the form of a flowchart[1]:



[1] "Estimating liquefaction-induced ground settlements from CPT for level ground", G. Zhang, P.K. Robertson, and R.W.I. Brachman

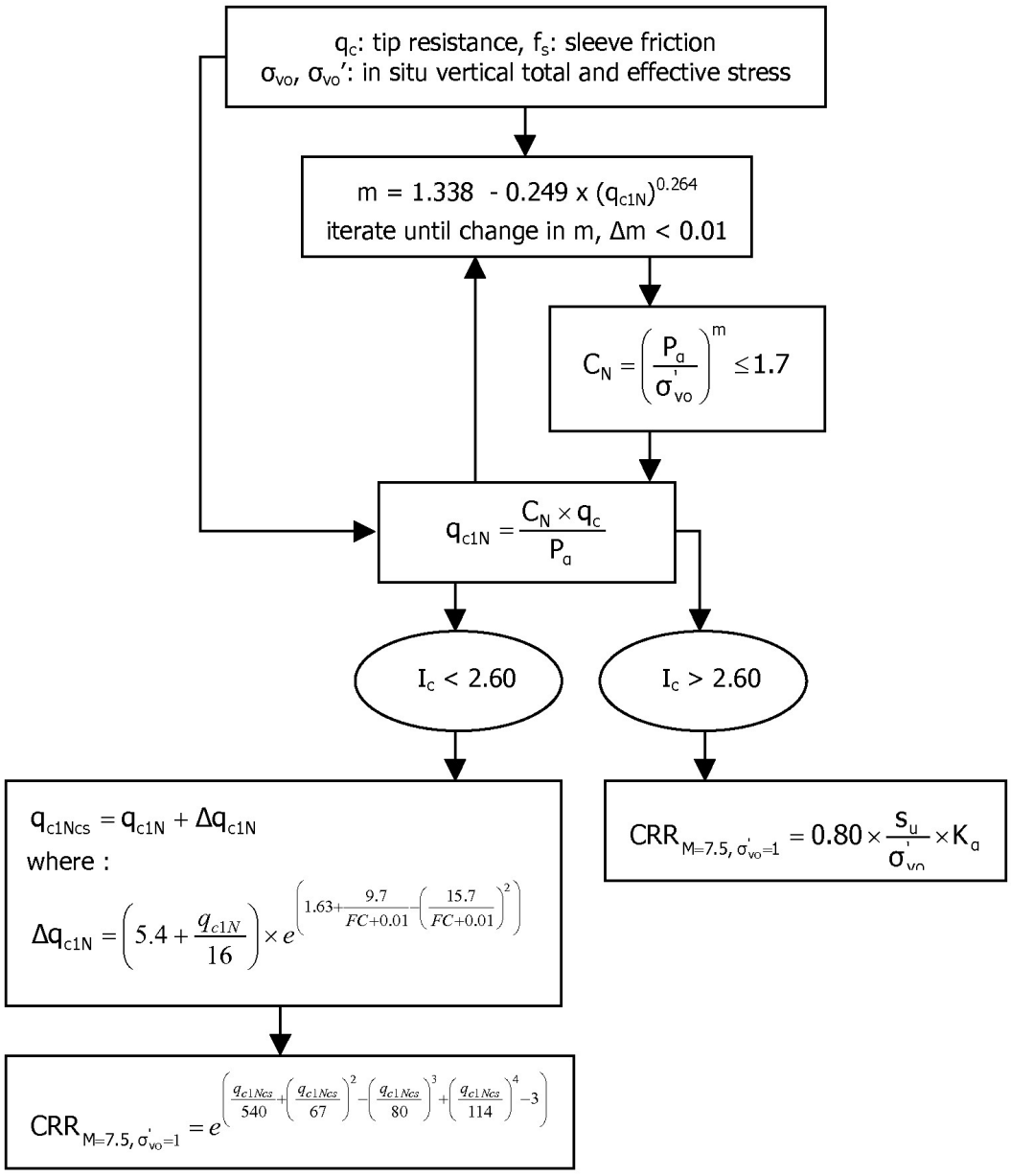
Procedure for the evaluation of soil liquefaction resistance (all soils), Robertson (2010)

Calculation of soil resistance against liquefaction is performed according to the Robertson & Wride (1998) procedure. This procedure used in the software, slightly differs from the one originally published in NCEER-97-0022 (Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils). The revised procedure is presented below in the form of a flowchart[1]:

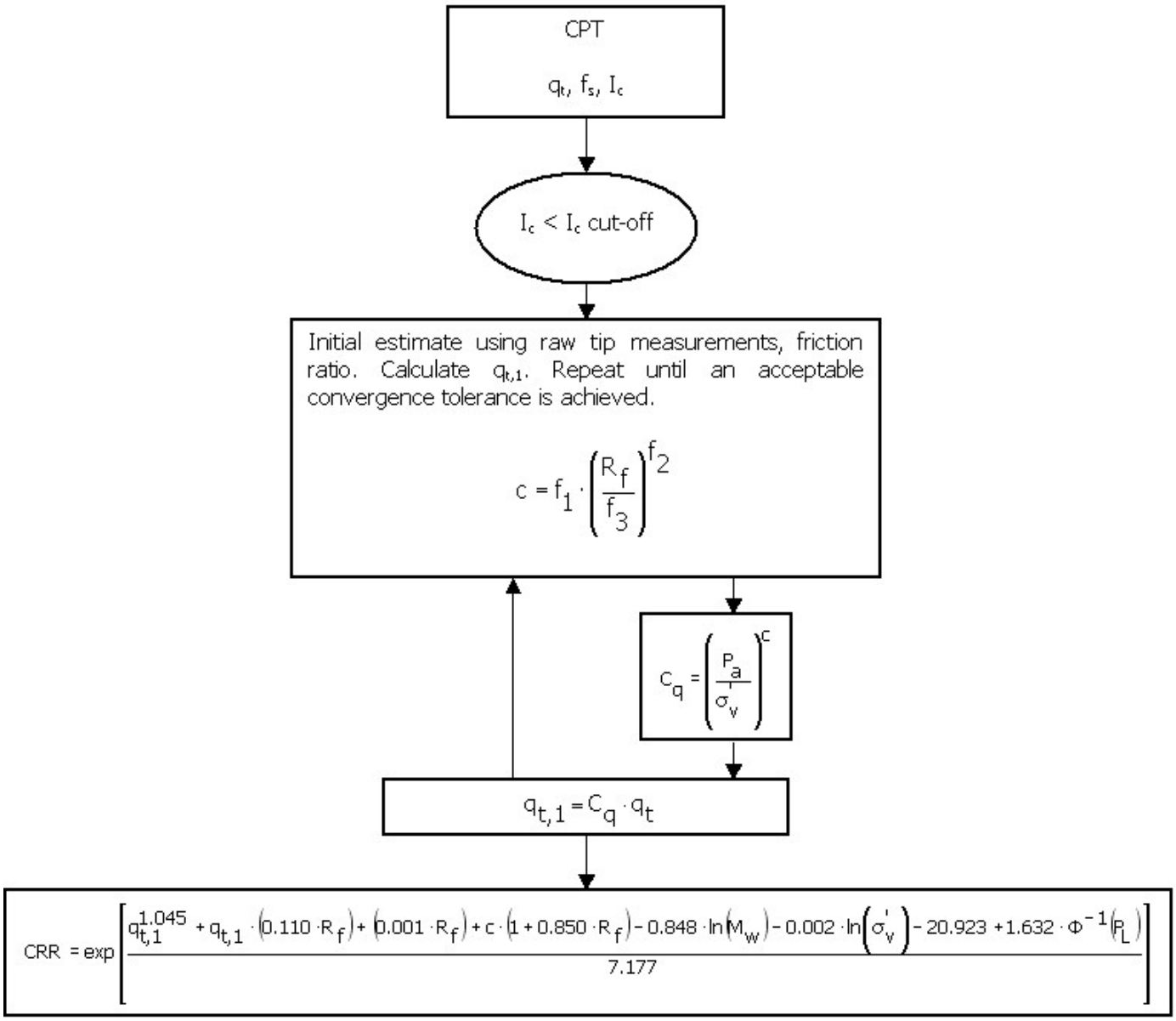


[1] P.K. Robertson, 2009. "Performance based earthquake design using the CPT", Keynote Lecture, International Conference on Performance-based Design in Earthquake Geotechnical Engineering – from case history to practice, IS-Tokyo, June 2009

