GHD Inc: 11110683

Manila Community Services District

Drinking Water Infrastructure Improvement Project

95% Technical Specifications

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Prepared for

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LIMITED HAZARDOUS MATERIALS ASSESSMENT SURVEY REPORT
GEOTECHNICAL REPORT

SECTION 00 31 00

AVAILABLE PROJECT INFORMATION

PART 1 GENERAL

1.1 SUMMARY

A. Document Includes:
   1. Hazardous material investigation report
   2. Subsurface investigation report.

B. Available Project information has been furnished by Owner to Architect/Engineer for use in designing this Project.
   1. Each Bidder shall be fully familiar with available Project information, which has been prepared for Owner by separate consultants.
   2. Available Project information is offered solely for reference and shall not be considered part of Contract Documents. Data contained in Documents prepared by Owner's separate consultants is believed to be reliable; however, Owner and Architect/Engineer do not guarantee their accuracy or completeness.
   3. In preparing their Bids, Bidders shall consider and evaluate data contained in available Project information as well as Contract Documents prepared by Architect/Engineer.

1.2 HAZARDOUS MATERIAL INVESTIGATION REPORT

A. A copy of a hazmat report is included as an attachment to this Document, titled *Limited Hazardous Materials Assessment Survey Report* Manila Community Services District Off and Water Storage Infrastructure Drinking Water Infrastructure Improvement Project, dated May 30, 2018 and prepared by GHD.

B. This report identifies asbestos material suspect lead materials subject to applicable regulations, recommendations for removal, and agency notifications.

1.3 SUBSURFACE INVESTIGATION REPORT

A. A copy of a geotechnical report is included as an attachment to this Document, titled *Geotechnical Report, Manila Community Services District Water Tank Replacement Project*, dated December 2017, and prepared by Crawford & Associates, Inc.

B. The report identifies properties of below-grade conditions and offers recommendations for design of foundations, prepared primarily for use of Architect/Engineer.

C. Recommendations described are not requirements of the Contract unless specifically referenced in Contract Documents.

D. The report, by its nature, cannot reveal all conditions existing on the Site. Should subsurface conditions be found to vary substantially from this report, changes in design and construction of foundations will be made, with resulting changes to Contract Price and/or Contract Time.

END OF SECTION

SECTION 01 15 00

MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.1 GENERAL

A. Unless otherwise specified in other individual sections of these Specifications, quantities of Work shall be determined from measurements or dimensions in horizontal planes.

B. Units of measurement shall be in accordance with U.S. Standard Measures.

C. See General Conditions for special provisions related to progress payments and payment schedule to the contractor.

1.2 MATERIALS

A. The measurement and payment items are listed below:
   1. The payments to the Contractor are based on the following items. It is the intent that the scope of the description of the following items encompasses the entire scope of the Work as shown on the Contract Drawings and described in the Specifications. The bid amounts shall be for complete in place installations.

BASE BID SCHEDULE

Bid Schedule to be developed under Final Design and Construction Bid Package scope of work.

END OF SECTION

SECTION 01 30 00

ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Coordination and project conditions.

B. Field engineering.

C. Preconstruction meeting.

D. Progress meetings.

E. Pre-installation meetings.

F. Cutting and patching.

G. Special procedures.

1.2 COORDINATION AND PROJECT CONDITIONS

A. Coordinate scheduling, submittals, utility shut downs, traffic interruptions, and Work of various sections of Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements.

B. Verify utility requirements and characteristics of operating piping infrastructure are compatible with new piping including pipe type, size, condition, location and interconnection requirements. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, new facilities.

C. Investigate utility locations in the vicinity of the work. Contact utility providers and verify the type, size, and location of utilities. Conduct field location methods such as ground penetrating radar and potholing to locate utilities that may be in conflict with the work or that are to be connected to. Relocate utilities that conflict.

D. Owner operations are conducted year round, during normal business hours, weekdays between 8 a.m. and 5 p.m., and extended hours as required during emergencies. Contractor is to coordinate with the Owner to accommodate the Owner's daily and emergency operations.

E. In finished areas conceal pipes, ducts, and wiring within construction. Coordinate locations of fixtures and outlets with finish elements.

F. Coordinate completion and clean-up of Work of separate sections in preparation for Substantial Completion.

G. After Owner acceptance of work, 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. Employ Land Surveyor registered in California as may be required for laying out the improvements.

B. Locate and protect survey control and reference points. Promptly notify Engineer of discrepancies discovered.

C. Provide control datum for survey in the vicinity of the work.

D. Verify set-backs and easements; confirm drawing dimensions and elevations.

E. Provide field engineering services. Establish elevations, lines, and levels, utilizing recognized engineering survey practices.

F. Submit copy of site drawing and certificate signed by Land Surveyor certifying elevations and locations of the Work are in conformance with Contract Documents.

G. Maintain complete and accurate log of control and survey work as Work progresses.

H. Protect survey control points prior to starting site work; preserve permanent reference points during construction.

I. Promptly report to Engineer loss or destruction of any reference points or monuments or relocation required because of changes in grades or other reasons. Contractor is responsible for the relocation or replacement of any monuments disturbed through the project.

J. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice to Engineer.

1.4 PRECONSTRUCTION MEETING

A. Engineer will schedule meeting after Notice of Award.

B. Attendance Required: Owner, Engineer, Contractor and major subcontractors.

C. Agenda Example:
   1. Distribution of Contract Documents.
   2. Submission of list of Subcontractors, schedule of values, and progress schedule.
   3. Designation of personnel representing parties in Contract and Engineer.
   4. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
   5. Scheduling.
   6. Use of premises by Owner and Contractor.
   7. Owner's requirements.

8. Construction facilities and controls provided by Owner.
9. Temporary utilities provided by Owner
10. Testing (provided by contractor)
11. Survey (provided by contractor).
12. Security and housekeeping procedures.
13. Site Safety (responsibility of contractor)
14. Application for payment procedures.
15. Procedures for testing.
16. Procedures for maintaining record documents.
17. Requirements for start-up of equipment.

D. Record minutes and distribute copies within two working days after meeting to participants, with two copies to Engineer, Owner, and those affected by decisions made.

1.5 PROGRESS MEETINGS

A. Schedule and administer meetings throughout progress of the Work at maximum of bi-monthly intervals.

B. Make arrangements for meetings, prepare agenda with copies for participants, preside at meetings.

C. Attendance Required: Owner, job superintendent, major subcontractors and suppliers, Engineer as appropriate to agenda topics for each meeting.

D. Agenda Example:
1. Review minutes of previous meetings.
2. Review of Work progress.
3. Field observations, problems, and decisions.
4. Identification of problems impeding 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. Effect of proposed changes on progress schedule and coordination.
13. Other business relating to Work.

E. Record minutes and distribute copies within two working days after meeting to participants, with two copies to Engineer, Owner, and those affected by decisions made.

1.6 PRE-INSTALLATION MEETINGS

A. When required in individual specification sections or as directed by the Engineer, convene pre-installation meetings at Project site prior to commencing work of specific section or direction.

B. Require attendance of parties directly affecting, or affected by, Work of specific section.

C. Notify Engineer four working days in advance of meeting date.

D. Prepare agenda and preside at meeting:
   1. Review conditions of installation, preparation and installation procedures.
   2. Review coordination with related work.

E. Record minutes and distribute copies within two working days after meeting to participants, with two copies to Engineer, Owner, and those affected by decisions made.

F. Such meetings shall be conducted prior to any planned utility or traffic interruptions.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 CUTTING AND PATCHING

A. Employ skilled and experienced installer to perform cutting and patching.

B. Submit written request in advance of cutting or altering elements affecting:
   1. Structural integrity of element.
   2. Integrity of weather-exposed or moisture-resistant elements.
   3. Efficiency, maintenance, or safety of element.
   4. Visual qualities of sight exposed elements.
   5. Work of Owner or separate contractor.

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

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

E. Cut masonry and concrete materials using masonry saw or core drill.

F. Restore Work with new products in accordance with requirements of Contract Documents.

G. Fit Work tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

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

I. Identify hazardous substances or conditions exposed during the Work to Engineer for decision or remedy.

END OF SECTION

SECTION 01 32 16

CONSTRUCTION PROGRESS SCHEDULE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. References.

B. Quality assurance.

C. Format.

D. Schedules.

E. Submittals.

F. Review and evaluation.

G. Updating schedules.

H. Distribution.

1.2 REFERENCES

A. The Use of CPM in Construction - A Manual for General Contractors and the Construction Industry, Washington, D.C., The Associated General Contractors of America (AGC).

1.3 QUALITY ASSURANCE

A. Scheduler: Contractor's personnel specializing in CPM scheduling of construction work of complexity comparable to this Project and having use of computer facilities capable of delivering graphic printout within 48 hours of request.

B. Contractor's Administrative Personnel: Experience in using and monitoring CPM schedules on comparable projects.

1.4 FORMAT

A. Listings: Reading from left to right, in ascending order for each activity. Identify each activity with applicable specification section number.

B. Diagram Sheet Size: 11 inches high x 17 inches wide.

C. Scale and Spacing: To allow for notations and revisions.

1.5 SCHEDULES

A. Prepare network analysis diagrams as needed to depict the planned schedule of work.

B. Illustrate order and interdependence of activities and sequence of work; how start of given activity depends on completion of preceding activities, and how completion of activity may restrain start of subsequent activities.

C. Illustrate complete sequence of construction by activity, identifying work of separate stages. Indicate dates for submittals and return of submittals; dates for procurement and delivery of critical products; and dates for installation and provision for testing. Include legend for symbols and abbreviations used.

D. Mathematical Analysis: Tabulate each activity of network diagrams, using calendar dates, and identify for each activity relevant information which may include:
   1. Preceding and following event numbers.
   2. Activity description.
   3. Estimated duration of activity, in maximum 15 day intervals.
   4. Earliest start date.
   5. Earliest finish date.
   6. Actual start date.
   7. Actual finish date.
   8. Latest start date.
   9. Latest finish date.
   10. Total and free float; accrue float time to Owner and to Owner's benefit.
   11. Monetary value of activity, keyed to Schedule of Values.
   12. Percentage of activity completed.
   13. Responsibility.

E. Analysis Program: Capable of accepting revised completion dates, and recomputation of scheduled dates and float.

F. Required Sorts: List activities in sorts or groups as required which may include:
   1. By preceding work item or event number from lowest to highest.
   2. By longest float, then in order of early start.
   3. By responsibility in order of earliest possible start date.
   4. In order of latest allowable start dates.
   5. In order of latest allowable finish dates.
   6. Contractor's periodic payment request sorted by Schedule of Values listings.
   7. Listing of basic input data generating report.
   8. Listing of activities on critical path.

G. Coordinate contents with Bid Schedule items in Section 01 15 00 - Measurement and Payment.

1.6 SUBMITTALS

A. Within 10 days after date established in Notice to Proceed, submit proposed preliminary network diagram defining planned operations for first 60 days of Work, with general outline for remainder of Work.

B. Participate in review of preliminary and complete network diagrams jointly with Engineer.

C. Within 20 days after joint review of proposed preliminary network diagram, submit draft of proposed complete graphical schedule for review. Include written certification that major Subcontractors have reviewed and accepted proposed schedule.

D. Within 10 days after joint review, submit complete network analysis consisting of network diagrams and mathematical analysis.

E. Submit updated network schedules with each Application for Payment.

F. Submit digitally and two hard copies.

G. Submit under transmittal letter form specified in Section 01 33 00 - Submittal Procedures.

1.7 REVIEW AND EVALUATION

A. Participate in joint review and evaluation of network diagrams and analysis with Engineer at each submittal.

B. Evaluate project status to determine work behind schedule and work ahead of schedule.

C. After review, revise network diagrams and analysis incorporating results of review, and resubmit within 10 days.

1.8 UPDATING SCHEDULES

A. Maintain schedules to record actual start and finish dates of completed activities.

B. Indicate progress of each activity to date of revision, with projected completion date of each activity. Annotate and/or update diagrams to graphically depict current status of Work.

C. Identify activities modified since previous submittal, major changes in Work, and other identifiable changes.

D. Indicate changes required to maintain Contract Date of Completion.

E. Submit sorts required to support recommended changes.

F. Prepare narrative report as needed to define problem areas, anticipated delays, and impact on schedule. Report corrective action taken or proposed and its effect.

1.9 DISTRIBUTION

A. Following joint review, distribute copies of updated schedules to Contractor's project site file, to Subcontractors, suppliers, Engineer, CM and Owner.

B. Instruct recipients to promptly report, in writing, problems anticipated by projections shown in schedules.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

END OF SECTION

SECTION 01 33 00

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Submittal procedures.

B. Proposed products list.

C. Product data.

D. Shop drawings.

E. Samples.

F. Design data.

G. Test reports.

H. Certificates.

I. Manufacturer's instructions.

J. Manufacturer's field reports.

K. Erection drawings.

L. Construction photographs.

1.2 SUBMITTAL PROCEDURES

A. Transmit each submittal with Engineer accepted form.

B. Sequentially number transmittal forms. Mark revised submittals with original number and sequential alphabetic suffix.

C. Identify Project, Contractor, subcontractor and supplier; pertinent drawing and detail number, and specification section number, appropriate to submittal.

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

E. Schedule submittals to expedite Project, and deliver to Engineer. Coordinate submission of related items.

F. For each submittal for review, allow 15 working days excluding delivery time to and from Contractor.

G. Identify variations from Contract Documents and product or system limitations which may be detrimental to successful performance of completed Work.

H. Allow space on submittals for Contractor and Engineer review stamps.

I. When revised for resubmission, identify changes made since previous submission.

J. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report inability to comply with requirements.

K. Submittals not requested will not be recognized or processed.

1.3 PROPOSED PRODUCTS LIST

A. Within 15 working days after date of Notice to Proceed, submit 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.

1.4 PRODUCT DATA

A. Product Data: Submit to Engineer for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.

B. Submit number of copies Contractor requires, plus three copies Engineer will retain.

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

D. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

E. After review, produce copies and distribute in accordance with SUBMITTAL PROCEDURES article and for record documents described in Section 01 70 00 - Execution and Closeout Requirements.

1.5 SHOP DRAWINGS

A. Shop Drawings: Submit to Engineer for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.

B. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

C. Submit number of opaque reproductions Contractor requires, plus three copies Engineer will retain. Alternatively, the engineer may require that all submittals are completed electronically.

D. When required by individual specification sections, provide shop drawings signed and sealed by professional engineer responsible for designing components shown on shop drawings.
   1. Include signed and sealed calculations to support design.
   2. Submit drawings and calculations in form suitable for submission to and approval by authorities having jurisdiction.
   3. Make revisions and provide additional information when required by authorities having jurisdiction.

E. After review, produce copies and distribute in accordance with SUBMITTAL PROCEDURES article and for record documents described in Section 01 70 00 - Execution and Closeout Requirements.

1.6 SAMPLES

A. Samples: Submit to Engineer for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.

B. Samples For Selection as Specified in Product Sections:
   1. Submit to Engineer for aesthetic, color, or finish selection.
   2. Submit samples of finishes from full range of manufacturers' standard colors, in custom colors selected, textures, and patterns for Engineer selection.

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

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

E. Submit number of samples specified in individual specification sections; Engineer will retain two samples.

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

G. Samples will not be used for testing purposes unless specifically stated in specification section.

H. After review, produce duplicates and distribute in accordance with SUBMITTAL PROCEDURES article and for record documents purposes described in Section 01 70 00 - Execution and Closeout Requirements.

1.7 DESIGN DATA

A. Submit for Engineer's knowledge as contract administrator or for Owner.

B. Submit for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

1.8 TEST REPORTS

A. Submit for Engineer's knowledge as contract administrator or for Owner.

B. Submit test reports for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

1.9 CERTIFICATES

A. When specified in individual specification sections, submit certification by manufacturer, installation/application subcontractor, or Contractor to Engineer’s, in quantities specified for Product Data.

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

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

1.10 MANUFACTURER'S INSTRUCTIONS

A. When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, to Engineer for delivery to Owner in quantities specified for Product Data.

B. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

1.11 MANUFACTURER'S FIELD REPORTS

A. Submit reports for Engineer’s benefit as contract administrator or for Owner.

B. Submit report in duplicate within 15 working days of observation to Engineer for information.

C. Submit for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

1.12 ERECTION DRAWINGS

A. Submit drawings for Engineer's benefit as contract administrator or for Owner.

B. Submit for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

C. Data indicating inappropriate or unacceptable Work may be subject to action by Engineer or Owner.

1.13 CONSTRUCTION PHOTOGRAPHS

A. Provide photographs of site and construction throughout progress of Work produced by an experienced photographer, acceptable to Engineer.