Procedure for the evaluation of soil liquefaction resistance, Idriss & Boulanger (2008)



Procedure for the evaluation of soil liquefaction resistance (sandy soils), Moss et al. (2006)



Procedure for the evaluation of soil liquefaction resistance, Boulanger & Idriss(2014)

$$FS_{liq} = \frac{CRR_{M=7.5,\sigma'_v=1atm}}{CSR_{M=7.5,\sigma'_v=1atm}}$$

$$CSR_{M=7.5,\sigma'_v=1atm} = 0.65 \frac{\sigma_v}{\sigma'_v} \frac{a_{max}}{g} r_d \frac{1}{MSF} \frac{1}{K_\sigma}$$

$$r_d = \exp\left[\alpha(z) + \beta(z) \cdot M\right]$$

$$\alpha(z) = -1.012 - 1.126 \sin\left(\frac{z}{11.73} + 5.133\right)$$

$$\beta(z) = 0.106 + 0.118 \sin\left(\frac{z}{11.28} + 5.142\right)$$

$$K_\sigma = 1 - C_\sigma \ln\left(\frac{\sigma'_v}{P_a}\right) \le 1.1$$

$$C_\sigma = \frac{1}{37.3 - 8.27\left(q_{c1Ncs}\right)^{0.264}} \le 0.3$$

$$MSF = 1 + \left(MSF_{max} - 1\right)\left(8.64 \exp\left(\frac{-M}{4}\right) - 1.325\right)$$

$$MSF_{max} = 1.09 + \left(\frac{q_{C1Ncs}}{180}\right)^3 \le 2.2$$

σ'_v *and* σ_v *at start of earthquake shaking*

$$CRR_{M=7.5,\sigma'_v=1atm} = \exp\left(\frac{q_{c1Ncs}}{113} + \left(\frac{q_{c1Ncs}}{1000}\right)^2 - \left(\frac{q_{c1Ncs}}{140}\right)^3 + \left(\frac{q_{c1Ncs}}{137}\right)^4 - 2.80\right)$$

$$q_{c1Ncs} = q_{c1N} + \Delta q_{c1N}$$

$$\Delta q_{c1N} = \left(11.9 + \frac{q_{c1N}}{14.6}\right) \exp\left(1.63 - \frac{9.7}{FC+2} - \left(\frac{15.7}{FC+2}\right)^2\right)$$

$$q_{c1N} = C_{Ne} \frac{q_c}{P_a}$$

$$C_{Ne} = \left(\frac{P_a}{\sigma'_v}\right)^m \le 1.7$$

$$m = 1.338 - 0.249\left(q_{c1Ncs}\right)^{0.264} \quad with \quad 0.264 \le m \le 0.782$$

$$FC = 80\left(I_C + C_{FC}\right) - 137 \quad with \quad 0\% \le FC \le 100\%$$

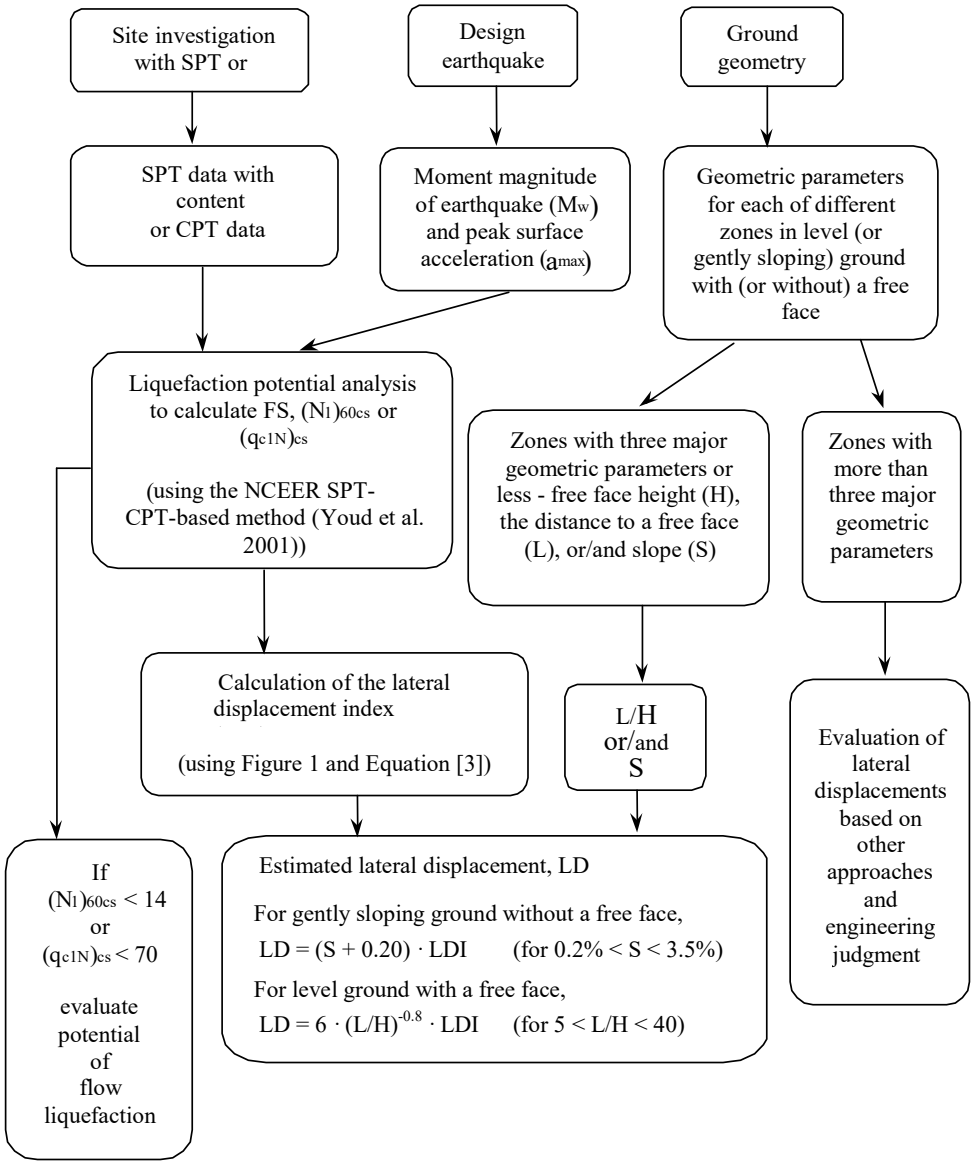
$$I_c = \left[\left(3.47 - \log\left(Q\right)\right)^2 + \left(1.22 + \log\left(F\right)\right)^2\right]^{0.5}$$

$$Q = \left(\frac{q_c - \sigma_{vc}}{P_a}\right)\left(\frac{P_a}{\sigma'_{vc}}\right)^n \; with \; 0.5 \le n \le 1.0 \; per \; Robertson \; \& \; Wride \; (1998)$$

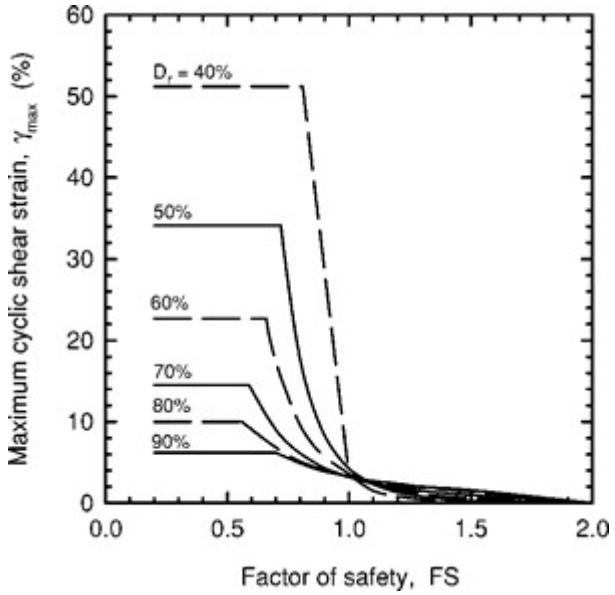
$$F = \left(\frac{f_s}{q_c - \sigma_{vc}}\right) \cdot 100\%$$

σ'_v *at time of CPT sounding*

Procedure for the evaluation of liquefaction-induced lateral spreading displacements



[1] Flow chart illustrating major steps in estimating liquefaction-induced lateral spreading displacements using the proposed approach



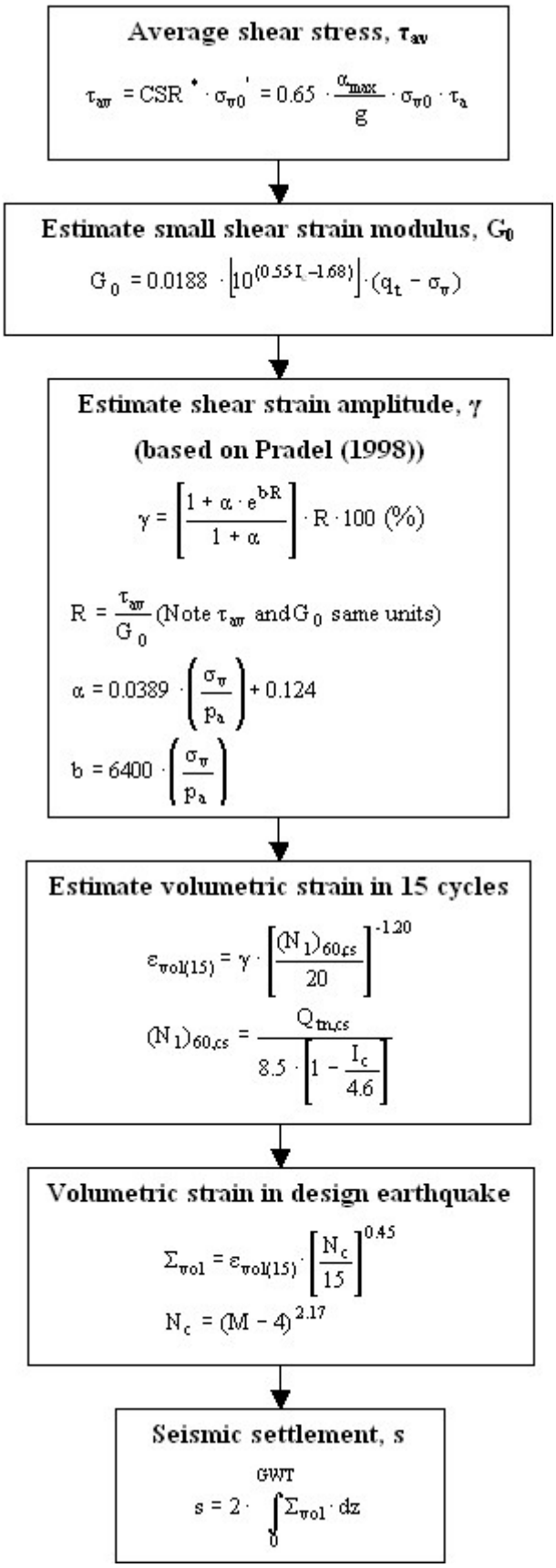
[1] **Figure 1**

$$LDI = \int_0^{z_{max}} \gamma_{max} dz$$

[1] **Equation [3]**

[1] "Estimating liquefaction-induced ground settlements from CPT for level ground", G. Zhang, P.K. Robertson, and R.W.I. Brachman

Procedure for the estimation of seismic induced settlements in dry sands



Robertson, P.K. and Lisheng, S., 2010, "Estimation of seismic compression in dry soils using the CPT" FIFTH INTERNATIONAL CONFERENCE ON RECENT ADVANCES IN GEOTECHNICAL EARTHQUAKE ENGINEERING AND SOIL DYNAMICS, Symposium in honor of professor I. M. Idriss, San Diego, CA

Liquefaction Potential Index (LPI) calculation procedure

Calculation of the Liquefaction Potential Index (LPI) is used to interpret the liquefaction assessment calculations in terms of severity over depth. The calculation procedure is based on the methology developed by Iwasaki (1982) and is adopted by AFPS.

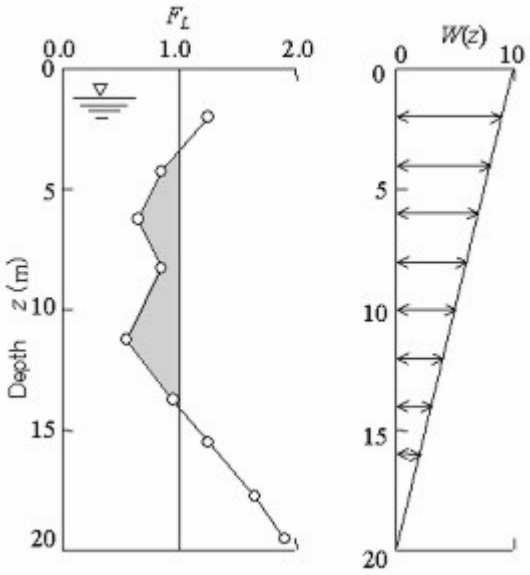
To estimate the severity of liquefaction extent at a given site, LPI is calculated based on the following equation:

$$\mathbf{LPI} = \int_0^{20} (10 - 0{,}5z) \times F_L \times dz$$

where:
F_L = 1 - F.S. when F.S. less than 1
F_L = 0 when F.S. greater than 1
z depth of measurment in meters

Values of LPI range between zero (0) when no test point is characterized as liquefiable and 100 when all points are characterized as susceptible to liquefaction. Iwasaki proposed four (4) discrete categories based on the numeric value of LPI:

- LPI = 0 : Liquefaction risk is very low
- 0 < LPI <= 5 : Liquefaction risk is low
- 5 < LPI <= 15 : Liquefaction risk is high
- LPI > 15 : Liquefaction risk is very high



Graphical presentation of the LPI calculation procedure

Shear-Induced Building Settlement (Ds) calculation procedure

The shear-induced building settlement (Ds) due to liquefaction below the building can be estimated using the relationship developed by Bray and Macedo (2017):

$$Ln(Ds) = c1 + c2 * LBS + 0.58 * Ln\left(Tanh\left(\frac{HL}{6}\right)\right) + 4.59 * Ln(Q) - 0.42 * Ln(Q)^2 - 0.02 * B + 0.84 * Ln(CAVdp) + 0.41 * Ln(Sa1) + \varepsilon$$

where Ds is in the units of mm, c1= -8.35 and c2= 0.072 for LBS ≤ 16, and c1= -7.48 and c2= 0.014 otherwise. Q is the building contact pressure in units of kPa, HL is the cumulative thickness of the liquefiable layers in the units of m, B is the building width in the units of m, CAVdp is a standardized version of the cumulative absolute velocity in the units of g-s, Sa1 is 5%-damped pseudo-acceleration response spectral value at a period of 1 s in the units of g, and ε is a normal random variable with zero mean and 0.50 standard deviation in Ln units. The liquefaction-induced building settlement index (LBS) is:

$$LBS = \sum W * \frac{\varepsilon_{shear}}{z} dz$$

where z (m) is the depth measured from the ground surface > 0, W is a foundation-weighting factor wherein W = 0.0 for z less than Df, which is the embedment depth of the foundation, and W = 1.0 otherwise. The shear strain parameter (ε_shear) is the liquefaction-induced free-field shear strain (in %) estimated using Zhang et al. (2004). It is calculated based on the estimated Dr of the liquefied soil layer and the calculated safety factor against liquefaction triggering (FSL).