B. Each month submit photographs with Application for Payment.

C. Photographs: Digital color photographs with resolution suitable for printing at 8-1/2" by 11" size.

D. Take five site photographs from differing directions and locations, and five interior photographs of structures indicating relative progress of the Work, three working days maximum prior to submitting an Application for Payment.

E. Identify each print on front. Identify name of Project, contract number, orientation of view, date and time of view.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

END OF SECTION

SUBMITTAL TRANSMITTAL

PROJECT:
Manila Community Services District
Water Infrastructure Improvement Project

CONTRACTOR:

SPECIFICATIONS SECTION:
SUBMITTAL NO.:
DRAWING REF. NO.:
SUBCONTRACTOR/SUPPLIER:
DATE:
PAGE NO.: OF
CC:

TRANSMITTAL RECORD	DATE SENT	DATE REC'D	QUANTITY				REVIEW CODES
			REPRO.	PRINT	SAMPLE	MFG. LIT.	
CONTRACTOR TO OWNER'S REP							1 REVIEWED, NO EXCEPTIONS
OWNER'S REP TO CONTRACTOR							2 MAKE CORRECTIONS NOTED
							3 REVISE AS NOTED, RESUBMIT
							4 REJECTED, RESUBMIT AS SPECIFIED
							5 CANCELLED

REVIEW ACTION:

1	2	3	4	5

DRAWING/ITEM	DATED	DESCRIPTION

OWNER'S REP'S REMARKS:

NOTE: NOTATIONS DO NOT AUTHORIZE CHANGES TO CONTRACT SUM OR TIME. IF YOU ARE AUTHORIZED TO PROCEED WITH THE WORK IDENTIFIED IN THIS SUBMITTAL, IT IS ASSUMED THAT NO CHANGE IN THE CONTRACT AMOUNT OR COMPLETION DATE IS REQUIRED. IF A CHANGE IN THE WORK AFFECTING YOUR CONTRACT AMOUNT OR COMPLETION DATE IS INVOLVED, NOTIFY THE OWNER'S REPRESENTATIVE IMMEDIATELY.

SECTION 01 40 00

QUALITY REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Quality control and control of installation.

B. Tolerances.

C. References.

D. Mock-up requirements.

E. Testing and inspection services.

F. Manufacturers' field services.

G. Examination.

H. Preparation.

1.2 QUALITY CONTROL AND CONTROL OF INSTALLATION

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

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

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

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

E. Perform Work by persons qualified to produce required and specified quality.

F. Verify field measurements are as indicated on Shop Drawings or as instructed by manufacturer.

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

1.3 TOLERANCES

A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

B. Comply with manufacturers' tolerances. When manufacturers' tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

1.4 REFERENCES

A. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of 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 for receiving bids, except where specific date is established by code.

C. Obtain copies of standards where required by product specification sections.

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

E. Neither contractual relationships, duties, nor responsibilities of parties in Contract nor those of Engineer shall be altered from Contract Documents by mention or inference otherwise in reference documents.

1.5 MOCK-UP REQUIREMENTS

A. Tests will be performed under provisions identified in this section and identified in respective product specification sections.

B. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.

C. Accepted mock-ups shall be the comparison standard for remaining Work.

D. Where mock-up has been accepted by Engineer and is specified in product specification sections to be removed; remove mock-up and clear area when directed to do so by Engineer.

1.6 TESTING AND INSPECTION SERVICES

A. Employ and pay for services of an independent testing agency or laboratory acceptable to Owner to perform specified testing.

1. Prior to start of Work, submit testing laboratory name, address, and telephone number, and names of full time specialist and responsible officer.
2. Submit copy of report of laboratory facilities inspection made by Materials Reference Laboratory of National Bureau of Standards during most recent inspection, with memorandum of remedies of deficiencies reported by inspection.

B. The independent firm will perform tests, inspections and other services specified in individual specification sections and as required by Engineer.

1. Laboratory Staff: Maintain full time specialist on staff to review services.
2. Testing Equipment: Calibrated at reasonable intervals with devices of an accuracy traceable to National Bureau of Standards or accepted values of natural physical constants.

C. Testing, inspections and source quality control may occur on or off project site. Perform off-site testing as required by Engineer.

D. Reports will be submitted by independent firm to Engineer and Contractor, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.
   1. Submit final report indicating correction of Work previously reported as non-compliant.

E. Cooperate with independent firm; furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.
   1. Notify Engineer and independent firm 24 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.

F. Testing and employment of testing agency or laboratory shall not relieve Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

G. Re-testing or re-inspection required because of non-conformance to specified requirements shall be performed by same independent firm on instructions by Engineer. Payment for re-testing or re-inspection will be by Contractor.

H. Contractor Responsibilities:
   1. Provide qualified third party testing entity.
   2. Collect samples as required by contract documents and as needed for Contractor means and methods. Review test results provided for by Contractor.
   3. Provide qualified personnel at site. Cooperate with Engineer and Owner in performance of services.
   4. Perform specified sampling and testing of products in accordance with specified standards.
   5. Provide test results to Engineer for review.
   6. Promptly notify Engineer of any observed irregularities or non-conformance of Work or products.
   7. Attend preconstruction meetings and progress meetings as needed to review results.

I. Reports: After each test, Contractor to promptly submit one copy of report to Engineer, Contractor, and authority having jurisdiction. When requested by Engineer, provide interpretation of test results. Include the following:
   1. Date issued.
   2. Project title and number.
   3. Name of inspector.
   4. Date and time of sampling or inspection.

5. Identification of product and specifications section.
6. Location in Project.
7. Type of inspection or test.
8. Date of test.
9. Results of tests.
10. Conformance with Contract Documents.

J. Limits On Testing Authority:
   1. Contractor or their third party testing entity may not release, revoke, alter, or enlarge on requirements of Contract Documents.
   2. Contractor, their third party testing entity, or laboratory may approve or accept any portion of the Work.

1.7 MANUFACTURERS' FIELD SERVICES

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. Submit qualifications of observer to Engineer 20 working days in advance of required observations. Observer is subject to approval of Engineer.

C. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

D. Refer to Section 01 33 00 - Submittal Procedures, MANUFACTURERS' FIELD REPORTS article.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

A. Contractor to provide and pay for third party testing and analysis services as required by the contract documents and in general conformance with the standard of care for such services.

B. Contractor shall notify Engineer a minimum of 48 hours prior to collecting samples.

C. Contractor shall deliver results within 24 hours of receiving them.

D. Contractor is responsible for any rework necessitated by Contractor proceeding prior to Engineer’s written acceptance of test results demonstrating conformance with contract requirements.

END OF SECTION

SECTION 01 50 00

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Public Utilities
   1. Agencies Affected
   2. Notification Requirements
   3. Contractor Responsibility

B. Temporary Utilities:
   1. Temporary electricity.
   2. Temporary lighting for construction purposes.
   3. Temporary cooling.
   4. Temporary ventilation.
   5. Internet service.
   6. Temporary water service.
   7. Temporary water storage and pumping.
   8. Temporary sanitary facilities.

C. Construction Facilities:
   1. Field offices and sheds.
   2. Vehicular access.
   3. Parking.
   4. Progress cleaning and waste removal.
   5. Project identification.
   6. Traffic regulation.
   7. Fire prevention facilities.

D. Temporary Controls:
   1. Barriers.
   2. Security.
   3. Water control.
   4. Dust control.
   5. Erosion and sediment control.
   6. Noise control.
   7. Pest control.
   8. Pollution control.
   9. Rodent control.

E. Removal of utilities, facilities, and controls.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 PUBLIC UTILITIES

A. Agencies Affected
   1. Electrical: Pacific Gas & Electric. It should be noted that where a structure is known to receive service does not have overhead service then underground service shall be assumed to exist.
   2. Gas (Propane): Sequoia Gas or Other. It should be noted that where a structure is known to receive service does not have overhead service then underground service shall be assumed to exist
   3. Telephone/Cable Service: AT&T and Suddenlink. It should be noted that where service to a structure is known to receive service does not have overhead service then underground service shall be assumed to exist.
   4. Potable Water Service: Owner has jurisdiction over potable water usage within the project area.
   5. Sanitary Sewer Service: Owner has jurisdiction over sanitary sewer usage within the project area.
   6. Drainage: Owner, County of Humboldt, or Caltrans has jurisdiction over drainage within the project area.

B. Notification Requirements
   1. Prior to any excavation in the vicinity of any existing underground facilities, including all water, sewer, storm drain, gas, or other pipelines; all buried electric power, communications, or television cables; all traffic signal and street lighting facilities; and all roadway; the Contractor shall notify the respective authorities representing the owners or agencies responsible for such facilities not less than three (3) work days nor more than seven (7) work days prior to excavation.
   2. Notify USA at (800) 227-2600 at least three (3) work days, but no more than fourteen (14) work days, prior to such excavation.

C. Contractor Responsibility
   1. The Contractor shall anticipate encountering water, sewer, electrical, communication, drainage and telephone/cable services. It may be expected that there will be variation in location from that as shown on the Plans to the actual location. Contractor responsible for verifying actual location in the field after pre-marking by the various utilities affected.
   2. No extra payment will be allowed for the removal, replacement, repair, or possible increased cost caused by inadvertent or planned interception and breaking of underground obstructions which may exist.
   3. It should be understood that the various utilities are indicated on the Plans to show only the approximate location and must be verified in the field by the Contractor. The various utility agencies will cooperate with the Contractor to endeavor to familiarize him with all known underground utilities obstructions, but this will not relieve the Contractor from full responsibility in anticipating and locating their actual location.
   4. The Contractor, in conjunction with the affected utility company(s), shall pothole and establish the horizontal and vertical locations of all utilities shown on the Plans and marked in the field. This may be done on an area-by-area basis, but shall be accomplished at least five working days in advance of the date of construction within such area. Any discrepancies (horizontal and/or vertical) between the locations of utilities found by the potholing operation than that shown on the Plans shall be brought to the Construction Manager's attention

immediately. Potholing shall be required at the connection to existing facilities prior to the shop drawing submittals.

1.4 TEMPORARY ELECTRICITY

A. Provide and pay for power service required from utility source or from portable generators as needed for construction operation.

B. Provide temporary electric feeder from existing electrical service if required. Coordinate location with the Engineer. Do not disrupt Owner's use of service.

C. Complement existing power service capacity and characteristics as required for construction operations.

D. Provide power outlets, with branch wiring and distribution boxes located as required for construction operations. Provide flexible power cords as required for portable construction tools and equipment.

E. Provide main service disconnect and over-current protection at convenient location.

F. Contractor to coordinate with District for convenience receptacles that may be required during construction.

1.5 TEMPORARY LIGHTING FOR CONSTRUCTION PURPOSES

A. Provide and maintain temporary lighting for construction operations as may be needed to achieve minimum lighting level of 2 watt/sq ft.

B. Provide and maintain 1 watt/sq ft lighting to exterior staging and storage areas after dark for security purposes.

C. Provide and maintain 0.25 watt/sq ft HID lighting to interior work areas after dark for security purposes if applicable.

D. Provide branch wiring from power source to distribution boxes with lighting conductors, pigtails, and lamps for specified lighting levels.

E. Maintain lighting and provide routine repairs.

F. Permanent building lighting may be utilized during construction.

1.6 TEMPORARY COOLING

A. Provide and pay for cooling devices and cooling as needed to maintain specified conditions for construction operations if applicable.

B. Prior to operation of permanent equipment for temporary cooling purposes, verify installation is approved for operation, equipment is lubricated and filters are in place. Provide and pay for operation, maintenance, and regular replacement of filters and worn or consumed parts.

C. Maintain maximum ambient temperature of 80 degrees F in areas where construction is in progress, unless indicated otherwise in specifications if applicable.

1.7 TEMPORARY VENTILATION

A. Ventilate enclosed areas to achieve curing of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases if applicable.

1.8 INTERNET SERVICE

A. Provide, maintain, and pay for high speed internet service to Contractor's and Engineer's field offices (if provided) at time of project mobilization. This may require wireless service be used until a land line can be brought to the site.

1.9 TEMPORARY WATER STORAGE AND PUMPING

A. Provide 20,000 gallons of temporary potable water storage including all associated pumping, piping, and control facilities until new storage and pumping system is installed to the satisfaction of the owner.

B. Contractor may choose to temporarily utilize the existing, to be demolished, pump station facilities as construction sequencing allows. Contractor is responsible for field verifying that existing pumping and control facilities are suitable for use with the temporary storage system.

1.10 TEMPORARY WATER SERVICE

A. Provide and pay for suitable quality water service as needed to maintain specified conditions for construction operations including as needed for compaction, dust control, etc. Contractor may purchase water from the District at standard rates and under standard requirements.

B. Provide metering for temporary water service.

C. Furnish cool, potable water for construction personnel in locations convenient to work stations.

1.11 TEMPORARY SANITARY FACILITIES

A. Provide and maintain required facilities and enclosures. Existing facility use is not permitted. Provide facilities at time of project mobilization.

1.12 FIELD OFFICES AND SHEDS

A. Locate offices and sheds minimum distance of 30 feet from existing and new structures.

B. Do not use permanent facilities, once constructed, for field offices or for storage.

C. Environmental Control:
   1. Storage Spaces: Ventilation as needed to maintain products in accordance with Contract Documents; lighting for maintenance and inspection of products.

D. Storage Areas And Sheds: Size to storage requirements for products of individual Sections, allowing for access and orderly provision for maintenance and for inspection of products to requirements of Section 01 60 00 - Product Requirements.

E. Preparation: Fill and grade sites for temporary structures sloped for drainage away from buildings.

F. Installation:
   1. Install office spaces for Contractor's use as deemed necessary by Contractor ready for occupancy 15 working days after date fixed in Notice to Proceed.
   2. Employee Residential Occupancy: Not allowed on property.

G. Maintenance and Cleaning:
   1. Periodic cleaning and maintenance for office and storage areas.
   2. Maintain approach walks free of mud and water.

H. Removal: At completion of Work remove temporary fill, buildings, foundations, utility services, and debris. Restore areas.

1.13 VEHICULAR ACCESS

A. Construct temporary all-weather access roads from public thoroughfares to serve construction area, of width and load bearing capacity to accommodate unimpeded traffic for construction purposes, if applicable. Remove temporary access road at completion of project and restore site to pre-existing condition.

B. Construct temporary bridges and culverts to span low areas and allow unimpeded drainage if required.

C. Extend and relocate vehicular access as Work progress requires, provide detours as necessary for unimpeded traffic flow if required.

D. Location approved by Engineer.

E. Provide unimpeded access for emergency vehicles. Maintain 20 feet wide driveways with turning space between and around combustible materials.

F. Provide means of removing mud from vehicle wheels before entering streets. Comply with any other requirements of project permits

1.14 PARKING

A. Locate as approved by Engineer.

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

C. Tracked vehicles not allowed on paved areas.

D. Do not allow heavy vehicles or construction equipment in parking areas.

E. Permanent Pavements And Parking Facilities:

1. Prior to Substantial Completion, bases for permanent roads and parking areas may be used for construction traffic.
2. Avoid traffic loading beyond paving design capacity. Tracked vehicles not allowed.

F. Maintenance:
1. Maintain traffic and parking areas in sound condition free of excavated material, construction equipment, products, and mud
2. Maintain existing and permanent paved areas used for construction; promptly repair breaks, potholes, low areas, standing water, and other deficiencies, to maintain paving and drainage in original, or specified, condition.

G. Removal, Repair:
1. Remove temporary materials and construction at Substantial Completion.
2. Remove underground work and compacted materials to depth of 2 feet; fill and grade site as specified.
3. Repair facilities damaged by use, to specified condition.

1.15 PROGRESS CLEANING AND WASTE REMOVAL

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

B. Remove debris and rubbish from work areas.

C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.

D. Collect and remove waste materials, debris, and rubbish from site weekly and dispose off-site.

E. Free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids if applicable.

F. Restore area.

1.16 TRAFFIC REGULATION

A. Haul Routes:
1. Consult with authority having jurisdiction, establish public thoroughfares to be used for haul routes and site access.
2. Confine construction traffic to designated haul routes.
3. Coordinate with Owner on the establishment of a haul route to take excess soil to established stockpile areas.
4. Provide traffic control at critical areas of haul routes to regulate traffic, to minimize interference with public traffic.

B. Traffic Signs And Signals:
1. Provide signs at approaches to site and on site, at crossroads, detours, parking areas, and elsewhere as needed to direct construction and affected public traffic.