References

- Lunne, T., Robertson, P.K., and Powell, J.J.M 1997. Cone penetration testing in geotechnical practice, E & FN Spon Routledge, 352 p, ISBN 0-7514-0393-8.
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TEST HOLE DATA REPORT

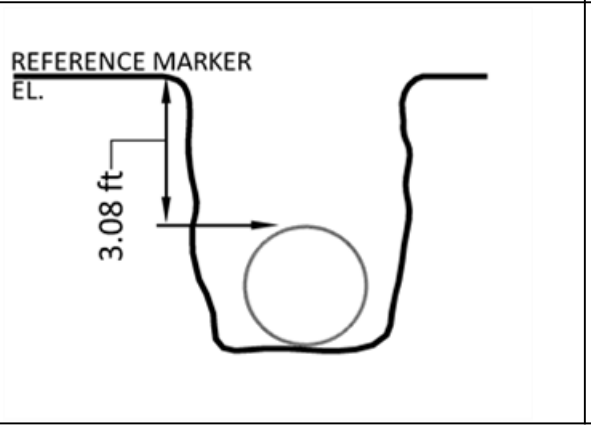
TEST HOLE NO:	1A	CLIENT TEST HOLE NO:	1
TEST HOLE DATE:	3/14/2024	SUE CREW/TRUCK NO:	JV MR/551081
PROJECT NO:	UT07400200	CITY,COUNTY:	WEST VALLEY CITY, SALT LAKE
CLIENT:	JUB	LOCATION/INTERSECTION:	
PROJECT:	GRANGER-HUNTER IMPROVEMENT DISTRICT		2320 S & LITTLE OAK DR

T2 utility engineers
150 Capital Drive Suite 190
Golden, Colorado 80401
TEL:720.452.1090
www.T2ue.com

MAP

SITE PHOTO - FACING EAST

CROSS SECTION - NOT TO SCALE



TEST HOLE - UTILITY - FACING NORTH

DISCLAIMER: ADDITIONAL MATERIAL AND/OR UTILITIES MAY EXIST BELOW APPARENT BOTTOM

UTILITY DESCRIPTION		**REFERENCE MARKER**	
UTILITY TYPE	WATER MAIN	NORTHING	-
UTILITY MATERIAL	METALLIC (IRON, STEEL, COATED)	EASTING	-
UTILITY DIRECTION	EAST - WEST	ELEVATION	-
UTILITY WIDTH (FIELD)	24.00"	LOCATION	CENTER OF UTILITY
UTILITY WIDTH (RECORD)	-	MARKED BY	NAIL & DISK
APPARENT UTILITY OWNER	UNK		
DEPTH FROM REFERENCE MARKER			
TOP OF UTILITY	3.04'		
BOTTOM OF UTILITY	-		
ELEVATION OF UTILITY			
TOP OF UTILITY	-		
APPARENT BOTTOM OF UTILITY	-		
SURFACE			
TYPE	ASPHALT		
THICKNESS	4.00"		

REMARKS:

FOUND 24" WATER LINE.

REVISION NOTES:

REVIEWED DATE:	CHECKED DATE:	REVISION DATE:
REVIEWED BY:	CHECKED BY:	

TEST HOLE DATA REPORT

TEST HOLE NO:	1B	CLIENT TEST HOLE NO:	1
TEST HOLE DATE:	3/8/2024	SUE CREW/TRUCK NO:	KI CA/55620
PROJECT NO:	UT07400200	CITY,COUNTY:	WEST VALLEY CITY, SALT LAKE
CLIENT:	JUB	LOCATION/INTERSECTION:	
PROJECT:	GRANGER-HUNTER IMPROVEMENT DISTRICT		2320 S & LITTLE OAK DR

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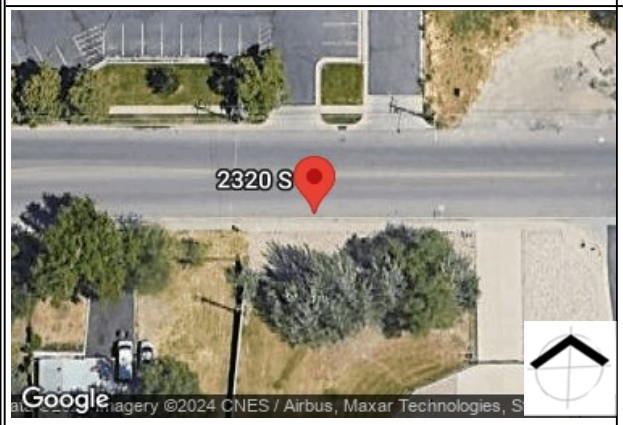
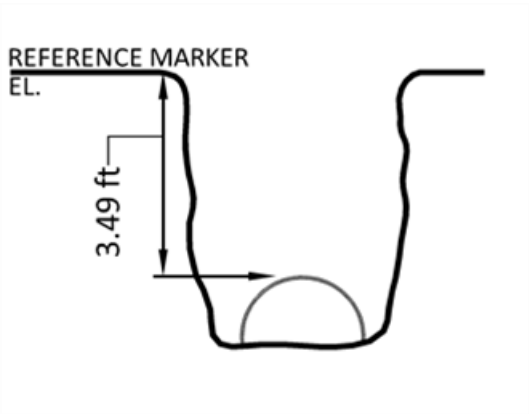
MAP



SITE PHOTO - FACING NORTH

CROSS SECTION - NOT TO SCALE



TEST HOLE - UTILITY - FACING NORTH

DISCLAIMER: ADDITIONAL MATERIAL AND/OR UTILITIES MAY EXIST BELOW APPARENT BOTTOM

UTILITY DESCRIPTION		**REFERENCE MARKER**	
UTILITY TYPE	UNKNOWN	NORTHING	-
UTILITY MATERIAL	METALLIC (IRON, STEEL, COATED)	EASTING	-
UTILITY DIRECTION	EAST - WEST	ELEVATION	-
UTILITY WIDTH (FIELD)	8.00"	LOCATION	CENTER OF UTILITY
UTILITY WIDTH (RECORD)	24"	MARKED BY	NAIL & DISK
APPARENT UTILITY OWNER	PLANS		
DEPTH FROM REFERENCE MARKER			
TOP OF UTILITY	3.49'		
BOTTOM OF UTILITY	-		
ELEVATION OF UTILITY			
TOP OF UTILITY	-		
APPARENT BOTTOM OF UTILITY	-		
SURFACE			
TYPE	ASPHALT		
THICKNESS	5.00"		

REMARKS:

TARGET UTILITY NOT FOUND IN THIS HOLE. FOUND 8" UNKNOWN LINE.

REVISION NOTES:

REVIEWED DATE:	CHECKED DATE:	REVISION DATE:
REVIEWED BY:	CHECKED BY:	

TEST HOLE DATA REPORT

TEST HOLE NO:	2	CLIENT TEST HOLE NO:	2
TEST HOLE DATE:	3/14/2024	SUE CREW/TRUCK NO:	JV MR/551081
PROJECT NO:	UT07400200	CITY,COUNTY:	WEST VALLEY CITY, SALT LAKE
CLIENT:	JUB	LOCATION/INTERSECTION:	
PROJECT:	GRANGER-HUNTER IMPROVEMENT DISTRICT		2320 S & LITTLE OAK DR

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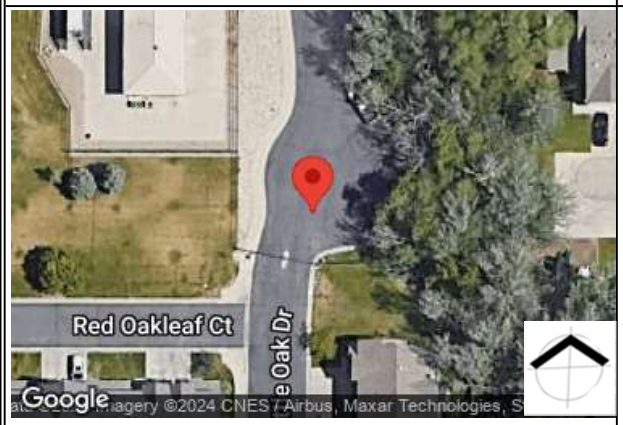
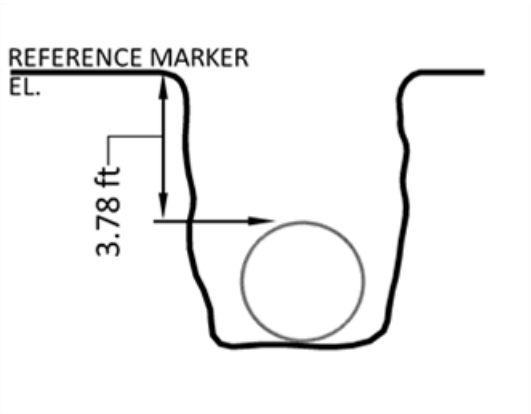
MAP

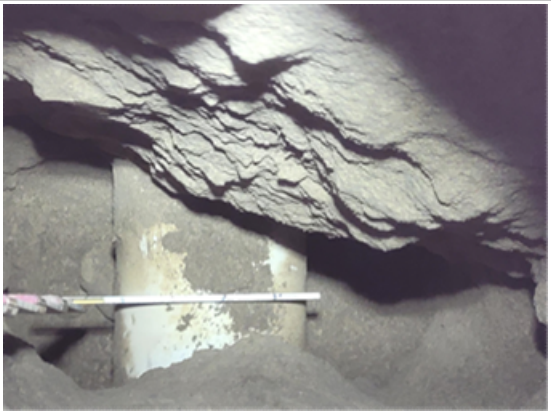


SITE PHOTO - FACING NORTH

CROSS SECTION - NOT TO SCALE



TEST HOLE - UTILITY - FACING NORTH



DISCLAIMER: ADDITIONAL MATERIAL AND/OR UTILITIES MAY EXIST BELOW APPARENT BOTTOM

UTILITY DESCRIPTION		**REFERENCE MARKER**	
UTILITY TYPE	WATER SERVICE	NORTHING	-
UTILITY MATERIAL	PLASTIC (PVC, PE, HDPE)	EASTING	-
UTILITY DIRECTION	NORTH - SOUTH	ELEVATION	-
UTILITY WIDTH (FIELD)	4.00"	LOCATION	CENTER OF UTILITY
UTILITY WIDTH (RECORD)	-	MARKED BY	NAIL & DISK
APPARENT UTILITY OWNER	UNK		
DEPTH FROM REFERENCE MARKER			
TOP OF UTILITY	3.78'		
BOTTOM OF UTILITY	-		
ELEVATION OF UTILITY			
TOP OF UTILITY	-		
APPARENT BOTTOM OF UTILITY	-		
SURFACE			
TYPE	ASPHALT		
THICKNESS	6.00"		

REMARKS:

4" FIRE LINE FOUND.

REVISION NOTES:

REVIEWED DATE:	CHECKED DATE:	REVISION DATE:
REVIEWED BY:	CHECKED BY:	

TEST HOLE DATA REPORT

TEST HOLE NO:	3	CLIENT TEST HOLE NO:	3
TEST HOLE DATE:	3/8/2024	SUE CREW/TRUCK NO:	KI CA/55620
PROJECT NO:	UT07400200	CITY,COUNTY:	WEST VALLEY CITY, SALT LAKE
CLIENT:	JUB	LOCATION/INTERSECTION:	
PROJECT:	GRANGER-HUNTER IMPROVEMENT DISTRICT		2320 S & LITTLE OAK DR

T2 utility engineers
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TEL:720.452.1090
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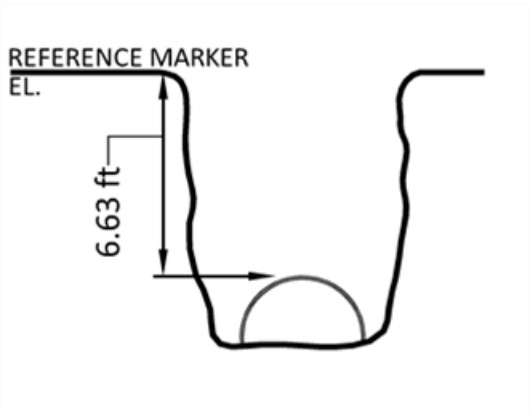
MAP

SITE PHOTO - FACING NORTH

CROSS SECTION - NOT TO SCALE



TEST HOLE - UTILITY - FACING NORTH

DISCLAIMER: ADDITIONAL MATERIAL AND/OR UTILITIES MAY EXIST BELOW APPARENT BOTTOM

UTILITY DESCRIPTION		REFERENCE MARKER	
UTILITY TYPE	WATER MAIN	NORTHING	-
UTILITY MATERIAL	PLASTIC (PVC, PE, HDPE)	EASTING	-
UTILITY DIRECTION	NORTH - SOUTH	ELEVATION	-
UTILITY WIDTH (FIELD)	16.00"	LOCATION	CENTER OF UTILITY
UTILITY WIDTH (RECORD)	16"	MARKED BY	CUT X
APPARENT UTILITY OWNER	PLANS		
DEPTH FROM REFERENCE MARKER			
TOP OF UTILITY	6.63'		
BOTTOM OF UTILITY	-		
ELEVATION OF UTILITY			
TOP OF UTILITY	-		
APPARENT BOTTOM OF UTILITY	-		
SURFACE			
TYPE	NATURAL GROUND		
THICKNESS	-		

REMARKS:

16" WATER LINE FOUND.

REVISION NOTES:

REVIEWED DATE:	CHECKED DATE:	REVISION DATE:
REVIEWED BY:	CHECKED BY:	

COM*check* Software Version COMcheckWeb

Interior Lighting Compliance Certificate

Project Information

Energy Code:	2021 IECC
Project Title:	Anderson Water Treatment Plant
Project Type:	New Construction

Construction Site:
1661 W 2320 S
West Valley, Utah 84119

Owner/Agent:
Granger-Hunter Improvement District

Designer/Contractor:

Efficiency Packages

Description	Credit
10% heating efficiency improvement	3.00
10% cooling efficiency improvement	0.00
Efficient fossil fuel water heater	0.00
Reduced lighting power	57.00
On-site renewable energy	7.00

Credits: 10.0 Required 67.0 Proposed

Allowed Interior Lighting Power

A Area Category	B Floor Area (ft2)	C Allowed Watts / ft2	D Allowed Watts
1-Main Interior (Manufacturing:Low Bay (< 25ft. Floor to Ceiling Height))	4100	0.86	3526
		Total Allowed Watts =	3526

Proposed Interior Lighting Power

A Fixture ID : Description / Lamp / Wattage Per Lamp / Ballast	B Lamps/ Fixture	C # of Fixture	D Fixture Watt.	E (C X D)
1-Main Interior (Manufacturing:Low Bay (< 25ft. Floor to Ceiling Height))				
F1:	0	15	62	930
F2:	0	2	25	50
F8:	0	1	50	50
			Total Proposed Watts =	1030

Proposed Interior Lighting Controls

Fixture	Lighting Control
1-Main Interior (Manufacturing:Low Bay (< 25ft. Floor to Ceiling Height))	
F1:	Manual Control

Fixture	Lighting Control
F2:	Occupancy Sensor, Manual Control
F8:	Manual Control

Interior Lighting PASSES: Design 71% better than code

Interior Lighting Compliance Statement

Compliance Statement: The proposed interior lighting design represented in this document is consistent with the building plans, specifications, and other calculations submitted with this permit application. The proposed interior lighting systems have been designed to meet the 2021 IECC requirements in COM*check* Version COMcheckWeb and to comply with any applicable mandatory requirements listed in the Inspection Checklist.