2. Provide, operate, and maintain traffic control signals to direct and maintain orderly flow of traffic in areas under Contractor's control, and areas affected by Contractor's operations.
3. Relocate as Work progresses, to maintain effective traffic control.
4. See typical traffic control requirements within the design set.

C. Removal:
1. Remove equipment and devices when no longer required.
2. Repair damage caused by installation.
3. Remove post settings to depth of 2 feet.

1.17 FIRE PREVENTION FACILITIES

A. Prohibit smoking within buildings under construction. Designate area on site where smoking is permitted. Provide approved ashtrays in designated smoking areas.

B. Establish fire watch for cutting and welding and other hazardous operations capable of starting fires. Maintain fire watch before, during, and after hazardous operations until threat of fire does not exist.

C. Portable Fire Extinguishers: NFPA 10; 10 pound capacity, 4A-60B: C UL rating.
1. Provide one fire extinguisher at each stair on each floor of buildings under construction if applicable.
2. Provide minimum one fire extinguisher in every construction trailer and storage shed.
3. Provide minimum one fire extinguisher on roof during roofing operations using heat producing equipment if applicable.
4. Provide minimum one fire extinguisher in every piece of construction equipment or service truck.

1.18 BARRIERS

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

B. Keep the public and other unauthorized personnel away from trenches and other excavations. Cover excavations with plates when not managed by contractor’s personnel. Provide other types of barriers as needed to control construction areas.

C. Provide protection for plants designated to remain. Replace damaged plants.

1.19 SECURITY

A. Security Program:
1. Protect Work and existing premises from theft, vandalism, and unauthorized entry.
2. Initiate program at project mobilization.
3. Maintain program throughout construction period until Owner occupancy.

B. Entry Control:

1. Restrict entrance of persons and vehicles into Project site.
2. Prepare list of authorized persons and allow entrance only to authorized persons.
3. Maintain log of visitors, make available to Owner on request.

1.20 WATER CONTROL

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

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

1.21 DUST CONTROL

A. Execute Work by methods to minimize raising dust from construction operations.

B. Provide positive means to prevent air-borne dust from dispersing into atmosphere including water and containment

1.22 EROSION AND SEDIMENT CONTROL

A. Implement approved erosion and sediment control measures as shown on the plans. Follow Best Management Practices for any other situations not specifically covered by a plans.

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

C. Minimize surface area of bare soil exposed at one time. Provide straw mulch, coir rolls, silt fences, and other means of controlling runoff and erosion.

D. Provide temporary measures including berms, dikes, and drains, and other devices to prevent water flow.

E. Construct fill and waste areas by selective placement to avoid erosive surface silts or clays.

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

1.23 NOISE CONTROL

A. Provide methods, means, and facilities to minimize noise produced by construction operations.

1.24 PEST CONTROL

A. Provide methods, means, and facilities to prevent pests and insects from damaging the Work.

1.25 POLLUTION CONTROL

A. Implement approved pollution control measures as detailed in the plans.

B. 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.

C. Comply with pollution and environmental control requirements of authorities having jurisdiction.

D. Do not dispose of volatile wastes or oils in storm or sanitary drains or on the ground.

E. Do not allow waste materials to be washed into streams, wetlands or any bodies of water.

1.26 RODENT CONTROL

A. Provide methods, means, and facilities to prevent rodents from accessing or invading premises, which may include but is not limited to hiring a licensed pest control contractor certified for work on schools if a problem develops.

1.27 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. Remove temporary utilities, equipment, facilities, materials, prior to Substantial Completion inspection.

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

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

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

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

END OF SECTION

SECTION 01 55 50

TEMPORARY TRAFFIC CONTROL SYSTEMS

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide all materials, equipment, and labor necessary to furnish, place, and maintain all temporary traffic control systems, including construction and maintenance area traffic control devices and flaggers as required to perform the Work in accordance with this Section, and all other appurtenant Work, complete in place, as shown on the Contract Drawings and as specified herein.

B. Section Includes:
   1. Review of proposed Work areas to determine temporary traffic control requirements.
   2. Verification of temporary traffic controls with the Project Engineer or the Owner prior to implementation.
   3. Maintenance of traffic control during the Work.
   4. Monitoring traffic control during the Work to determine necessary changes required to maintain adequacy.
   5. Maintenance of traffic control during non-work hours to maintain adequacy.
   6. Removal of temporary traffic control systems after completion of the Work.

1.2 REFERENCES

A. General Conditions, Section 48 – Public Convenience.

B. State of California, Department of Transportation (Caltrans) Specifications and Standards
   1. Standard Specifications
      a. Section 7 Legal Relations and Responsibility to the Public
      b. Section 12 Temporary Traffic Control
   2. Standard Plans
      a. Temporary Traffic Control Systems
   3. California Manual on Uniform Traffic Control Devices, Current Edition (California MUTCD)

C. Commercial Standards
   1. State of California, Division of Industrial Safety, Department of Industrial Relations.
   2. Safety Orders of the Division of Industrial Safety, Department of Industrial Relations of the State of California, current edition.

1.3 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.4 SUBMITTALS

A. In addition to the submittal requirements of Section 01 33 00 Submittal Procedures, the Contractor shall provide the following at least fourteen (14) calendar days prior to excavation or horizontal directional drilling and shall meet with the approval of the Owner:

1. The Contractor shall submit for review by the Engineer, a Work Zone Traffic Control Plan on 11" x 17" format which contains only information specifically related to work zone traffic control, including pedestrian traffic control. The plan will show which California MUTCD typical applications are to be used for each work operation in addition to site specific traffic control. If the Contractor proposed to use the current edition of California MUTCD in specific work operations, they shall submit in writing for consideration which Typical Application Diagram will be used for each work operation. The Work Zone Traffic Control Plan shall be specific to the proposed method of pipeline construction (open trench or horizontal directional drill), and shall include:
    a. Specific details for construction staging, including the location and limits of the work zone.
    b. Identification of changeable message board locations. A minimum of 2 changeable message boards and 2 arrow boards shall be required.
    c. Locations of all excavations.
    d. American's with Disabilities Act (ADA) compliant pedestrian routing plans and details showing how pedestrians will be routed through the work area.
    e. Plans for protection of the public from construction-related hazards.
    f. Lane closures and traffic routing including consideration of construction-related trucking routes.
    g. A trucking route for approval by the Engineer. The route must minimize traffic on residential streets that are not part of the project.
    h. Lane closure markings, barricade locations, and sign locations showing the necessary signing, methods of delineation and channelization and reference to the appropriate Caltrans standards and California MUTCD details for all affected roads.
    i. Dimensions of lanes affected by traffic control that will be open to traffic.
    j. Dimensions and locations of signs and cone tapers.
    k. Identification of side streets and driveways affected by construction and show how they will be handled.
    l. Detail of how public transit will be handled through the construction area.
    m. Time periods of lane closures and detours.

2. The Work Zone Traffic Control Plan shall contain a title block which contains the Contractor's name, address, phone number, project superintendent's name, contract name, dates and hours traffic control will be in effect, and a space for review acknowledgment.
3. The Work Zone Traffic Control Plan shall be prepared by a licensed California Civil or Traffic Engineer. The Work Zone Traffic Control Plan shall be submitted to the Engineer and other affected agencies for review at least two weeks prior to implementation in order to determine the Contractor's compliance with the requirements of this section.
4. No work except for installation of project identification signs will be allowed to commence prior to approval of the Work Zone Traffic Control Plan.

5. A "Letter of Responsibility," on company letterhead, indicating the names and telephone numbers of at least three different persons who shall be available to be contacted in case of emergency at any time during the life of the contract. Said persons must have decision-making authority within the company.

PART 2 PRODUCTS

2.1 GENERAL

A. All construction area stationary and portable sign panels, lights, barricades, and traffic control devices shall be the product of a commercial sign or safety device manufacturer conforming to the requirements of Section 12, Temporary Traffic Control, of the Caltrans Standard Specifications, unless otherwise specified in this Section, shown on the Drawings, and/or as directed by the Engineer.

PART 3 EXECUTION

3.1 GENERAL

A. No work shall commence until traffic control signing has been approved by the Engineer.

B. The Contractor shall provide all appropriate traffic control measures in accordance with this Section prior to start of construction in the public right-of-way or in any area adjacent to the street right of way where public safety is affected.

C. The Contractor shall take all necessary precautions for the protection of the Work and the safety of its employees and the public. Traffic shall be maintained through the construction or maintenance zone in accordance with Sections 7-1.08, 7-1.09 and 12 of the Caltrans Standard Specifications.

D. Field changes to traffic control plans shall be approved by the Engineer prior to installation.

E. When traffic cones or delineators are used to delineate a temporary edge of a traffic lane, the line of cones or delineators shall be considered to be the edge of the traffic lane, however, the Contractor shall not reduce the width of an existing lane to less than 10 feet without written approval from the Engineer.

F. All construction area signs, lights, barricades, and traffic control devices shall be furnished, installed, maintained, and removed in conformance with the latest edition of the California MUTCD. Additional or alternate signs may only be used when specifically authorized by the Engineer.

G. The Contractor shall monitor traffic and safety conditions and maintain adequate traffic control measures during both work and non-work hours in order to maintain compliance with the requirements of this Section.

H. The Contractor shall conform to all requirements of the current "Safety Orders of the Division of Industrial Safety, Department of Industrial Relations of the State of California."

I. If a hazardous condition is observed and the Engineer notifies the Contractor either directly or by telephone, the Contractor shall correct the condition immediately. If the Contractor fails to correct the hazardous condition immediately, the Owner reserves the right to call in a local contractor to perform the necessary work needed to improve public safety. The cost incurred shall be billed to the Contractor. Should the Engineer point out any inadequacy of warning and protective measures, such action on the part of the Engineer shall not relieve the Contractor from responsibility for public safety nor abrogate his obligation to furnish and pay for these devices.

J. All construction area signs, lights, barricades, and temporary traffic control devices shall be completely removed from the roadway when not in use. Locations and methods of storing traffic control equipment adjacent to the roadway between interrupted use shall require prior approval of the Engineer.

K. The Contractor shall completely remove all temporary signs, striping and/or delineators and restore the pavement, as necessary, upon removal or relocation of any temporary traffic controls or detours constructed as part of the Work.

L. Temporary traffic control measures shall be in effect only during Work hours. Normal traffic routing shall be reestablished at the end of each workday.

M. Contractor shall conduct his operation as to offer the least possible obstruction and inconvenience to the public, and he shall have under construction no greater amount of Work than he can prosecute properly with due respect to the rights of the public. Contractor shall provide personal advance notice to each affected resident or business informing him of impending work and provide ample time to remove vehicles and estimated time of driveway closure. This shall be accomplished by delivering a notice to all houses or businesses to be affected by the impending work. The notice shall be typed and signed by the contractor or his designated superintendent. The format and contents of the notice shall be approved by the Engineer prior to commencement of the Work.

N. Construction operations shall be conducted in such a manner as to cause as little inconvenience as possible to abutting property owners. Convenient access to drive-ways, houses, and buildings along the line of the work shall be maintained, and temporary approaches to crossings or intersecting roads shall be provided and kept in good condition.

O. Whenever the Contractor’s operations create a condition hazardous to the public, furnish, erect, and maintain such fences, barricades, lights, signs and other devices as are necessary to prevent accidents or damage or injury to the public.

P. Should the Contractor appear to be neglectful or negligent in furnishing warning and productive measures as above specified, the Engineer may direct attention to the existence of hazard, and the necessary warning and protective measures shall be furnished and installed by the Contractor at his expense, without cost to the Owner. Should the Engineer point out any inadequacy of warning and protective measures,

such action on the part of the Engineer shall not relieve the Contractor from responsibility for public safety nor abrogate his obligation to furnish and pay for these devices.

Q. Under no circumstances shall access to businesses or residences be held up more than 30 minutes at any one time. The Contractor may coordinate with property and business owners to schedule work so that longer delays do not adversely affect residents or business owners to their satisfaction. In addition, Contractor shall give personal notice to all affected property owners as specified in paragraph M, hereinbefore. Before closing any street to through traffic, Contractor shall obtain prior approval from the Engineer seven (7) calendar days in advance of closure. Contractor shall at all times provide access to public facilities such as schools, etc. and make provisions for passage of emergency vehicles.

3.2 PEDESTRIAN TRAFFIC

A. The Contractor is directed to Chapter 6D, Pedestrian and Worker Safety, in the California MUTCD, the Drawings, and these Specifications.

B. Pedestrians shall be provided with a safe, convenient and accessible path that, at a minimum, replicates the most desirable characteristics of the existing sidewalk, path or footpath.

C. The Contractor shall construct and maintain temporary pedestrian pathways through the work zone, where required, that shall be in compliance with the requirements of the Americans with Disabilities Act (ADA) and the California MUTCD.

D. Pedestrian routes shall not be impacted for the purposes of any non-construction activities such as parking of vehicles or equipment, or stock piling of materials.

E. Pedestrians shall not be led into conflicts with work site vehicles, equipment or operations.

END OF SECTION

SECTION 01 60 00

PRODUCT REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Products.

B. Product delivery requirements.

C. Product storage and handling requirements.

D. Product options.

E. Product substitution procedures.

F. Equipment electrical characteristics and components.

1.2 PRODUCTS

A. Furnish products of qualified manufacturers suitable for intended use. Furnish products of each type by single manufacturer unless specified otherwise.

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

C. Furnish interchangeable components from same manufacturer for components being replaced.

D. Materials and equipment are to be new.

1.3 PRODUCT DELIVERY REQUIREMENTS

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

B. Promptly inspect shipments to ensure products comply with requirements, quantities are correct, and products are undamaged.

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

D. Arrange deliveries of materials in accordance with construction schedules; coordinate to avoid conflict with work and conditions at the site. Deliver materials in undamaged condition, in manufacturer’s original containers or packaging, with identifying labels intact and legible. Contractor is encouraged to obtain materials in biodegradable or recyclable/reusable packaging which uses the minimum amount of packaging possible.

1.4 PRODUCT STORAGE AND HANDLING REQUIREMENTS

A. Store and protect products in accordance with manufacturers' instructions.

B. Store with seals and labels intact and legible.

C. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.

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

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

F. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.

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

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

I. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

1.5 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: Products of one of manufacturers named and meeting specifications, no options or substitutions allowed.

C. Products Specified by Naming One or More Manufacturers with Provision for Substitutions: Submit request for substitution for any manufacturer not named in accordance with the following article.

D. The Contractor is encouraged to submit for approval products made out of recycled or environmentally responsible materials.

1.6 PRODUCT SUBSTITUTION PROCEDURES

A. Engineer will consider requests for Substitutions only within 60 calendar days after date established in Notice to Proceed.

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

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

D. A request constitutes a representation that Contractor:
   1. Has investigated proposed product and determined that it meets or exceeds quality level of specified product.
   2. Will provide same warranty for Substitution as for specified product.
   3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
   4. Waives claims for additional costs or time extension which may subsequently become apparent.
   5. Will reimburse Owner for review or redesign services associated with re-approval by authorities having jurisdiction.

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 Contract Documents.

F. Substitution Submittal Procedure:
   1. Submit four copies 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 proposed product equivalence. Burden of proof is on proposer.
   3. 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

SECTION 01 70 00

EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Closeout procedures.

B. Final cleaning.

C. Starting of systems.

D. Demonstration and instructions.

E. Testing, adjusting and balancing.

F. Protecting installed construction.

G. Project record documents.

H. Operation and maintenance data.

I. Spare parts and maintenance products.

J. Product warranties and product bonds.

1.2 CLOSEOUT PROCEDURES

A. Closeout Submittals
   1. Project Record Drawings: As specified in individual Sections and this Section 01 70 00 Execution and Closeout Requirements.
   2. Warranties and Bonds: As specified in individual sections and this Section 01 70 00 Execution and Closeout Requirements.

B. Substantial Completion and Final Inspection
   1. Submit written certification that project, or designated portion of project, is substantially complete, and request in writing a final inspection. Certification shall include a listing of significant items that are not complete in accordance with the Contract and shall indicate the schedule date for the completion of these items. Upon receipt of written certification that Project is substantially complete; the Engineer will proceed with inspection within 10 working days of receipt of request or will advise the Contractor of items that prevent the Project from being designated as substantially complete.
   2. If, following final inspection, the work is determined to be substantially complete, Engineer will prepare a list of deficiencies to be corrected before final acceptance and issue a Letter of Substantial Completion. Contractor shall complete the work described on the list of deficiencies within 30 calendar days. If the Contractor fails to complete the work within this time frame, the Engineer may either replace or correct the work with an appropriate reduction in the Contract price or charge

for re-inspection costs in accordance with the Inspection of Construction clause of the contract.

3. If, following final inspection, the work is not determined to be substantially complete, Engineer will notify Contractor in writing. After completing work, Contractor shall resubmit certification and request a new final inspection. All re-inspection costs shall be paid for by the Contractor.

C. Acceptance of Work
   1. After all deficiencies have been corrected a Letter of Acceptance will be issued.

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

1.3 FINAL CLEANING

A. Execute final cleaning prior to final project assessment.

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

C. Dispose of concrete and other debris off site.

D. Move all clean surplus soils to stockpile area.

1.4 STARTING AND TESTING OF SYSTEMS

A. Coordinate schedule for start-up and testing of systems.

B. Notify Engineer five working days prior to start-up and testing.

C. Submit a written report in accordance with Section 01 33 00 - Submittal Procedures that facilities have been properly installed, tested and area functioning correctly.

1.5 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate facilities to Owner's personnel two weeks prior to date of Substantial Completion.

B. Demonstrate any start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of facilities as applicable.

1.6 TESTING, ADJUSTING AND BALANCING

A. Provide additional testing, adjusting, and balancing if required. Reports will be submitted by independent firm to Engineer indicating observations and results of tests and indicating compliance or non-compliance with requirements of Contract Documents.

1.7 PROTECTING INSTALLED CONSTRUCTION

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 prevent damage.

C. Prohibit traffic from landscaped areas.

1.8 PROJECT RECORD DOCUMENTS

A. Maintain on site one set of the following record documents; record actual revisions to the Work:
   1. 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 instruction for assembly, installation, and adjusting.

B. Ensure entries are complete and accurate, enabling future reference by Owner.

C. Store record documents separate from documents used for construction.

D. Record information concurrent with construction progress, not less than weekly. Make record drawings available to the Engineer for inspection at the time of monthly progress payment requests. If project record drawings are not current, the Engineer may retain an appropriate amount of the progress payment.

E. 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.

F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
   1. Measured depths of foundations in relation to finish floor datum.
   2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
   3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
   4. Field changes of dimension and detail.
   5. Details not on original Contract drawings.

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

1.9 OPERATION, MAINTENANCE, AND MANUFACTURER’S DATA

A. Submit data bound in 8-1/2 x 11 inch text pages, three D side ring binders with durable plastic covers.

B. Prepare binder cover with printed title "OPERATION, MAINTENANCE, AND MANUFACTURER’S DATA", title of project, and subject matter of binder when multiple binders are required.

C. Internally subdivide binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.

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

E. Contents: Prepare Table of Contents for each volume, with each product or system description identified, typed on white paper, 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 specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following as 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 special 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. Air and water balance reports.
      c. Certificates.
      d. Originals of warranties and bonds.

1.10 SPARE PARTS AND MAINTENANCE PRODUCTS

A. Furnish spare parts, maintenance, and extra products in quantities specified in individual Specification Sections.

B. Deliver to Project Site and place in location as directed by Owner; obtain receipt prior to final payment.

1.11 PRODUCT WARRANTIES AND PRODUCT BONDS

A. Obtain warranties and bonds executed in duplicate by responsible subcontractors, suppliers, and manufacturers, within ten working days after completion of applicable item of work.

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

C. Verify documents are in proper form, contain full information, and are notarized.

D. Co-execute submittals when required.

E. Include Table of Contents and assemble in three D side ring binder with durable plastic cover.

F. Submit prior to final Application for Payment.

G. Time Of Submittals:
   1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within ten working days after acceptance.
   2. Make other submittals within ten working days after Date of Substantial Completion, prior to final Application for Payment.
   3. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within ten working days after acceptance, listing date of acceptance as beginning of warranty or bond period.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

END OF SECTION

SECTION 02 41 16

SITE DEMOLITION AND DEBRIS REMOVAL

PART 1 GENERAL

1.1 DESCRIPTION

A. Work Includes:
   1. Site Demolition required for this Work shall be as specified on contract drawings and as otherwise required to complete the work shown on the drawings. Site demolition is needed to access existing utilities, make utility connections, install new utilities, and other related work necessitated by the utility replacement work.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 JOB CONDITIONS

A. Extent and Character of Demolition:
   1. Prior to bidding, the contract shall verify the extent and character of demolition required to complete the work as shown on the plans and as required by the specifications. The contractor shall anticipate that the area requiring demolition shall be more extensive than that shown on the plans due to materials encountered during excavations, vegetation covering areas to be demolished, and the overall nature of the work. Also, the contractor should expect that the thickness and character of the materials to be demolished shall be more extensive that may be shown and could be variable. Concrete should be assumed to be reinforced with rebar.

B. Dust control:
   1. Use all means necessary to prevent the spread of dust during performance of the work of this Section. The contractor shall be responsible for obtaining and paying for water for dust control.

C. Runoff and Erosion Control:
   1. The contractor shall be responsible for complying with the Stormwater Best Management Practices and any other requirements of permits required for the project. This shall include the control of runoff and erosion associated with demolition.

D. On Site Burning
   1. On-site burning will not be permitted.

E. Protection:
   1. Use all means necessary to protect existing structures designated to remain and, in the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer at no additional cost to the Owner.

2. Use all means necessary to protect existing utilities, roadways, driveways, paths of travel and other features to remain in service.
3. The campus shall be in active use throughout the construction project and so the contractor is responsible for coordinating activities with the owner and installing and maintaining temporary barricades, trench plates, detours, and other control features to allow campus activities to continue while protecting work areas and students.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 SITE INSPECTION

A. Prior to bidding and again prior to any demolition work, carefully inspect the site and determine the extent of work involved as well as above and below ground utilities. The contractor shall locate all utilities prior to demolition. The contractor should anticipate that not all utilities are shown on the plans and that further investigation by the contractor is required.

B. Report any discrepancy to the Engineer immediately.

3.2 COORDINATION AND SCHEDULING

A. Schedule and coordinate demolition with Owner, any utilities or other contractors which may be involved.

3.3 HAZARDOUS MATERIALS

A. A copy of a hazmat report is included as an attachment to this Document, titled *Limited Hazardous Materials Assessment Survey Report* Manila Community Services District Off and Water Storage Infrastructure Drinking Water Infrastructure Improvement Project, dated May 30, 2018 and prepared by GHD.

B. This report identifies asbestos material suspect lead materials subject to applicable regulations, recommendations for removal, and agency notifications.

C. Contractor shall assume existing piping to be asbestos cement and shall handle accordingly.

3.4 SAFETY

A. All work shall conform to pertinent OSHA regulations and to other local codes and ordinances as applicable.

3.5 REMOVAL OF DEBRIS AND SITE RESTORATION

A. Remove all debris from the site and dispose of in accordance with all local and federal laws and regulations. Leave the site in a neat and orderly condition. Restore areas as specified on the plans or as per preconstruction conditions.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Formwork
   2. Reinforcement
   3. Accessories
   4. Cast-in place concrete
   5. Finishing and curing

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal requirements.

B. Shop Drawings:
   1. Indicate pertinent dimensioning, location of construction joints, and pouring sequence.
   2. Indicate reinforcement sizes, spacing, locations, and quantities, bending and cutting schedules.

C. Product Data: Indicate admixtures, anchors, grout, and epoxy grout.

D. Design Data: Submit mix designs.

E. Testing: submit results of testing including compressive strength and slump.

F. Transit mix delivery slips
   1. Keep a record at the job site showing the time and place of each pour of concrete, together with transit mix delivery slip certifying contents of the pour, time of batching, etc.

1.4 QUALITY ASSURANCE

A. Construct and erect concrete formwork in accordance with ACI 318.

B. Perform concrete reinforcing work in accordance with ACI 318.

C. Perform cast-in-place concrete work in accordance with ACI 318 .

D. Qualifications of workmen:
   1. Provide at least one (1) person who shall be present at all times during execution of this portion of the Work and who shall be thoroughly trained and experienced

in placing the types of concrete specified and who shall direct all Work performed under this Section.

2. For finishing of exposed surfaces of the concrete, use only thoroughly trained and experienced journeyman concrete finishers.

PART 2 PRODUCTS

2.1 FORM MATERIALS AND ACCESSORIES

A. Form Materials: At discretion of Contractor.

B. Form Release Agent: Colorless mineral oil not capable of staining concrete or impairing natural bonding characteristics of coating intended for use on concrete.

2.2 REINFORCEMENT MATERIALS

A. Reinforcing Steel: ASTM A615/A615M, 60 ksi yield grade, deformed billet bars, uncoated finish.

B. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for support of reinforcing; plastic tipped or non-corroding for supports in slabs forming finished ceilings or where supports are exposed to weather.

C. Fabricate concrete reinforcement in accordance with ACI 318.

2.3 CONCRETE MATERIALS

A. Cement: ASTM C150, Normal-Type I Portland type.

B. Fine and Coarse Aggregates: ASTM C33. Maximum aggregate size.

C. Water: Clean and not detrimental to concrete.

D. Air Entrainment Admixture: ASTM C260.

E. Non-shrink Grout: Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents.

F. Epoxy Grout: ASTM C881, two-component high-solids epoxy based system supplied in manufacturer's standard cartridge and dispensed through a static-mixing nozzle supplied by the manufacturer. Anchors and dowels shall be installed per manufacturer’s instructions.

G. Pozzolan: If used for cement replacement, shall conform to ASTEM C618 Class N or Class F (fly ash) with the following exceptions:

1. Pozzolanic activity index with lime, at 7 days, shall be 1000 psi minimum (Table 2, ASTM C618).

H. All other materials not specifically described but required for a complete and proper installation or cast-in-place concrete, shall be as selected by the Contractor subject to the approval of the Engineer.

2.4 COMPOUNDS, HARDENERS AND SEALERS

A. Curing Compound: ASTM C309, Type 1, Class A.

B. Membrane Curing Compound: ASTM C1315 Type I, Class C.

C. Absorptive Mats Type C: ASTM C171.

2.5 CONCRETE MIX

A. Mix and deliver concrete in accordance with ASTM C94/C94M, Option A.

B. Furnish concrete of the following strength:
   1. Compressive strength 3000 psi (28 day).
   2. Slump four (4) to six (6) inches.

C. Select admixture proportions for normal weight concrete in accordance with ACI 318.

PART 3 EXECUTION

3.1 FORMWORK ERECTION

A. Erect formwork, shoring and bracing to achieve design requirements.

B. Provide bracing to ensure stability of formwork.

C. Form external corners of all concrete with 1/2 inch chamfer.

D. Apply form release agent to formwork prior to placing form accessories and reinforcement.

E. Do not apply form release agent where concrete surfaces will receive special finishes or applied coverings affected by agent.

F. Clean forms as erection proceeds, to remove foreign matter.

3.2 INSERTS, EMBEDDED COMPONENTS, AND OPENINGS

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

B. Coordinate work of other sections in forming and setting openings, slots, recesses, chases, sleeves, bolts, anchors, and other inserts.

C. Install concrete accessories straight, level, and plumb.

3.3 REINFORCEMENT PLACEMENT

A. Place reinforcement, supported and secured against displacement.

B. Ensure reinforcing is clean, free of loose scale, dirt, or other foreign coatings.

C. Space reinforcement bars with minimum clear spacing in accordance with ACI 318.

D. Maintain concrete cover around reinforcement in accordance with ACI 318.

3.4 PLACING CONCRETE

A. Prepare previously placed concrete by cleaning with steel brush and applying bonding agent.

B. Remove all wood scraps, debris, and standing water from the areas in which concrete will be placed. Use cleanout openings in wall forms and otherwise where access for removal of debris is not practicable.

C. Place concrete continuously between predetermined expansion, control and construction joints. Do not break or interrupt successive pours creating cold joints unless approved by the Engineer during the submittal process.

D. Concrete shall be placed and consolidated by methods that will not cause segregation of the aggregates and will result in dense, homogeneous concrete which is free of voids and rock pockets. All concrete shall be placed while fresh and before it has taken an initial set.

E. Forms and subgrade shall be thoroughly moistened with water immediately before placing concrete.

F. Concrete shall be consolidated by means of high frequency internal vibrations within 15 minutes after it is deposited in the forms. The vibrators shall not be attached to or held against the forms or reinforcing steel. The vibration shall be done with care and in such a manner that displacement of reinforcement is avoided.

G. Where new concrete is doweled to existing work, drill holes in existing concrete and secure dowels with epoxy grout per manufacturer’s instructions.

H. Screed slabs-on-grade level, unless it is sloped to a drain.

3.5 FORM REMOVAL

A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.

B. Remove formwork progressively and in accordance with code requirements.

3.6 CURING AND PROTECTION

A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
   1. Protect concrete footings from freezing for minimum 5 days.

B. Place absorptive matting, moisten, and keep damp.

C. Immediately after placement, protect concrete from premature drying.

D. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete for not less than 7 days.

E. At formed surfaced wet forms at least twice daily or sufficient to minimize moisture loss until forms are removed or until 7 days have elapsed from time of pour. If forms are removed before 7 days, cure concrete for remaining days similar to exposed surfaces.

3.7 FORMED SURFACES

A. Provide all formed surfaces with smooth rubbed finish.

3.8 ERECTION TOLERANCES

A. Install reinforcement within tolerances required by ACI 318.

3.9 FIELD QUALITY CONTROL

A. Contractor to hire an independent materials tester to perform field inspection and testing in accordance with ACI 318.

B. Reinforcement Inspection:
   1. Inspect for correct materials, fabrication, sizes, locations, spacing, concrete cover, and splicing.

C. Strength Test Samples:
   1. Sample concrete and make one set of three cylinders for every 150 cu yds or less of each class of concrete placed each day and for every 5,000 sf of surface area for slabs and walls.

D. Field Testing:
   1. Measure slump and temperature for each compressive strength concrete sample.
   2. Measure air content in air entrained concrete for each compressive strength concrete sample.

E. Cylinder Compressive Strength Testing:
   1. Test Method: ASTM C39/C39M.
   2. Test Acceptance: In accordance with ACI 318.
   3. Test two cylinders at 28 days.
   4. Retain one cylinder for 56 days for testing when requested by the Engineer.
   5. Dispose remaining cylinders when testing is not required.

F. Contractor to submit all test results to Engineer for final approval.

G. Notification: Notify the Engineer at least 60 hours prior to placing concrete.

3.10 DEFECTIVE CONCRETE

A. Modify or replace concrete not conforming to required lines, details and elevations, as directed by the Engineer.

END OF SECTION

SECTION 03 60 00

GROUT

PART 1 GENERAL

1.1 SUMMARY OF SECTION

A. The principal items specified herein are:
   1. Non-Shrink Grout: Non-Shrink grout is to be used unless another type is specifically referenced or shown on the Drawings.
   2. Epoxy Grout
   3. Cement Grout

B. The Contractor shall provide all materials, equipment, and labor necessary to furnish and place grout and shall form, mix, place, cure, repair, finish, and do all other work as necessary to produce finished grout as shown on the Drawings and as specified herein.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCED CODES AND SPECIFICATIONS

A. The following standards apply:
   1. Specifications, codes, and standards shall be as specified in Section 03 30 00, Cast-in-Place Concrete, and as referred to herein.
   2. Commercial Standards:
      a. ASTM C 109 Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-In. or 50-mm Cube Specimens).
      b. ASTM C 531 Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacings.
      c. ASTM C 579 Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacings.
      d. ASTM C 827 Test Method for Change in Height of Early Ages of Cylindrical Specimens from Cementitious Mixtures.
      e. ASTM D 696 Test Method for Coefficient of Linear Thermal Expansion of Plastics.
      f. CRD-C 621 Corps of Engineers Specification for Non-shrink Grout.

1.4 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – “Submittal Procedures”:
   1. Certificates of Compliance: Certificates of Compliance shall be provided for all products and materials proposed to be used under this Section.
   2. Manufacturer’s preprinted, or on letterhead, written standard instructions for material handling, safety procedures, surface preparation, mixing, application, disposal, and acceptable repair methods as proposed for use on this project.

PART 2 PRODUCTS

2.1 PREPACKAGED GROUTS

A. Non-Shrink Grout:
   1. Non-shrink grout shall be a prepackaged, inorganic, non-gas-liberating, non-metallic, cement-based grout requiring only the addition of water. Manufacturer's instructions shall be printed on each bag or other container in which the materials are packaged. The specific formulation for each class of non-shrink grout specified herein shall be that recommended by the manufacturer for the particular application.
   2. Non-shrink grouts shall have a minimum 28-day compressive strength of 7000 psi; shall have no shrinkage (zero percent) and a maximum 4.0 percent expansion in the plastic state when tested in accordance with ASTM C 827; and shall have no shrinkage (zero percent) and a maximum of 0.2-percent expansion in the hardened state when tested in accordance with CRD C 621.
   3. Application: Non-shrink grout shall be used for the repair of all holes and defects in concrete members, grouting under all equipment base plates, and at all locations where non-shrink grout is specified.