BOB HILLYER, P.E.
Name - Title

Signature

06/25/2024
Date

90% SET NOT FINAL

COMcheck Software Version COMcheckWeb

Exterior Lighting Compliance Certificate

Project Information

Energy Code:	2021 IECC
Project Title:	Anderson Water Treatment Plant
Project Type:	New Construction
Exterior Lighting Zone	2 (Residential mixed use area (LZ2))

Construction Site:
1661 W 2320 S
West Valley, Utah 84119

Owner/Agent:
Granger-Hunter Improvement District

Designer/Contractor:

Efficiency Packages

Description	Credit
10% heating efficiency improvement	3.00
10% cooling efficiency improvement	0.00
Efficient fossil fuel water heater	0.00
Reduced lighting power	57.00
On-site renewable energy	7.00

Credits: 10.0 Required 67.0 Proposed

Allowed Exterior Lighting Power

A Area/Surface Category	B Quantity	C Allowed Watts /	D Tradable Wattage	E Allowed Watts (B X C)
Exterior around building (Walkway >= 10 feet wide)	3696 ft2	0.1	Yes	370
			Total Tradable Watts (a) =	370
			Base Site Allowance (b) =	400
			Total Allowed Watts =	370

(a) Wattage tradeoffs are only allowed between tradable areas/surfaces.
(b) A base site allowance equal to 400 watts may be applied toward compliance of both non-tradable and tradable areas/surfaces.

Proposed Exterior Lighting Power

A Fixture ID : Description / Lamp / Wattage Per Lamp / Ballast	B Lamps/ Fixture	C # of Fixture	D Fixture Watt.	E (C X D)
Exterior around building (Walkway >= 10 feet wide, 3696 ft2): Tradable Wattage				
F3:	0	8	12	96
			Total Tradable Proposed Watts =	96

Proposed Exterior Lighting Controls

Fixture	Lighting Control

Fixture	Lighting Control

Exterior around building (Walkway >= 10 feet wide, 3696 ft2): Tradable Wattage

F3:	Daylight Shutoff, Facade or Landscape

Exterior Lighting PASSES: Design 88% better than code

Exterior Lighting Compliance Statement

Compliance Statement: The proposed exterior lighting design represented in this document is consistent with the building plans, specifications, and other calculations submitted with this permit application. The proposed exterior lighting systems have been designed to meet the 2021 IECC requirements in COM*check* Version COMcheckWeb and to comply with any applicable mandatory requirements listed in the Inspection Checklist.

BOB HILLYER, P.E.		06/25/2024
Name - Title	Signature	Date

90% SET NOT FINAL

COM*check* Software Version COMcheckWeb

Inspection Checklist

Energy Code: 2021 IECC

Requirements: 0.0% were addressed directly in the COM*check* software

Text in the "Comments/Assumptions" column is provided by the user in the COMcheck Requirements screen. For each requirement, the user certifies that a code requirement will be met and how that is documented, or that an exception is being claimed. Where compliance is itemized in a separate table, a reference to that table is provided.

Section # & Req.ID	Plan Review	Complies?	Comments/Assumptions
C103.2 [PR4][1]	Plans, specifications, and/or calculations provide all information with which compliance can be determined for the interior lighting and electrical systems and equipment and document where exceptions to the standard are claimed. Information provided should include interior lighting power calculations, wattage of bulbs and ballasts, transformers and control devices.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C103.2 [PR8][1]	Plans, specifications, and/or calculations provide all information with which compliance can be determined for the exterior lighting and electrical systems and equipment and document where exceptions to the standard are claimed. Information provided should include exterior lighting power calculations, wattage of bulbs and ballasts, transformers and control devices.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C406 [PR9][1]	Plans, specifications, and/or calculations provide all information with which compliance can be determined for the additional energy efficiency package options.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	

Additional Comments/Assumptions:

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)

Section # & Req.ID	Rough-In Electrical Inspection	Complies?	Comments/Assumptions
C405.2.3.1 [EL22][1]	Spaces required to have light-reduction controls have a manual control that allows the occupant to reduce the connected lighting load in a reasonably uniform illumination pattern >= 50 percent.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C405.2.1, C405.2.1.1 [EL18][1]	Occupancy sensors installed in classrooms/lecture/training rooms, conference/meeting/multipurpose rooms, copy/print rooms, lounges/breakrooms, enclosed offices, open plan office areas, restrooms, storage rooms, locker rooms, corridors, warehouse storage areas, and other spaces <= 300 sqft that are enclosed by floor-to-ceiling height partitions. Reference section language C405.2.1.2 for control function in warehouses and section C405.2.1.3 for open plan office spaces.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C405.2.1.2 [EL19][1]	Occupancy sensors control function in warehouses: In warehouses, the lighting in aisleways and open areas is controlled with occupant sensors that automatically reduce lighting power by 50% or more within 20 minutes of when the areas are unoccupied. The occupant sensors control lighting in each aisleway independently and do not control lighting beyond the aisleway being controlled by the sensor. Lights not turned off by occupant sensors is done so by time-switch.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C405.2.1.3 [EL20][1]	Occupant sensor control function in open plan office areas: Occupant sensor controls in open office spaces >= 300 sq.ft. have controls 1) configured so that general lighting can be controlled separately in control zones with floor areas <= 600 sq.ft. within the space, 2) general lighting in each zone permitted to turn on upon occupancy in control zone, 3) automatically turn off general lighting in all control zones within 20 minutes after all occupants have left the space, 4) are configured so that general lighting power in each control zone is reduced by >= 80% of the full zone general lighting power within 20 minutes of all occupants leaving that control zone.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C405.2.2, C405.2.2.1 [EL21][2]	Each area not served by occupancy sensors (per C405.2.1.1) have time-switch controls and functions detailed in sections C405.2.2.1.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)

Section # & Req.ID	Rough-In Electrical Inspection	Complies?	Comments/Assumptions
C405.2.4, C405.2.4.1, C405.2.4.2 [EL23][2]	Daylight zones provided with individual controls that control the lights independent of general area lighting. See code section C405.2.3 Daylight-responsive controls for applicable spaces, C405.2.3.1 Daylight responsive control function and section C405.2.3.2 Sidelit zone.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C405.2.5 [EL27][1]	Additional interior lighting power allowed for special functions per the approved lighting plans and is automatically controlled and separated from general lighting.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C405.2.7 [EL28][1]	Automatic lighting controls for exterior lighting installed. Controls will be daylight controlled, set based on business operation time-of-day, or reduce connected lighting > 30%.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C405.7 [EL26][2]	Low-voltage dry-type distribution electric transformers meet the minimum efficiency requirements of Table C405.6.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C405.8 [EL27][2]	Electric motors meet the minimum efficiency requirements of Tables C405.7(1) through C405.7(4). Efficiency verified through certification under an approved certification program or the equipment efficiency ratings shall be provided by motor manufacturer (where certification programs do not exist).	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C405.9.1, C405.9.2 [EL28][2]	Escalators and moving walks comply with ASME A17.1/CSA B44 and have automatic controls configured to reduce speed to the minimum permitted speed in accordance with ASME A17.1/CSA B44 or applicable local code when not conveying passengers.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C405.10 [EL29][2]	Total voltage drop across the combination of feeders and branch circuits <= 5%.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C405.1.1 [EL30][2]	At least 90% of dwelling unit permanently installed lighting shall have lamp efficacy >= 65 lm/W or luminaires with efficacy >= 45 lm/W or comply with C405.2.4 or C405.3.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C405.11, C405.11.1 [EL31][2]	50% of 15/20 amp receptacles installed in enclosed offices, conference rooms, copy rooms, break rooms, classrooms and workstations and > 25% of branch circuit feeders for modular furniture will have automatic receptacle control in accordance with C405.11.1.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	