B. Epoxy Grout:
   1. Epoxy grout shall be a pourable, non-shrink, 100-percent solids system. The epoxy grout system shall have 3 components: resin, hardener, and specially blended aggregate, all premeasured and prepackaged. The resin component shall not contain any non-reactive diluents. Resins containing butyl glycidyl ether (BGE) or other highly volatile and hazardous reactive diluents are not acceptable. Variation of component ratios is not permitted unless specifically recommended by the manufacturer. Manufacturer's instructions shall be printed on each container in which the materials are packaged.
   2. The chemical formulation of the epoxy grout shall be that recommended by the manufacturer for the particular application.
   3. The mixed epoxy grout system shall have a minimum working life of 45 minutes at 75 degrees F.
   4. The epoxy grout shall develop a compressive strength of 5000 psi in 24 hours and 10,000 psi in 7 days when tested in accordance with ASTM C 579, Method B. There shall be no shrinkage (zero percent) and a maximum 4.0 percent expansion when tested in accordance with ASTM C 827.

2.2 CEMENT GROUT

A. Cement Grout: Cement grout shall be composed of one part cement, 3 parts sand, and the minimum amount of water necessary to obtain the desired consistency. Where needed to match the color of adjacent concrete, white portland cement shall be blended with regular cement as needed. The minimum compressive strength at 28 days shall be 4000 psi.

B. Cement shall be as specified in Section 03 30 00, Cast-in-Place Concrete.

2.3 CONSISTENCY

A. The consistency of grouts shall be that necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is such that the grout is plastic and moldable but will not flow. Where "dry pack" is specified, it shall mean a grout of that consistency; the type of grout to be used shall be as specified herein for the particular application.

2.4 MEASUREMENT OF INGREDIENTS

A. Measurements for cement grout shall be made accurately by volume using appropriate containers. Shovel measurement will not be allowed.

B. Prepackaged grouts shall have ingredients measured by means recommended by the manufacturer.

PART 3 EXECUTION

3.1 GENERAL

A. All surface preparation, curing, and protection of cement grout shall be as specified in Section 03 30 00, Cast-in-Place Concrete. The finish of the grout surface shall match that of the adjacent concrete.

B. The manufacturer of non-shrink grout and epoxy grout shall provide on-site technical assistance upon request.

C. All mixing, surface preparation, handling, placing, consolidation and other means of execution for prepackaged grouts shall be done according to the printed instructions and recommendations of the manufacturer.

3.2 CONSOLIDATION

A. Grout shall be placed in such a manner, for the consistency necessary for each application, so as to assure that the space to be grouted is completely filled.

PART 4 TESTING

4.1 GENERAL

A. Contractor's independent testing laboratory shall perform strength testing of grout in accordance with ASTM C39 and C301. Submit test reports to the Owner.

END OF SECTION

SECTION 04 05 03

MASONRY MORTARING AND GROUTING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes mortar and grout for masonry.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCES

A. American Concrete Institute:
   1. ACI 530 - Building Code Requirements for Masonry Structures.
   2. ACI 530.1 - Specifications for Masonry Structures.

B. ASTM International:
   1. ASTM C5 - Standard Specification for Quicklime for Structural Purposes.
   2. ASTM C91 - Standard Specification for Masonry Cement.
   3. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete.
   4. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic Cement Concrete.
   5. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar.
   6. ASTM C150 - Standard Specification for Portland Cement.
   7. ASTM C199 - Standard Test Method for Pier Test for Refractory Mortars.
   8. ASTM C206 - Standard Specification for Finishing Hydrated Lime.
   9. ASTM C270 - Standard Specification for Mortar for Unit Masonry.
   10. ASTM C387/C387M - Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
   11. ASTM C404 - Standard Specification for Aggregates for Masonry Grout.
   12. ASTM C476 - Standard Specification for Grout for Masonry.
   13. ASTM C595 - Standard Specification for Blended Hydraulic Cements.
   14. ASTM C780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
   15. ASTM C1019 - Standard Test Method for Sampling and Testing Grout.
   16. ASTM C1142 - Standard Specification for Extended Life Mortar for Unit Masonry.
   17. ASTM C1314 - Standard Test Method for Compressive Strength of Masonry Prisms.
   18. ASTM C1329 - Standard Specification for Mortar Cement.
   19. ASTM C1357 - Standard Test Method for Evaluating Masonry Bond Strength.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal requirements.

B. Design Data: Submit design mix when Property specification of ASTM C270 is to be used, required environmental conditions, and admixture limitations.

C. Test Reports:
   1. Submit reports on mortar indicating conformance of mortar to property requirements of ASTM C270 and compressive strength.
   2. Submit reports on grout indicating conformance of grout to property requirements of ASTM C476.

D. Manufacturer's Installation Instructions: Submit premix mortar manufacturer's installation instructions.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 530 and ACI 530.1.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Cold Weather Requirements: In accordance with ACI 530.1 when ambient temperature or temperature of masonry units is less than 40 degrees F.

B. Hot Weather Requirements: In accordance with ACI 530.1 when ambient temperature is greater than 100 degrees F or ambient temperature is greater than 90 degrees F with wind velocity greater than eight (8) mph.

PART 2 PRODUCTS

2.1 COMPONENTS

A. Masonry Cement: ASTM C91, Type S.

B. Mortar Aggregate: ASTM C144, standard masonry type.

C. Hydrated Lime: ASTM C206, Type S.

D. Grout Aggregate: ASTM C404.

E. Water: Clean and potable.

F. Calcium chloride is not permitted.

2.2 MIXES

A. Mortar Mixes:
   1. Mortar for Structural Masonry: ASTM C270, Type S using proportion specifications.

B. Mortar Mixing:

1. Thoroughly mix mortar ingredients in accordance with ASTM C270 in quantities needed for immediate use.
2. Achieve uniformly damp sand immediately before mixing process.
3. Re-temper only within two hours of mixing.

C. Grout Mixes:
   1. Grout for Structural Masonry: 2,000 psi strength at 28 days; eight (8) to eleven (11) inches slump; mixed in accordance with ASTM C476 Fine grout.

D. Grout Mixing - Either of the following may be used:
   1. Mix grout in accordance with ASTM C94/C94M modified to use ingredients complying with ASTM C476.
   2. Thoroughly mix grout ingredients in quantities needed for immediate use in accordance with ASTM C476.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Request inspection of spaces to be grouted.

3.2 INSTALLATION

A. Install mortar and grout in accordance with ACI 530.1 Specifications for Masonry Structures.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.

B. Testing Frequency: One set of specified tests for every 5,000 sf of completed wall area.

C. Testing of Mortar Mix: In accordance with ASTM C780 for aggregate ratio and water content, and compressive strength.

D. Testing of Grout Mix: In accordance with ASTM C1019 for compressive strength, and in accordance with ASTM C143/C143M for slump.

E. Contractor is responsible for facilitating and paying for testing of all materials.

END OF SECTION

SECTION 04 20 00

UNIT MASONRY

PART 1 GENERAL

1.1 SUMMARY

A. Section includes concrete masonry units, reinforcement, anchorage, and accessories.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCES

A. American Concrete Institute:
   1. ACI 530 - Building Code Requirements for Masonry Structures.
   2. ACI 530.1 - Specifications for Masonry Structures.

B. ASTM International:
   1. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   2. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
   3. ASTM A615/A615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   4. ASTM C90 - Standard Specification for Loadbearing Concrete Masonry Units.
   5. ASTM C140 - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.

1.4 PERFORMANCE REQUIREMENTS

A. Concrete Masonry Compressive Strength (f'm): 1,500 psi; determined by unit strength method.
   1. Concrete Masonry Units: 2000 psi minimum net area compressive strength.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal requirements.

B. Product Data:
   1. Submit data for concrete masonry units and other accessories.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 530 Building Code Requirements for Masonry Structures and ACI 530.1 Specification for Masonry Structures.

1.7 QUALIFICATIONS

A. Installer: Company specializing in performing Work of this section with minimum three years' experience.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Cold Weather Requirements: In accordance with ACI 530.1 when ambient temperature or temperature of masonry units is less than forty (40) degrees F.

B. Hot Weather Requirements: In accordance with ACI 530.1 when ambient temperature is greater than 100 degrees F or ambient temperature is greater than ninety (90) degrees F with wind velocity greater than eight (8) mph.

1.9 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Coordinate masonry work with installation of doors and louvers.

PART 2 PRODUCTS

2.1 COMPONENTS

A. Hollow Load Bearing Concrete Masonry Units (CMU): ASTM C90; normal weight.

B. Concrete Masonry Unit Size and Shape: Nominal modular size of 8x8x16 inches. Furnish special units 90 degree corners, bond beams, and lintels.

C. Color: Selected by Owner during submittal process

D. Type: Split Face, Smooth Interior

2.2 ACCESSORIES

A. Reinforcing Steel: ASTM A615/A615M, 60 ksi yield grade, deformed billet bars, uncoated finish.

B. Anchor Rods: ASTM A307; Grade C; J-shaped or L-shaped; complete with washers and heavy hex nuts; sized for minimum fifteen (15) inch embedment; galvanized finish.
   1. Hot-Dipped Galvanizing: ASTM A153/A153M.

C. Mortar and Grout: As specified in Section 04 05 03.

D. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials, recommended by masonry unit manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: coordination and project conditions.

B. Verify field conditions are acceptable and are ready to receive work.

C. Verify items provided by other sections of work are properly sized and located.

D. Verify built-in items are in proper location, and ready for roughing into masonry work.

3.2 PREPARATION

A. Direct and coordinate placement of metal anchors supplied to other sections.

B. Furnish temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent support.

3.3 INSTALLATION

A. Establish lines, levels, and coursing indicated. Protect from displacement.

B. Maintain masonry courses to uniform dimension. Form bed and head joints of uniform thickness.

C. Coursing of Concrete Masonry Units:
   1. Bond: Running.
   2. Coursing: One unit and one mortar joint to equal 8 inches.
   3. Mortar Joints: Concave.

D. Placing And Bonding:
   1. Lay hollow masonry units with face shell bedding on head and bed joints.
   2. Buttering corners of joints or excessive furrowing of mortar joints are not permitted.
   3. Remove excess mortar as work progresses.
   4. Interlock intersections and external corners.
   5. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment is required, remove mortar and replace.
   6. Perform job site cutting of masonry units with proper tools to assure straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.

E. Grouted Components:
   1. Lap splices bar diameters required by code.
   2. Support and secure reinforcing bars from displacement.
   3. Place and consolidate grout fill without displacing reinforcing.

F. Reinforced Masonry:
   1. Lay masonry units with cells vertically aligned and cavities between wythes clear of mortar and unobstructed.
   2. Place reinforcement bars as indicated on Drawings.

3. Support and secure reinforcement from displacement.
4. Place and consolidate grout fill without displacing reinforcing.
5. Place grout in accordance with ACI 530.1 Specification for Masonry Structures.

G. Control Joints:
1. Install control joints where indicated on Drawings:
2. Do not continue horizontal joint reinforcement through control joints.
3. Form control joint with sheet building paper bond breaker fitted to one side of hollow contour end of block unit. Fill resultant core with grout fill. Rake joint at exposed unit faces for placement of backer rod and sealant.

H. Built-In Work:
1. As work progresses, install built-in metal door frames, and other items to be built-in the work and furnished by other sections.
2. Install built-in items plumb and level.
3. Bed anchors of metal door frames in adjacent mortar joints. Fill frame voids solid with grout or mortar.
4. Do not build in materials subject to deterioration.

I. Cutting And Fitting:
1. Cut and fit for pipes and gable end roof slope. Coordinate with other sections of work to provide correct size, shape, and location.
2. Obtain Engineer's approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.4 ERECTION TOLERANCES

A. Maximum Variation From Unit to Adjacent Unit: 1/16 inch.

B. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft and 1/2 inch in 20 ft or more.

C. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.

D. Maximum Variation from Level Coursing: 1/8 inch in 3 ft and 1/4 inch in 10 ft; 1/2 inch in 30 ft.

E. Maximum Variation of Joint Thickness: 1/8 inch in 3 ft.

F. Maximum Variation from Cross Sectional Thickness of Walls: 1/4 inch.

G. Maximum Variation for Steel Reinforcement:
1. Install reinforcement within the tolerances specified in ACI 530.1 for foundation walls.
2. Plus or minus 1/2 inch when distance from centerline of steel to opposite face of masonry is 8 inches or less.
3. Plus or minus 1 inch when distance is between 8 and 24 inches.
4. Plus or minus 1-1/4 inch when distance is greater than 24 inches.
5. Plus or minus 2 inches from location along face of wall.

3.5 FIELD QUALITY CONTROL

A. Concrete Masonry Units: Test each type in accordance with ASTM C140.
   1. Concrete is responsible for facilitating and paying for testing of all materials.

3.6 CLEANING

A. Remove excess mortar and mortar smears as work progresses.

B. Replace defective mortar. Match adjacent work.

C. Clean soiled surfaces with cleaning solution.

D. Use non-metallic tools in cleaning operations.

3.7 PROTECTION OF FINISHED WORK

A. Protect exposed external corners subject to damage.

B. Protect base of walls from mud and mortar splatter.

C. Protect masonry and other items built into masonry walls from mortar droppings and staining caused by mortar.

D. Protect tops of masonry work with waterproof coverings secured in place without damaging masonry. Provide coverings where masonry is exposed to weather when work is not in progress.

END OF SECTION

SECTION 05 50 00

MISCELLANEOUS METALS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes shop fabricated metal items.
   1. Ledge and shelf angles.
   2. Structural supports for miscellaneous attachments.
   3. Anchor bolts for sill plates

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCES

A. 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 A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   6. ASTM A269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
   7. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.
   8. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
   9. ASTM A312/A312M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes.
   10. ASTM A354 - Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners.
   11. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
   12. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts.
   13. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
   14. ASTM A992/A992M - Standard Specification for Structural Steel Shapes.
   15. ASTM B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
   16. ASTM F436 - Standard Specification for Hardened Steel Washers.

B. American Welding Society:
   1. AWS D1.1 - Structural Welding Code - Steel.
   2. AWS D1.6 - Structural Welding Code - Stainless Steel.

C. National Ornamental & Miscellaneous Metals Association:
   1. NOMMA Guideline 1 - Joint Finishes.

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 Paint.
   5. SSPC Paint 20 - Zinc-Rich Primers (Type I - Inorganic and Type II - Organic).

1.4 SUBMITTALS

A. Section 01 33 00 - 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.

C. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.5 QUALITY ASSURANCE

A. Finish joints in accordance with NOMMA Guideline 1.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: 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.

1.7 FIELD MEASUREMENTS

A. Verify field measurements are as on shop drawings.

PART 2 PRODUCTS

2.1 MATERIALS - STEEL

A. Structural W-Shapes: ASTM A992/A992M.

B. Structural Shapes: ASTM A36/A36M.

C. Channels and Angles: ASTM A36/A36M.

D. Steel Plate: ASTM A36/A36M.

E. Hollow Structural Sections: ASTM A500/A500M, Grade B.

F. Steel Pipe: ASTM A53/A53M, Grade B Schedule 40.

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 Primer: SSPC Paint 15, Type 1, red oxide.

L. Touch-Up Primer: Match shop primer.

M. Touch-Up Primer for Galvanized Surfaces: SSPC Paint 20 Type I Inorganic.

2.2 MATERIALS - STAINLESS STEEL

A. Bars and Shapes: ASTM A276; Type 304.

B. Tubing: ASTM A269; Type 304.

C. Pipe: ASTM A312/A312M, welded; Type 304.

D. Plate, Sheet and Strip: ASTM A240/A240M OR ASTM A666; Type 304.

E. Bolts, Nuts, and Washers: ASTM A354.

F. Welding Materials: AWS D1.6; type required for materials being welded.

2.3 ANCHOR BOLTS

A. Anchor Rods: ASTM A307; Grade A.
   1. Shape: Hooked.
   2. Furnish with nut and washer; unfinished.

2.4 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. 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.

D. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.

E. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.5 FACTORY APPLIED FINISHES - STEEL

A. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.

B. Do not prime surfaces in direct contact with concrete or where field welding is required.

C. Prime paint items with two coats except where galvanizing is specified.

D. Galvanizing: ASTM A123/A123M; hot dip galvanize after fabrication.

E. Galvanizing for Fasteners, Connectors, and Anchors:
1. Hot-Dipped Galvanizing: ASTM A153/A153M.
2. Mechanical Galvanizing: ASTM B695; Class 50 minimum.

2.6 FACTORY APPLIED FINISHES - STAINLESS STEEL

A. Satin Polished Finish: Number 4, satin directional polish parallel with long dimension of finished face.

B. Mirror Polished Finish: Number 8, mirror polish with preliminary directional polish lines removed.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify field conditions are acceptable and are ready to receive Work.

3.2 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 indicated on Drawings.

D. Perform field welding in accordance with AWS D1.1.

E. Obtain approval of Architect/Engineer prior to site cutting or making adjustments not scheduled.

F. After erection, touch up welds, abrasions, and damaged finishes with prime paint or galvanizing repair paint to match shop finishes.

END OF SECTION

SECTION 06 10 00

ROUGH CARPENTRY

PART 1 GENERAL

1.1 SUMMARY

A. Section includes structural roof framing and roof sheathing.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 QUALITY ASSURANCE

A. Perform Work in accordance with the following:
   1. Lumber Grading Agency: Certified by DOC PS 20.
   2. Wood Structural Panel Grading Agency: Certified by EWA - The Engineered Wood Association.
   3. Lumber: DOC PS 20.
   4. Wood Structural Panels: DOC PS 1 or DOC PS 2.

PART 2 PRODUCTS

2.1 LUMBER MATERIALS

A. Lumber Grading Rules: WCLIB.

B. Rafter Framing: Douglas Fir-Larch #1, 19 percent maximum moisture content.

C. Top Plate: Pressure treated.

2.2 SHEATHING MATERIALS

A. Plywood Roof Sheathing: Rated Sheathing, Structural I, plywood Span Rating 32/16; Exterior.

2.3 SHEATHING AND UNDERLAYMENT LOCATIONS

A. Sloped Roof Sheathing: 3/4 inch thick, 48 x 96 inch sized sheets, 24 inch minimum panel width.

2.4 ACCESSORIES

A. Fasteners and Anchors:
   1. Fasteners: ASTM A153/A153M, hot dipped galvanized steel for high humidity and treated wood locations, unfinished steel elsewhere.

PART 3 EXECUTION

3.1 FRAMING

A. Set structural members level and plumb, in correct position.

B. Fasten framing in accordance with the 2013 California Building Code.

C. Place horizontal members crown side up.

D. Frame double joist headers at floor and ceiling openings. Frame rigidly into joists. Frame double joists under wall studding.

E. Curb roof openings except where curbs are provided. Construct curb members of single pieces for each side.

3.2 SHEATHING

A. Fasten sheathing in accordance with the 2013 California Building Code.

B. Secure wall sheathing with ends staggered, over firm bearing.

3.3 SITE APPLIED WOOD TREATMENT

A. Treat site-sawn cuts. Apply preservative to site-sawn cuts in accordance with AWPA M4.

B. Brush apply two coats of preservative treatment on untreated wood in contact with cementitious materials.

C. Allow preservative to cure prior to erecting members.

END OF SECTION

SECTION 06 17 53

SHOP-FABRICATED WOOD TRUSSES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes shop fabricated wood trusses for roof framing; bridging, bracing, and anchorage; and preservative treatment of wood.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 SYSTEM DESCRIPTION

A. Design Roof Live Load: 20 lbs/sq ft with deflection limited to 1/240 of span.

1.4 SUBMITTALS

A. Shop Drawings: Indicate sizes and spacing of trusses and associated components, web and chord sizes, plate sizes, fastener descriptions and spacings, loads, and truss cambers. Submit design calculations signed and stamped by a California registered Structural Engineer.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with the following:
   1. Lumber Grading Agency: Certified by DOC PS 20.
   2. Wood Structural Panel Grading Agency: Certified by EWA - The Engineered Wood Association.
   3. Lumber: DOC PS 20.
   4. Wood Structural Panels: DOC PS 1 or DOC PS 2.

B. Truss Design, Fabrication, and Installation: In accordance with TPI 1.

C. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years' experience.

D. Design trusses under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of California.

PART 2 PRODUCTS

2.1 MATERIALS

A. Lumber Grading Rules: WCLIB.

B. Wood Members: Single top and bottom chord, Douglas Fir-Larch #1,19 percent maximum moisture content.

C. Steel Plate Connectors: TPI 1, Section 6; galvanized.

2.2 ACCESSORIES

A. Wood Support Members: In accordance with Section 06 10 00.

B. Fasteners and Anchors:
   1. Fasteners: ASTM A153/A153M, hot dipped galvanized steel for high humidity and treated wood locations, unfinished steel elsewhere.
   2. Nails and Staples: ASTM F1667.

2.3 FABRICATION

A. Fabricate trusses to achieve structural requirements specified.

B. Furnish top chord extensions as indicated on Drawings.

2.4 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Testing, inspection and analysis requirements.

B. Inspect Work performed at fabricator's facility to verify conformance to Contract Documents.

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 inspections are not required for Work performed by approved fabricator.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify supports and openings are ready to receive trusses.

3.2 ERECTION

A. Set members level and plumb, in correct position.

B. Make provisions for erection loads, and for sufficient temporary bracing to maintain structure plumb, and in indicated alignment until completion of erection and installation of permanent bracing.

C. Do not field cut or alter structural members without approval of Engineer.

D. Place headers and supports to frame openings.

E. Frame openings between trusses with lumber in accordance with Section 06 10 00.

F. After erection, touch-up damaged surfaces with primer consistent with shop coat.

3.3 ERECTION TOLERANCES

A. Framing Members: ½ inch maximum, from indicated position.

END OF SECTION

SECTION 07 31 13

ASPHALT SHINGLES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Asphalt shingles.
   2. Underlayment.
   3. Metal flashings and accessories.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCE STANDARDS

A. ASTM International:
   1. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   2. ASTM A755/A755M - Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products.
   3. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   4. ASTM B370 - Standard Specification for Copper Sheet and Strip for Building Construction.
   5. ASTM C1371 - Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers.
   6. ASTM C1549 - Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer.
   7. ASTM D225 - Standard Specification for Asphalt Shingles (Organic Felt) Surfaced with Mineral Granules.
   8. ASTM D226 - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
   9. ASTM D1970 - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection.
   10. ASTM D2178 - Standard Specification for Asphalt Glass Felt Used in Roofing and Waterproofing.
   11. ASTM D3018 - Standard Specification for Class A Asphalt Shingles Surfaced with Mineral Granules.
   12. ASTM D3161 - Standard Test Method for Wind-Resistance of Asphalt Shingles (Fan-Induced Method).
   13. ASTM D3462 - Standard Specification for Asphalt Shingles Made from Glass Felt and Surfaced with Mineral Granules.
   14. ASTM D3909 - Standard Specification for Asphalt Roll Roofing (Glass Felt) Surfaced With Mineral Granules.

15. ASTM D4586 - Standard Specification for Asphalt Roof Cement, Asbestos-Free.
16. ASTM D4869 - Standard Specification for Asphalt-Saturated Organic Felt Underlayment Used in Steep Slope Roofing.
17. ASTM D6380 - Standard Specification for Asphalt Roll Roofing (Organic Felt).
18. ASTM E108 - Standard Test Methods for Fire Tests of Roof Coverings.
19. ASTM E408 - Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques.
20. ASTM E903 - Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres.
21. ASTM E1918 - Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field.
22. ASTM E1980 - Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces.
23. ASTM F1667 - Standard Specification for Driven Fasteners: Nails, Spikes, and Staples.

B. National Roofing Contractors Association:
   1. NRCA - The NRCA Steep Roofing Manual.

C. Sheet Metal and Air Conditioning Contractors:
   1. SMACNA - Architectural Sheet Metal Manual.

D. Single Ply Roofing Institute:
   1. SPRI ES-1 - Wind Design Standard for Edge Systems Used with Low Slope Roofing Systems.

E. Underwriters Laboratories Inc.:
   1. UL 580 - Tests for Uplift Resistance of Roof Assemblies.
   2. UL 790 - Tests for Fire Resistance of Roof Covering Materials.
   3. UL 997 - Wind Resistance of Prepared Roof Covering Materials.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate metal flashings, jointing methods and locations, fastening methods and locations, and installation details.

C. Samples: Submit two (12 x 12 inch) samples of each shingle color indicating color range and finish texture/pattern; for color and texture selection.

D. Manufacturer's Instructions: Submit installation criteria and procedures.

E. Inspection Report: Submit report of roof inspection verifying shingles are sealed. Indicate extent of areas that did not properly self-seal and what corrective measures were required.

F. Field Quality Control Submittals: Indicate results of Contractor furnished tests and inspections.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with 2013 California Building Code (CBC).

1.6 WARRANTY

A. Furnish manufacturer's standard warranty for asphalt shingles.

PART 2 PRODUCTS

2.1 ASPHALT SHINGLES

A. Manufacturers:
   1. Owens Corning, Duration Premium Cool Roof Shingles or Equivalent.
   2. Substitutions: Section 01 60 00 – "Product Requirements"

B. Description: ASTM D3018, Class A, Type I - Self Sealing; glass fiber mat base, mineral granule surface type; laminated overlay type.

C. Performance
   1. Perform Work in accordance with NRCA Steep Roofing Manual.

2.2 MATERIALS

A. Underlayment: meet the performance requirements of ASTM D226; and ASTM D4869; Fiberglass Reinforced Felt Underlayment.

2.3 ACCESSORIES

A. Nails: ASTM F1667; standard round wire roofing nails hot dipped galvanized steel type, minimum 0.105 inch diameter shank, minimum 0.375 inch diameter head; of sufficient length to penetrate 3/4 inch into roof sheathing.

B. Plastic Cement: ASTM D4586, Type recommended by shingle manufacturer.

C. Lap Cement: Type recommended by shingle manufacturer.

D. Flashing Materials:
   1. Galvanized Steel: ASTM A653; structural steel sheet, G90 zinc coating. 24-gage cove steel; minimum 27% post-consumer recycled content. Finishes to comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for applying and designating finishes.

E. Bituminous Paint: Acid and alkali resistant type; black color.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify roof penetrations and plumbing stacks are in place and flashed to deck surface.

B. Verify roof openings are correctly framed.

C. Verify deck surfaces are dry, free of ridges, warps, or voids.

3.2 INSTALLATION

A. Underlayment Installation:
   1. Place one ply of underlayment over substrate with ends and edges weather lapped 2 inches. Stagger end laps of each consecutive layer. Nail underlayment in place.
   2. Install underlayment in accordance with manufacturer's instructions without distortions capable of preventing shingles from sealing. Nail underlayment overlap at 36 inches on center.
   3. Weather lap and seal items projecting through or mounted on roof watertight with plastic cement.

B. Metal Flashing and Accessories Installation:
   1. Weather lap joints minimum 2 inches and seal weather tight with plastic cement.
   2. Secure in place with nails. Conceal fastenings.
   3. Flash and seal work weather tight, projecting through or mounted on roofing with plastic cement.

C. Asphalt Shingles Installation:
   1. Place shingles in coursing pattern with 5 5/8 inch weather exposure.
   2. Project first course of shingles 3/4 inch beyond fascia boards.
   3. Extend shingles 1/2 inch beyond face of gable edge fascia boards.
   4. Cap ridges with individual shingles, maintaining 5 5/8 inch weather exposure. Place to avoid exposed nails.
   5. Coordinate installation of roof mounted components or items projecting through roof with weather tight placement of counter flashings.
   6. Complete installation to provide weather tight service.

3.3 FIELD QUALITY CONTROL

A. Before Substantial Completion, inspect roof to verify shingles self-sealed from exposure to prevent wind uplift. Apply plastic cement to secure shingles that failed to seal. Report results of inspection and required corrective measures.

3.4 PROTECTION

A. Do not permit traffic over finished roof surface.

END OF SECTION

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Formed low-slope roof sheet metal fabrications.
   2. Formed wall sheet metal fabrications.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show installation layouts of sheet metal flashing and trim, including plans, elevations, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work.

   1. Include details for forming, joining, supporting, and securing sheet metal flashing and trim, including pattern of seams, termination points, fixed points, expansion joints, expansion-joint covers, edge conditions, special conditions, and connections to adjoining work.

C. Samples: For each exposed product and for each finish specified.

1.3 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 QUALITY ASSURANCE

A. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or shown on Drawings.

B. Copper Sheet Metal Standard: Comply with CDA's "Copper in Architecture Handbook." Conform to dimensions and profiles shown unless more stringent requirements are indicated.

1.6 WARRANTY

A. Special Warranty on Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SHEET METALS

A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.

B. Aluminum Sheet: ASTM B 209, alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required.

1. As-Milled Finish: One-side bright mill finish.
2. Alclad Finish: Metallurgically bonded surfacing to both sides, forming a composite aluminum sheet with reflective luster.
3. Factory Prime Coating: Where painting after installation is indicated, pretreat with white or light-colored, factory-applied, baked-on epoxy primer coat; minimum dry film thickness of 0.2 mil.
4. Clear Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.
5. Color Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

6. Exposed Coil-Coated Finishes:

a. Two-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat.
b. Three-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
c. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat.

C. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304, dead soft, fully annealed; 2D (dull, cold rolled) finish.

D. Metallic-Coated Steel Sheet: Restricted flatness steel sheet, metallic coated by the hot-dip process and pre-painted 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 coating designation; structural quality.
2. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40; structural quality.
3. Surface: Mill phosphatized for field painting.
4. Exposed Coil-Coated Finish:

a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat.
b. Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
c. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat.

2.2 UNDERLAYMENT MATERIALS

A. Polyethylene Sheet: 6-mil- thick polyethylene sheet complying with ASTM D 4397.

B. Felt: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, non-perforated.

C. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

1. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F.
2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F.

D. Slip Sheet: Building paper, 3-lb/100 sq. ft. minimum, rosin sized.

2.3 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 and recommended by manufacturer of primary sheet metal unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal.

1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.

a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating.
b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.

2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
3. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.
4. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329 or Series 300 stainless steel.

C. Solder:

1. For Stainless Steel: ASTM B 32, Grade Sn60, with an acid flux of type recommended by stainless-steel sheet manufacturer.
2. For Zinc-Coated (Galvanized) Steel: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead or Grade Sn60, 60 percent tin and 40 percent lead.

D. Sealant Tape: Pressure-sensitive, 100 percent solids, gray poly-isobutylene compound sealant tape with release-paper backing. Provide permanently elastic, non-sag, nontoxic, non-staining tape 1/2 inch wide and 1/8 inch thick.

E. Elastomeric Sealant: ASTM C 920, elastomeric polymer sealant; low modulus; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

F. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; poly-isobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

G. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.

H. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.4 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, geometry, metal thickness, and other characteristics of item indicated. Fabricate items at the shop to greatest extent possible.

1. Obtain field measurements for accurate fit before shop fabrication.
2. Form 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.
3. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.

B. Sealed Joints: Form non-expansion but movable joints in metal to accommodate elastomeric sealant.

C. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.

D. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

E. Seams: Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.

F. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use.

G. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer.

2.5 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. Roof-Penetration Flashing: Fabricate from the following materials:
1. Stainless Steel: 0.019 inch thick.
2. Galvanized Steel: 0.028 inch thick.
3. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.

2.6 WALL SHEET METAL FABRICATIONS

A. 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. Aluminum: 0.032 inch thick.
2. Stainless Steel: 0.016 inch thick.
3. Galvanized Steel: 0.022 inch thick.
4. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.

PART 3 - EXECUTION

3.1 UNDERLAYMENT INSTALLATION

A. Polyethylene Sheet: Install polyethylene sheet with adhesive for anchorage. Apply in shingle fashion to shed water, with lapped and taped joints of not less than 2 inches.

B. Felt Underlayment: Install felt underlayment with adhesive for temporary anchorage. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches.

C. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps with roller. Cover underlayment within 14 days.

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 so that completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.

1. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
2. 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.
3. Space cleats not more than 12 inches apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.
4. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
5. Install sealant tape where indicated.
6. 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 SMACNA.

1. Coat back side of uncoated aluminum and stainless-steel 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 sheet.

C. Seal joints as shown and as required for watertight construction.

D. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches, except reduce pre-tinning where pre-tinned surface would show in completed Work.

1. Do not solder metallic-coated steel and aluminum sheet.
2. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.
3. Stainless-Steel Soldering: Tin edges of uncoated sheets using solder recommended for stainless steel and acid flux. Promptly remove acid flux residue from metal after tinning and soldering. Comply with solder manufacturer's recommended methods for cleaning and neutralization.

E. Rivets: Rivet joints in uncoated aluminum where indicated and where necessary for strength.

3.3 ROOF FLASHING INSTALLATION

A. General: Install sheet metal 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 and weather resistant.

B. 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 sealant.

C. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with sealant and clamp flashing to pipes that penetrate roof.