Additional Comments/Assumptions:

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)

Section # & Req.ID	Final Inspection	Complies?	Comments/Assumptions
C303.3, C408.2.5.2 [FI17][3]	Furnished O&M instructions for systems and equipment to the building owner or designated representative.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C405.5.1 [FI19][1]	Exterior lighting power is consistent with what is shown on the approved lighting plans, demonstrating proposed watts are less than or equal to allowed watts.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	*See the Exterior Lighting fixture schedule for values.*
C406.2.3 [FI66][1]	10% heating efficiency improvement - all HVAC and Plant heating equipment is 10% more efficient than required by 2021 IECC.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C406.2.4 [FI66][1]	10% cooling efficiency improvement - all HVAC and Plant cooling equipment is 10% more efficient than required by 2021 IECC.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C406.3 [FI67][1]	Reduced lighting power - this credit specifies that the connected lighting power is >= 10% more efficient than 2021 IECC requirements.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C406.5 [FI49][1]	On-site renewable energy credits - on-site renewable energy system supplies at least 0.86 Btuh or 0.25 watts per square foot of conditioned floor area OR provides at least 2 percent of the energy used within the building for mechanical and service water heating equipment and lighting regulated in C405.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C406.7.3 [FI53][1]	Reduced energy use in service water heating - the hot water heating system shall have a capacity weighted average fossil fuel water heating efficiency at least 95 thermal efficiency or 0.95 EF.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C408.1.1 [FI57][1]	Building operations and maintenance documents will be provided to the owner. Documents will cover manufacturers' information, specifications, programming procedures and means of illustrating to owner how building, equipment and systems are intended to be installed, maintained, and operated.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C408.2.5 [FI16][3]	Furnished as-built drawings for electric power systems within 90 days of system acceptance.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C408.3 [FI33][1]	Lighting systems have been tested to ensure proper calibration, adjustment, programming, and operation.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	

Additional Comments/Assumptions:

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)

COM*check* Software Version COMcheckWeb
Mechanical Compliance Certificate

Project Information

Energy Code:	2021 IECC
Project Title:	Anderson Water Treatment Plant
Location:	West Valley City, Utah
Climate Zone:	5b
Project Type:	New Construction

Construction Site:
1661 W 2320 S
West Valley, Utah 84119

Owner/Agent:
Granger-Hunter Improvement District

Designer/Contractor:

Efficiency Packages

Description	Credit
10% heating efficiency improvement	3.00
10% cooling efficiency improvement	0.00
Efficient fossil fuel water heater	0.00
Reduced lighting power	57.00
On-site renewable energy	7.00

Credits: 10.0 Required 67.0 Proposed

Mechanical Systems List

Quantity **System Type & Description**

3 HVAC System UH-1, 2, & 3 (Unknown w/ PerimeterSystem):
Heating: 1 each - Unit Heater, Gas, Capacity = 146 kBtu/h
Proposed Efficiency = 93.00% Ec, Required Efficiency: 80.00 % Ec

2 HVAC System SHP-1 & 2 (Single Zone):
Split System Heat Pump
Heating Mode: Capacity = 7 kBtu/h,
Proposed Efficiency = 10.20 HSPF2, Required Efficiency = 7.50 HSPF2
Cooling Mode: Capacity = 10 kBtu/h,
Proposed Efficiency = 21.30 SEER2, Required Efficiency = 14.30 SEER2
Proposed Part Load Efficiency = 0.00 , Required Part Load Efficiency = 0.00

1 WH-1:
Gas Instantaneous Water Heater, Capacity: 8 gallons, Input Rating: 160 kBtu/h
No minimum efficiency requirement applies

Mechanical Compliance Statement

Compliance Statement: The proposed mechanical design represented in this document is consistent with the building plans, specifications, and other calculations submitted with this permit application. The proposed mechanical systems have been designed to meet the 2021 IECC requirements in COM*check* Version COMcheckWeb and to comply with any applicable mandatory requirements listed in the Inspection Checklist.

Karson Halverson, P.E.		6/24/2024
Name - Title	Signature	Date

COM*check* Software Version COMcheckWeb

Inspection Checklist

Energy Code: 2021 IECC

Requirements: 49.0% were addressed directly in the COM*check* software

Text in the "Comments/Assumptions" column is provided by the user in the COMcheck Requirements screen. For each requirement, the user certifies that a code requirement will be met and how that is documented, or that an exception is being claimed. Where compliance is itemized in a separate table, a reference to that table is provided.

Section # & Req.ID	Plan Review	Complies?	Comments/Assumptions
C103.2 [PR2][1]	Plans, specifications, and/or calculations provide all information with which compliance can be determined for the mechanical and service water heating systems and document where exceptions to the standard are claimed. Load calculations per acceptable engineering standards and handbooks. Hot water system sized per manufacturer's sizing guide.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	Requirement will be met. **Location on plans/spec:** Construction Documents
C406 [PR9][1]	Plans, specifications, and/or calculations provide all information with which compliance can be determined for the additional energy efficiency package options.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	

Additional Comments/Assumptions:

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)

Section # & Req.ID	Footing / Foundation Inspection	Complies?	Comments/Assumptions
C403.13.2, C403.13.3 [FO9][3]	Snow/ice melting system and freeze protection systems have sensors and controls configured to limit service for pavement temperature above 50F and outdoor temperature above 40F.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	**Exception:** Requirement does not apply.

Additional Comments/Assumptions:

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)

Section # & Req.ID	Plumbing Rough-In Inspection	Complies?	Comments/Assumptions
C404.5, C404.5.1, C404.5.2 [PL6][3]	Heated water supply piping conforms to pipe length and volume requirements. Refer to section details.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	**Exception:** Requirement does not apply.

Additional Comments/Assumptions:

Section # & Req.ID	Mechanical Rough-In Inspection	Complies?	Comments/Assumptions
C402.2.6 [ME41][3]	Thermally ineffective panel surfaces of sensible heating panels have insulation >= R-3.5.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	**Exception:** Requirement does not apply.
C403.8.1 [ME65][3]	HVAC fan systems at design conditions do not exceed allowable fan system motor nameplate hp or fan system bhp.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	**Exception:** Requirement does not apply. *See the Mechanical Systems list for values.*
C403.8.3 [ME117][2]	Fans have a fan energy index (FEI) >= 1.00. Variable volume fans will have an FEI >= 0.95.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	**Exception:** Single fans with motor nameplate horsepower of = 1 hp or 0.89 kW.
C403.8.3 [ME117][2]	Fans have a fan energy index (FEI) >= 1.00. Variable volume fans will have an FEI >= 0.95.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	**Exception:** Single fans with motor nameplate horsepower of = 1 hp or 0.89 kW.
C403.9 [ME144][2]	Large diameter fans where installed shall be tested and labeled in accordance with AMCA 230.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	Requirement will be met.
C403.3 [ME55][2]	HVAC equipment efficiency verified.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	*See the Mechanical Systems list for values.*
C403.2.2 [ME59][1]	Natural or mechanical ventilation is provided in accordance with International Mechanical Code Chapter 4. Mechanical ventilation has capability to reduce outdoor air supply to minimum per IMC Chapter 4.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	**Exception:** Requirement does not apply.
C403.7.1 [ME59][1]	Demand control ventilation provided for spaces >500 ft2 and >15 people/1000 ft2 occupant density and served by systems with air side economizer, auto modulating outside air damper control, or design airflow >3,000 cfm.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	**Exception:** Requirement does not apply.
C403.7.2 [ME115][3]	Enclosed parking garage ventilation has automatic contaminant detection and capacity to stage or modulate fans to 50% or less of design capacity.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	**Exception:** Requirement does not apply.
C403.7.6 [ME141][3]	HVAC systems serving guestrooms in Group R-1 buildings with > 50 guestrooms: Each guestroom is provided with controls that automatically manage temperature setpoint and ventilation (see sections C403.7.6.1 and C403.7.6.2).	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	**Exception:** Requirement does not apply.
C403.7.4 [ME57][1]	Exhaust air energy recovery on systems meeting Table C403.7.4(1) and C403.7.4(2).	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	**Exception:** Requirement does not apply.
C403.7.5 [ME116][3]	Kitchen exhaust systems comply with replacement air and conditioned supply air limitations, and satisfy hood rating requirements and maximum exhaust rate criteria.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	**Exception:** Requirement does not apply.