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. Opening Flashings in Frame Construction: Install continuous head, sill and similar flashings to extend 4 inches beyond wall openings.

3.5 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 unless otherwise indicated in manufacturer's written installation instructions.

END OF SECTION 076200

SECTION 07 71 23

GUTTERS AND DOWNSPOUTS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes pre-finished aluminum gutters and downspouts.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCES

A. American Architectural Manufacturers Association:
   1. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.

B. ASTM International:
   1. ASTM B32 - Standard Specification for Solder Metal.
   2. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

C. Sheet Metal and Air Conditioning Contractors:
   1. SMACNA - Architectural Sheet Metal Manual

1.4 DESIGN REQUIREMENTS

A. Conform to applicable provisions of the SMACNA Manual.

1.5 SUBMITTALS

A. Section 01330 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate locations, configurations, jointing methods, fastening methods, locations, and installation details.

C. Product Data: Submit data on manufactured components, materials, and finishes.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with SMACNA Manual.

B. Perform Work in accordance with 2010 California Building Code (CBC).

1.7 DELIVERY, STORAGE, AND HANDLING

A. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope to drain.

B. Prevent contact with materials during storage capable of causing discoloration, staining, or damage.

PART 2 PRODUCTS

2.1 GUTTERS AND DOWNSPOUTS

A. Product Description:
   1. Gutters: Sheet metal; SMACNA Rectangular style profile**.**
   2. Downspouts: Sheet metal; SMACNA Round profile.

2.2 COMPONENTS

A. Pre-finished Aluminum Sheet: ASTM B209, manufacturer's standard alloy and temper for specific finish; 0.032 inch thick; plain finish shop pre-coasted; color as selected from manufacturer's standard colors.

2.3 ACCESSORIES

A. Anchors and Supports: Profiled to suit gutters and downspouts.
   1. Anchoring Devices: SMACNA requirements, type recommended by fabricator.
   2. Gutter Supports: See drawings.
   3. Downspout Supports: See drawings.

B. Fasteners: Same material and finish as gutters and downspouts.

C. Primer: Zinc molybdate type.

D. Protective Backing Paint: Zinc molybdate alkdy.

E. Solder: ASTM B32; Alloy Grade Sn50 type.

2.4 FABRICATION

A. Form gutters and downspouts of profiles and sizes indicated.

B. Fabricate with required connection pieces.

C. Form sections to shape indicated on Drawings, square, and accurate in size, in maximum possible lengths, free of distortion or defects detrimental to appearance or performance. Allow for expansion at joints.

D. Hem exposed edges of metal.

E. Fabricate gutter and downspout accessories; watertight.

2.5 FACTORY FINISHING

A. Modified silicone or Acrylic polyester coasting: Baked enamel system conforming to AAMA 2603.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify surfaces are ready to receive gutters and downspouts.

3.2 PREPARATION

A. Paint concealed metal surfaces and surfaces in contact with dissimilar metals with protective backing paint to minimum dry film thickness of .15 mil.

3.3 INSTALLATION

A. Join lengths with formed seams sealed watertight. Flash and seal gutters to downspouts and accessories.

B. Solder metal joints for full metal surface contact. After soldering, wash metal clean with neutralizing solution and rinse with water.

C. Connect downspouts to storm drains per plans.

END OF SECTION

SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Penetrations in fire-resistance-rated walls.
2. Penetrations in horizontal assemblies.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Product Schedule: For each penetration firestopping system. Include location and design designation of qualified testing and inspecting agency.

1. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.3 INFORMATIONAL SUBMITTALS

A. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer's written recommendations.

B. Product test reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

B. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:

1. Penetration firestopping tests are performed by UL.
2. Penetration firestopping is identical to those tested per testing standard referenced in "Penetration Firestopping" Article. Provide rated systems bearing marking of qualified testing and inspection agency.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. 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:

1. A/D Fire Protection Systems Inc.
2. Grace Construction Products.
3. Hilti, Inc.
4. Johns Manville.
5. Nelson Firestop Products.
6. NUCO Inc.
7. Passive Fire Protection Partners.
8. RectorSeal Corporation.
9. Specified Technologies Inc.
10. 3M Fire Protection Products.
11. Tremco, Inc.; Tremco Fire Protection Systems Group.
12. USG Corporation.

2.2 PENETRATION FIRESTOPPING

A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist 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.

B. Penetrations in Fire-Resistance-Rated Walls: Ratings determined per ASTM E 814 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: Ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
2. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.

D. Penetrations in Smoke Barriers: Provide penetration firestopping with ratings determined per UL 1479.

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at 0.30-inch wg at both ambient and elevated temperatures.

E. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

F. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

G. Low-Emitting Materials: Penetration firestopping sealants and sealant primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

H. 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 manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

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. Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

C. 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 indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.

D. Install fill materials for firestopping by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
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.

3.2 IDENTIFICATION

A. Identify penetration firestopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping. 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.

3.3 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections.

B. Where deficiencies are found or penetration firestopping is damaged or removed because of testing, repair or replace penetration firestopping to comply with requirements.

C. Proceed with enclosing penetration firestopping with other construction only after inspection reports are issued and installations comply with requirements.

3.4 PENETRATION FIRESTOPPING SCHEDULE

A. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHEZ.

B. Where Intertek ETL SEMKO-listed systems are indicated, they refer to design numbers in Intertek ETL SEMKO's "Directory of Listed Building Products" under "Firestop Systems."

C. Where FM Global-approved systems are indicated, they refer to design numbers listed in FM Global's "Building Materials Approval Guide" under "Wall and Floor Penetration Fire Stops."

D. Firestopping for Metallic Pipes, Conduit, or Tubing:

1. UL-Classified Systems: W-J 1127.

END OF SECTION 078413

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Silicone joint sealants.
2. Urethane joint sealants.
3. Latex joint sealants.
4. Preformed joint sealants.
5. Acoustical joint sealants.

1.2 PRECONSTRUCTION TESTING

A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers eight samples of materials that will contact or affect joint sealants. Use manufacturer's standard test method to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.

B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates. Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.

1.3 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples: For each kind and color of joint sealant required.

C. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Preconstruction compatibility and adhesion test reports.

C. Preconstruction field-adhesion test reports.

D. Field-adhesion test reports.

E. Warranties.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C 1021 to conduct the testing indicated.

1.6 WARRANTY

A. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Architectural Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

B. Low-Emitting Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

1. Suitability for Immersion in Liquids. Where sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C 1247. Liquid used for testing sealants is deionized water, unless otherwise indicated.

D. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

E. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.

2.2 SILICONE JOINT SEALANTS

A. Mildew-Resistant Silicone Joint Sealant: ASTM C 920.

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. BASF Building Systems.
    b. Dow Corning Corporation.
    c. GE Advanced Materials - Silicones.
    d. May National Associates, Inc.
    e. Pecora Corporation.
    f. Polymeric Systems, Inc.
    g. Schnee-Morehead, Inc.
    h. Sika Corporation; Construction Products Division.
    i. Tremco Incorporated.

2. Type: Single component (S).
3. Grade: Pourable (P).
4. Class: 100/50.
5. Uses Related to Exposure: Traffic (T).

2.3 URETHANE JOINT SEALANTS

A. Urethane Joint Sealant: ASTM C 920.

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. BASF Building Systems.
    b. Bostik, Inc.
    c. Lymtal, International, Inc.
    d. May National Associates, Inc.
    e. Pacific Polymers International, Inc.
    f. Pecora Corporation.
    g. Polymeric Systems, Inc.
    h. Schnee-Morehead, Inc.
    i. Sika Corporation; Construction Products Division.
    j. Tremco Incorporated.

2. Type: Single component (S).
3. Grade: Pourable (P).
4. Class: 100/50.
5. Uses Related to Exposure: Traffic (T).

2.4 LATEX JOINT SEALANTS

A. Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

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. BASF Building Systems.
b. Bostik, Inc.
c. May National Associates, Inc.
d. Pecora Corporation.
e. Schnee-Morehead, Inc.
f. Tremco Incorporated.

2.5 PREFORMED JOINT SEALANTS

A. Preformed Foam Joint Sealant: Manufacturer's standard preformed, pre-compressed, open-cell foam sealant manufactured from urethane foam with minimum density of 10 lb/cu. ft. and impregnated with a nondrying, water-repellent agent. Factory produce in pre-compressed sizes in roll or stick form to fit joint widths indicated; coated on one side with a pressure-sensitive adhesive and covered with protective wrapping.

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. Dayton Superior Specialty Chemicals.
b. EMSEAL Joint Systems, Ltd.
c. Sandell Manufacturing Co.
d. Schul International, Inc.
e. Willseal USA, LLC.

2.6 ACOUSTICAL JOINT SEALANTS

A. Acoustical Joint Sealant: Manufacturer's standard non-sag, paintable, non-staining 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.

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. Pecora Corporation.
    b. USG Corporation.

2.7 JOINT SEALANT BACKING

A. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin) and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

B. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer.

2.8 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.

C. Masking Tape: Non-staining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.

1. Remove laitance and form-release agents from concrete.
2. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by 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 or primer 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.

3.2 INSTALLATION

A. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

B. Install sealant backings of kind 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.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

C. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

D. Install sealants using proven techniques that 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 in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Non-sag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs 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 sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.

F. Acoustical Sealant Installation: Comply with ASTM C 919 and with manufacturer's written recommendations.

G. Clean off excess sealant 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.

3.3 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

1. Extent of Testing: Test completed and cured sealant joints as follows:

    a. Perform 10 tests for the first 1000 feet of joint length for each kind of sealant and joint substrate.
    b. Perform 1 test for each 1000 feet of joint length thereafter or 1 test per each floor per elevation.

2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.

B. Evaluation of Field-Adhesion Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.4 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.

1. Joint Locations:

    a. Control and expansion joints in brick pavers.
    b. Isolation and contraction joints in cast-in-place concrete slabs.
    c. Joints between plant-precast architectural concrete paving units.
    d. Joints in stone paving units.
    e. Tile control and expansion joints.
    f. Joints between different materials listed above.

2. Joint Sealant: Silicone.
3. Joint Sealant: Urethane.
4. Joint Sealant: Preformed foam.

B. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal non-traffic surfaces.

1. Joint Locations:

    a. Construction joints in cast-in-place concrete.
    b. Joints between plant-precast architectural concrete units.
    c. Control and expansion joints in unit masonry.
    d. Joints in dimension stone cladding.
    e. Joints in glass unit masonry assemblies.
    f. Joints in exterior insulation and finish systems.
    g. Joints between metal panels.
    h. Joints between different materials listed above.
    i. Perimeter joints between materials listed above and frames of louvers.
    j. Control and expansion joints in ceilings and other overhead surfaces.
    k. Other joints as indicated.

2. Joint Sealant: Silicone.
3. Joint Sealant: Urethane.
4. Joint Sealant: Preformed foam.

C. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.

1. Joint Locations:

a. Isolation joints in cast-in-place concrete slabs.
b. Control and expansion joints in stone flooring.
c. Control and expansion joints in brick flooring.
d. Control and expansion joints in tile flooring.

2. Joint Sealant: Silicone.
3. Joint Sealant: Urethane.
4. Joint Sealant: Preformed foam.

D. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal non-traffic surfaces.

1. Joint Locations:

a. Control and expansion joints on exposed interior surfaces of exterior walls.
b. Perimeter joints of exterior openings where indicated.
c. Tile control and expansion joints.
d. Vertical joints on exposed surfaces of interior unit masonry.
e. Joints on underside of plant-precast structural concrete beams.

2. Joint Sealant: Latex.

E. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal non-traffic surfaces.

1. Joint Sealant Location:

a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
b. Tile control and expansion joints where indicated.

2. Joint Sealant: Silicone.

F. Joint-Sealant Application: Interior acoustical joints in vertical surfaces and horizontal non-traffic surfaces.

1. Joint Location:

a. Acoustical joints where indicated.
b. Other joints as indicated.

2. Joint Sealant: Acoustical.

END OF SECTION 079200

SECTION 08 11 14

STANDARD STEEL DOORS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes non-rated, insulated, steel doors.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCES

A. American National Standards Institute:
   1. ANSI A250.8 - Recommended Specifications for Standard Steel Doors and Frames.

B. ASTM International:
   1. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   2. ASTM C1363 - Standard Test Method for the Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus.
   3. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
   4. ASTM E413 - Classification for Rating Sound Insulation.

C. Hollow Metal Manufacturers Association:
   1. HMMA 810 - Hollow Metal Doors.

D. National Fire Protection Association:
   1. NFPA 80 - Standard for Fire Doors, Fire Windows.
   2. NFPA 105 - Standard for the Installation of Smoke Door Assemblies and other Opening Protectives.
   3. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies.

E. Steel Door Institute:
   1. SDI 108 - Recommended Selection and Usage Guide for Standard Steel Doors.

F. Underwriters Laboratories Inc.:
   1. UL 10B - Fire Tests of Door Assemblies.
   2. UL 10C - Positive Pressure Fire Tests of Door Assemblies.
   3. UL 1784 - Air Leakage Tests of Door Assemblies.

1.4 SUBMITTALS

A. Shop Drawings: Indicate door elevations, internal reinforcement, closure method, and cut-outs for glazing, finishes.

B. Product Data: Submit door configurations, location of cut-outs for hardware reinforcement.

C. Manufacturer's Installation Instructions: Submit special installation instructions.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with ANSI A250.8.

B. Perform Work in accordance with 2013 California Building Code (CBC).

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years' documented experience.

B. Installer: Company specializing in performing work of this section with minimum 5 years documented experience approved by manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Accept doors on site in manufacturer's packaging. Inspect for damage.

B. Break seal on site to permit ventilation.

1.8 COORDINATION

A. Coordinate Work with door opening construction, door frame, and door hardware installation.

PART 2 PRODUCTS

2.1 STANDARD STEEL DOORS

A. Product Description:
   1. Exterior Doors (Insulated): ANSI A250.8, 1-3/4 inch thick.
      a. Level 3 - Extra heavy Duty, Model 2, seamless design.

2.2 COMPONENTS

A. Face: Steel sheet in accordance with ANSI A250.

B. End Closure: Channel, 0.04 inches thick, flush.

C. Core: vertical steel stiffeners.

D. Thermal Insulated Door: Total insulation R-Value of 2.4.

2.3 ACCESSORIES

A. Removable Stops: Rolled steel, channel shape, mitered corners; prepared for countersink style tamper proof screws.

B. Primer: ANSI A250.10 rust inhibitive type.

2.4 FABRICATION

A. Fabricate doors with hardware reinforcement welded in place.

B. Attach astragal to one leaf of pairs of doors.

2.5 SHOP FINISHING

A. Steel Sheet: Galvanized to ASTM A653/A653M A60.

B. Primer: Air dried or Baked rust-inhibitive primer capable of passing a 120-hour salt spray test in accordance with ASTMB 117 and a 250- hour humidity test in accordance with ASTM D 1735.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify opening sizes and tolerances are acceptable.

3.2 INSTALLATION

A. Install doors in accordance with ANSI A250.8.

B. Coordinate installation of glass and glazing specified in Section 08800.

C. Coordinate installation of doors with installation of frames specified in Section 08 11 15 and hardware specified in Section 08 71 00.

D. Touch-up damaged shop finishes.

3.3 ERECTION TOLERANCES

A. Maximum Diagonal Distortion: 1/16 inch measured with straight edge, corner to corner.

3.4 ADJUSTING

A. Adjust door for smooth and balanced door movement.

END OF SECTION

SECTION 08 11 15

STANDARD STEEL FRAMES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes non-rated steel frames.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCES

A. American National Standards Institute:
   1. ANSI A250.8 - Recommended Specifications for Standard Steel Doors and Frames.

B. ASTM International:
   1. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

C. National Fire Protection Association:
   1. NFPA 80 - Standard for Fire Doors, Fire Windows.
   2. NFPA 105 - Standard for the Installation of Smoke Door Assemblies and other Opening Protectives.
   3. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies.

D. Underwriters Laboratories Inc.:
   1. UL 10B - Fire Tests of Door Assemblies.
   2. UL 10C - Positive Pressure Fire Tests of Door Assemblies.
   3. UL 1784 - Air Leakage Tests of Door Assemblies.

1.4 SUBMITTALS

A. Shop Drawings: Indicate frame elevations, reinforcement, anchor types and spacing, location of cut-outs for hardware, and finish.

B. Product Data: Submit frame configuration and finishes.

C. Manufacturer's Installation Instructions: Submit special installation instructions.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

A. Conform to requirements of ANSI A250.8.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Accept frames on site in manufacturer's packaging. Inspect for damage.