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)

Section # & Req.ID	Mechanical Rough-In Inspection	Complies?	Comments/Assumptions
C403.4.3.3.2 [ME121][3]	Closed-circuit cooling tower within heat pump loop have either automatic bypass valve or lower leakage positive closure dampers. Open-circuit tower within heat pump loop have automatic valve to bypass all heat pump water flow around the tower. Open- or closed-circuit cooling towers used in conjunction with a separate heat exchanger have heat loss by shutting down the circulation pump on the cooling tower loop. Open- or closed circuit cooling towers have a separate heat exchanger to isolate the cooling tower from the heat pump loop, and heat loss is controlled by shutting down the circulation pump on the cooling tower loop.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	**Exception:** Requirement does not apply.
C403.4.1.4 [ME63][2]	Heating for vestibules and air curtains with integral heating include automatic controls that shut off the heating system when outdoor air temperatures > 45F. Vestibule heating and cooling systems controlled by a thermostat in the vestibule with heating setpoint <= 60F and cooling setpoint >= 80F.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	**Exception:** Requirement does not apply.
C408.2.2.1 [ME53][3]	Air outlets and zone terminal devices have means for air balancing.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	**Exception:** Requirement does not apply.
C403.11.3, C403.11.3.1, C403.11.3.2 [ME123][3]	Refrigerated display cases, walk-in coolers or walk-in freezers served by remote compressors and remote condensers not located in a condensing unit, have fan-powered condensers that comply with Sections C403.11.3.1 and refrigeration compressor systems that comply with C403.11.3.2..	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	**Exception:** Requirement does not apply.

Additional Comments/Assumptions:

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)

Section # & Req.ID	Rough-In Electrical Inspection	Complies?	Comments/Assumptions
C405.7 [EL26][2]	Low-voltage dry-type distribution electric transformers meet the minimum efficiency requirements of Table C405.6.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C405.8 [EL27][2]	Electric motors meet the minimum efficiency requirements of Tables C405.7(1) through C405.7(4). Efficiency verified through certification under an approved certification program or the equipment efficiency ratings shall be provided by motor manufacturer (where certification programs do not exist).	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C405.9.1, C405.9.2 [EL28][2]	Escalators and moving walks comply with ASME A17.1/CSA B44 and have automatic controls configured to reduce speed to the minimum permitted speed in accordance with ASME A17.1/CSA B44 or applicable local code when not conveying passengers.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C405.10 [EL29][2]	Total voltage drop across the combination of feeders and branch circuits <= 5%.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C405.1.1 [EL30][2]	At least 90% of dwelling unit permanently installed lighting shall have lamp efficacy >= 65 lm/W or luminaires with efficacy >= 45 lm/W or comply with C405.2.4 or C405.3.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C405.11, C405.11.1 [EL31][2]	50% of 15/20 amp receptacles installed in enclosed offices, conference rooms, copy rooms, break rooms, classrooms and workstations and > 25% of branch circuit feeders for modular furniture will have automatic receptacle control in accordance with C405.11.1.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	

Additional Comments/Assumptions:

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)

Section # & Req.ID	Final Inspection	Complies?	Comments/Assumptions
C303.3, C408.2.5.3 [FI8][3]	Furnished O&M manuals for HVAC systems within 90 days of system acceptance.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C403.3.1 [FI27][3]	HVAC systems and equipment capacity does not exceed calculated loads.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	Requirement will be met. **Location on plans/spec:** Construction Documents
C403.4.1 [FI47][3]	Heating and cooling to each zone is controlled by a thermostat control. Minimum one humidity control device per installed humidification/dehumidification system.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	Requirement will be met. **Location on plans/spec:** Construction Documents
C403.4.1.1 [FI42][3]	Heat pump controls prevent supplemental electric resistance heat from coming on when not needed.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	**Exception:** Requirement does not apply.
C403.4.1.2 [FI38][3]	Thermostatic controls have a 5 °F deadband.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	Requirement will be met. **Location on plans/spec:** Construction Documents
C403.4.1.3 [FI20][3]	Temperature controls have setpoint overlap restrictions.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	**Exception:** Requirement does not apply.
C403.4.2 [FI39][3]	Each zone equipped with setback controls using automatic time clock or programmable control system.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	**Exception:** Requirement does not apply.
C403.4.2.1, C403.4.2.2 [FI40][3]	Automatic Controls: Setback to 55°F (heat) and 85°F (cool); 7-day clock, 2-hour occupant override, 10-hour backup	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	**Exception:** Requirement does not apply.
C404.3 [FI11][3]	Heat traps installed on supply and discharge piping of non-circulating systems.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	Requirement will be met. **Location on plans/spec:** Construction Documents
C406.2.3 [FI66][1]	10% heating efficiency improvement - all HVAC and Plant heating equipment is 10% more efficient than required by 2021 IECC.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C406.2.4 [FI66][1]	10% cooling efficiency improvement - all HVAC and Plant cooling equipment is 10% more efficient than required by 2021 IECC.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C406.3 [FI67][1]	Reduced lighting power - this credit specifies that the connected lighting power is >= 10% more efficient than 2021 IECC requirements.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)

Section # & Req.ID	Final Inspection	Complies?	Comments/Assumptions
C406.5 [FI49][1]	On-site renewable energy credits - on-site renewable energy system supplies at least 0.86 Btuh or 0.25 watts per square foot of conditioned floor area OR provides at least 2 percent of the energy used within the building for mechanical and service water heating equipment and lighting regulated in C405.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C406.7.3 [FI53][1]	Reduced energy use in service water heating - the hot water heating system shall have a capacity weighted average fossil fuel water heating efficiency at least 95 thermal efficiency or 0.95 EF.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C408.1.1 [FI57][1]	Building operations and maintenance documents will be provided to the owner. Documents will cover manufacturers' information, specifications, programming procedures and means of illustrating to owner how building, equipment and systems are intended to be installed, maintained, and operated.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C408.2.1 [FI28][1]	Commissioning plan developed by registered design professional or approved agency.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C408.2.3.1 [FI31][1]	HVAC equipment, systems and system-to-system relationships have been tested to ensure proper operation.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C408.2.3.2 [FI10][1]	HVAC and service water heating control systems have been tested to ensure proper operation, calibration and adjustment of controls.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C408.2.4 [FI29][1]	Preliminary commissioning report completed and certified by registered design professional or approved agency.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C408.2.5 [FI7][3]	Furnished HVAC as-built drawings submitted within 90 days of system acceptance.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C408.2.5.1 [FI43][1]	An air and/or hydronic system balancing report is provided for HVAC systems.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	
C408.2.5.2 [FI30][1]	Final commissioning report due to building owner within 90 days of receipt of certificate of occupancy.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	

Additional Comments/Assumptions:

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)