B. Break seal on-site to permit ventilation.

1.8 COORDINATION

A. Coordinate Work with frame opening construction, door, and hardware installation.

PART 2 PRODUCTS

2.1 STANDARD STEEL FRAMES

A. Product Description: Standard shop fabricated steel frames, non-rated types.
   1. Frames: To suit ANSI A250.8 Grade and Model of door specified in Section 08 11 14.

2.2 ACCESSORIES

A. Bituminous Coating: Non-asbestos fibered asphalt emulsion.

B. Primer: ANSI A250.10 rust inhibitive type.

C. Silencers: Specified in Section 08 71 00.

D. Weatherstripping: Specified in Section 08 71 00.

2.3 FABRICATION

A. Fabricate frames as welded unit.

B. Fabricate frames with hardware reinforcement plates welded in place. Provide mortar guard boxes.

C. Reinforce frames wider than 48 inches with roll formed steel channels fitted tightly into frame head, flush with top.

D. Prepare frames for silencers. Provide three single silencers for single doors on strike side.

E. Fabricate frames to suit masonry wall coursing with 2 inch head member.

2.4 SHOP FINISHING

A. Steel Sheet: Galvanized to ASTM A653/A653M A60.

B. Primer: Air dried or Baked rust-inhibitive primer. Primer coast to be capable of passing a 120-hour salt spray test in accordance with ASTMB 117 and a 250-hour humidity test in accordance with ASTMD 1735.

C. Coat inside of frame profile with bituminous coating to minimum thickness of .1/16 inch..

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify opening sizes and tolerances are acceptable.

3.2 INSTALLATION

A. Install frames in accordance with ANSI A250.8.

B. Coordinate with masonry wall construction for anchor placement.

C. Coordinate installation of frames with installation of hardware specified in Section 08 71 00 and doors in Section 08 11 14.

3.3 ERECTION TOLERANCES

A. Maximum Diagonal Distortion: .1/16 inch. measured with straight edges, crossed corner to corner.

END OF SECTION

SECTION 08 71 00

DOOR HARDWARE

PART 1 GENERAL

1.1 SUMMARY

A. Section includes hardware for steel doors.
   1. Provide door gaskets, including weatherstripping and seals, and thresholds.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCES

A. American National Standards Institute:
   1. ANSI A156.1 - Butts and Hinges.
   2. ANSI A156.2 - Bored and Preassembled Locks and Latches.
   3. ANSI A156.3 - Exit Devices.
   4. ANSI A156.4 - Door Controls - Closures.
   5. ANSI A156.5 - Auxiliary Locks and Associated Products.
   6. ANSI A156.6 - Architectural Door Trim.
   7. ANSI A156.7 - Template Hinge Dimensions.
   8. ANSI A156.8 - Door Controls - Overhead Holders.
   9. ANSI A156.12 - Interconnected Locks and Latches.
   10. ANSI A156.13 - Mortise Locks and Latches.
   11. ANSI A156.14 - Sliding and Folding Door Hardware.
   12. ANSI A156.15 - Closer Holder Release Devices.
   13. ANSI A156.16 - Auxiliary Hardware.
   14. ANSI A156.18 - Materials and Finishes
   15. ANSI A156.19 - Power Assist and Low Energy Power Operated Doors.
   16. ANSI A156.23 - Electromagnetic Locks.
   17. ANSI A156.24 - Delayed Egress Locks.
   18. ANSI A156 - Complete Set of 24 BHMA Standards (A156 Series) with Binder.

B. Builders Hardware Manufacturers Association:
   1. BHMA Directory of Certified Products.

C. National Fire Protection Association:
   1. NFPA 80 - Standard for Fire Doors, Fire Windows.
   2. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies.

D. Underwriters Laboratories Inc.:
   1. UL 10B - Fire Tests of Door Assemblies.
   2. UL 305 - Panic Hardware.
   3. UL - Building Materials Directory.

E. Intertek Testing Services (Warnock Hersey Listed):

1. WH - Certification Listings.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Indicate locations and mounting heights of each type of hardware, schedules, and catalog cuts.
   2. Submit manufacturer's parts lists, and templates.

B. Manufacturer's Installation Instructions: Submit special procedures, and perimeter conditions requiring special attention.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of installed cylinders and their master key code.

B. Operation and Maintenance Data: Submit data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.

C. Keys: Deliver with identifying tags to Owner by security shipment direct from hardware supplier.

D. All doors on the new pump building shall be keyed alike.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with the following requirements:
   1. ANSI A156 series.
   2. NFPA 80.
   3. UL 305.

B. Furnish hardware marked and listed in BHMA Directory of Certified Products.

C. Perform Work in accordance with 2013 California Building Code (CBC).

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Hardware Supplier: Company specializing in supplying commercial door hardware with minimum three years documented experience.

1.8 PRE-INSTALLATION MEETINGS

A. Convene minimum week prior to commencing work of this section.

B. Include persons involved with installation of doors, frames, and hardware.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Package hardware items individually with necessary fasteners, instructions, and installation templates, when necessary; label and identify each package with door opening code to match hardware schedule.

1.10 COORDINATION

A. Coordinate Work with other directly affected sections involving manufacture or fabrication of internal reinforcement for door hardware and recessed items.
   1. Provide templates or actual hardware as required to ensure proper preparation of doors and frames.

B. Coordinate Owner's keying requirements during course of Work.
   1. Key all Pump Station Building doors the same.

1.11 WARRANTY

A. Furnish five year manufacturer warranty for locksets and door closers.

1.12 MAINTENANCE MATERIALS

A. Furnish special wrenches and tools applicable for each different and for each special hardware component.

B. Furnish maintenance tools and accessories supplied by hardware component manufacturer.

PART 2 PRODUCTS

2.1 DOOR HARDWARE

A. All door hardware of all types shall be stainless steel including screws, bolts, plates, etc.

B. Hinge Manufacturers:
   1. Stanley (STA), Hager, Lawrence, McKinney or Equivalent.

C. Lockset , Latch Set , and Cylinder Manufacturers:
   1. Schlage (SCH) or Equivalent.

D. Exit Device Manufacturers:
   1. Von Duprin (VON), Precision Hardware, Inc or Equivalent.

E. Closers Manufacturers:
   1. LCN, Dorma, Norton or Equivalent.

F. Door Controls and Overhead Holders Manufacturers:
   1. Ives (IVE), Door Controls Inc or Equivalent.

G. Protection Plates, Gaskets, Thresholds, and Trim Manufacturers:

1. Pemko (PEM), Reese, Zero, Hager or Equivalent.

2.2 COMPONENTS

A. General Hardware Requirements: Where not specifically indicated, comply with applicable ANSI A156 standard for type of hardware required. Furnish each type of hardware with accessories as required for applications indicated and for complete, finished, operational doors.
   1. All hardware to be stainless steel.
   2. Templates: Furnish templates or physical hardware items to door and frame manufacturers sufficiently in advance to avoid delay in Work.
   3. Reinforcing Units: Furnished by door and frame manufacturers; coordinated by hardware supplier or hardware manufacturer.
   4. Fasteners: Furnish as recommended by hardware manufacturer and as required to secure hardware.
      a. Finish: Match hardware item being fastened.

B. Hinges: ANSI A156.1, full mortise type complying with following general requirements unless otherwise scheduled.
   1. Widths: Sufficient to clear trim projection when door swings 180 degrees.
   2. Number: Furnish minimum three hinges to 90 inches high, four hinges to 120 inches high for each door leaf.
   3. Size and Weight: 4-1/2 inch heavy weight typical for 1-3/4 inch doors.
   4. Pins: Furnish nonferrous hinges with non-removable pins (NRP).
   5. Tips: Flush tips.

C. Locksets: Furnish locksets compatible with specified cylinders. Typical 2-3/4 inch backset. Furnish standard strikes with extended lips to protect trim from being marred by latch bolt verify type of cutouts provided in metal frames.
   1. Bored (Cylindrical) Locksets: ANSI A156.2, Series 4000, Grade 1 unless otherwise indicated.

D. Cylinders: Confirm Owner Preference.
   1. Keying: Key as directed by the Owner.
   2. Include construction keying.
   3. Keys: Nickel silver. Stamp keys with “DO NOT DUPLICATE”.

E. Closers: ANSI A156.4 modern type with cover, surface mounted closers; full rack and pinion type with steel spring and non-freezing hydraulic fluid.
   1. Adjustability: Furnish controls for regulating closing, latching, speeds, and back checking.
   2. Arms: Type to suit individual condition; parallel-arm closers at reverse bevel doors and where doors swing full 180 degrees.
   3. Location: Mount closers on inside of exterior doors.
   4. Operating Pressure: Maximum operating pressure as follows.
      a. Interior Doors: Maximum 5 pounds.
      b. Exterior Doors: Maximum 8.5 pound.

F. Door Controls and Overhead Holders: Furnish with accessories as required for complete operational installation.

1. Manual Door Holders and Overhead Stops: ANSI A156.8, Grade 1 types as specified
2. Closer Holder Release Devices: ANSI A156.15 door mounted closer holder release devices closers with multiple point hold.

G. Manual Bolts, Protection Plates, Gaskets, Thresholds, and Trim: Furnish as indicated in Schedule, with accessories as required for complete operational door installations.
   1. Manual Bolts: ANSI A156.16 Grade 1 top and bottom flush bolts, with dust-proof floor strike, unless otherwise indicated.
   2. Kickplates: ANSI A156.6, metal; height indicated in Schedule by [1 inch] less than door width; minimum [0.050 inch] thick stainless steel.
   3. Weatherstripping: Furnish continuous weatherstripping at top and sides of exterior doors.
   4. Thresholds: Maximum [1/2 inch] height.
   5. Floor Stops: ANSI A156.1 Grade 1 standard floor type with [no] visible screws; furnish with accessories as required for applications indicated.

2.3 ACCESSORIES

A. Lock Trim: Furnish levers with rose as selected from manufacturer's full range of levers and roses.

B. Through Bolts: Do not permit through bolts and grommet nuts on door faces in occupied areas unless no alternative is possible.

2.4 FINISHING

A. Finishes: ANSI A156.18; furnish following finishes except where otherwise indicated in Schedule at end of section.
   1. Hinges:
      a. BHMA 630, satin finish stainless steel.
   2. Lockset:
      a. BHMA 630, satin finished stainless steel.
   3. Closers: Finish appearance to match door hardware on same face of door.
      a. BHMA 630, satin finish stainless steel.
   4. Thresholds: Finish appearance to match door hardware on exterior face of door.
      a. BHMA 630, satin finish stainless steel.
   5. Other Items: Furnish manufacturer's standard finishes to match similar hardware types on same door, and maintain acceptable finish considering anticipated use and BHMA category of finish.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify doors and frames are ready to receive door hardware and dimensions are as indicated on shop drawings.

B. Verify electric power is available to power operated devices and is of correct characteristics.

3.2 INSTALLATION

A. Coordinate mounting heights with door and frame manufacturers. Use templates provided by hardware item manufacturer.

B. Mounting Heights From Finished Floor to Center Line of Hardware Item: Comply with manufacturer recommendations and applicable codes where not otherwise indicated.
   1. Locksets: .38 inch..
   2. Top Hinge: Jamb manufacturer's standard, but not greater than .10 inches. from head of frame to center line of hinge.
   3. Bottom Hinge: Jamb manufacturer's standard, but not greater than .12-1/2 inches. from floor to center line of hinge.
   4. Intermediate Hinges: Equally spaced between top and bottom hinges and from each other.
   5. Hinge Mortise on Door Leaf: .1/4 inch. to .5/16 inch. from stop side of door.

3.3 FIELD QUALITY CONTROL

A. Architectural Hardware Consultant inspect installation and certify hardware and installation has been furnished and installed in accordance with manufacturer's instructions.

3.4 ADJUSTING

A. Adjust hardware for smooth operation.

3.5 PROTECTION OF INSTALLED CONSTRUCTION

A. Do not permit adjacent work to damage hardware or hardware finish.

3.6 SCHEDULES

A. The following hardware sets are intended to establish type and standard of quality when used together with this section requirements. Examine Drawings and Specifications and furnish proper hardware for door openings.

Hardware Group #1 (Exterior HM 2'-8" Door)			
4	Hinges	Stanley	FBB191xNRP
1	Lockset	Schlage	ND80PD, Rhodes
1	Closer	LCN	4111
1	Floor Stop	IVE	FS448
1	Set Gasketing	Pemko	S88
1	Threshold	Pemko	271A
1	Door Shoes/Drips	Pemko	216AV
2	Kickplates	Hager	10"

END OF SECTION

SECTION 09 80 00

PAINTING AND COATING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes
   1. Surface preparation and finish painting of interior and exterior surfaces indicated.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCES

A. 29 CFR, Code of Federal Regulations
   1. Title 29 - Occupational Safety and Health Administration (OSHA), U.S. Department of Labor
   2. Title 40 - Environmental Protection Agency

B. ASTM, American Society for Testing and Materials International
   1. D16 - Standard Terminology for Paint, Related Coatings, Materials and Applications

C. SSPC, Steel Structures Painting Council, the Society for Protective Coatings
   1. SP1- Solvent Cleaning
   2. SP2 - Hand Tool Cleaning
   3. SP3 - Power Tool Cleaning
   4. SP6 - Commercial Blast Cleaning
   5. SP10 - Near-White Blast Cleaning
   6. SP11 - Power Tool Cleaning to Bare Metal

D. NSF, National Sanitation Foundation
   1. NSF 61 - Drinking Water System Components

E. NAPF, National Association of Pipe Fabricators, Inc.
   1. NAPF 500-03

1.4 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – “Submittal Procedures”.

B. Product Data: For each coating system to be used, the Contractor shall submit the manufacturer’s catalogue containing the following data:
   1. Technical data sheet for each product used, including statements of the suitability of the material for the intended use.

2. Instructions and recommendations for surface preparation, thinning, mixing, handling, application, and proper storage. This shall include minimum time requirements for coating, recoating and surface patches.
3. Material safety data sheet for each product used.

C. Manufacturer's Details and Instructions: The manufacturer's standard details for coating over joints/cracks, pipe penetrations, and edge terminations shall be provided. Indicate special surface preparation procedures, substrate conditions requiring special attention.

D. Qualifications of the Coating Contractor:
1. Copy of valid state of California A or C-33 Contractor's license.
2. Three references from projects completed within the last 5 years.
3. Written certification that each applicator performing Work on the projects is trained and qualified to perform the Work.
4. Written certification from the Contractor that they are qualified to apply the coating system specified.

E. For consideration of products of manufacturers other than those named, in addition to the information required to be submitted for substitutions by the General Conditions and Division 1, for each product submit current (within the last 6 months) test data from a recognized independent testing laboratory, accompanied by a letter stating that the proposed products are equal to or better than those specified.

1.5 QUALITY ASSURANCE

A. Conform to local Air Quality Management District (AQMD) regulations.

B. Paint materials not otherwise specified shall be products of one manufacturer regularly producing materials of types specified.

1.6 PERMITS, CERTIFICATES, LAWS AND ORDINANCES

A. The Contractor shall, at his own expense, procure all permits, certificates, and licenses required of him by law for the execution of the work. He shall comply with all Federal, State, Air Quality District, County, City or District laws, ordinances, or rules and regulations relating to the performance of the work.

B. Without limiting the general aspects or other requirements of this specification, all surface preparation, coating and painting of surfaces shall conform to applicable standards and practices as set forth by the National Association of Corrosion Engineers (NACE), Steel Structures Painting Council (SSPC), American Water Works Association (AWWA), and coating manufacturer's printed instructions.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 01 60 00 – Product Requirements.

B. Deliver products to site in sealed and labeled containers; inspect to verify acceptability. A product exceeding the manufacturer's recommended shelf life shall not be used.

C. Container label to include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

D. Store paint materials at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the coating product manufacturer.

B. Do not apply exterior coatings during rain or snow.

C. General sound levels for the project shall not affect routine facility or neighborhood activities.

D. VOC levels shall never exceed local VOC limits. The Contractor shall be responsible for all fines or legal costs resulting from any VOC violations.

1.9 INSPECTION AND TESTING

A. At the discretion of the Owner, all Work related to coating preparation or application shall be conducted under the supervision of a full time Inspector to be provided by the Owner. It is recommended that the Inspector be a NACE Certified Coating Inspector.

B. Prior to the start of any Work, the Contractor shall establish schedules and notification procedures with the Inspector to ensure that all surface preparation Work is inspected prior to coating application.

1.10 RECORDS

A. The Contractor shall maintain a daily written record of the quantity of coating applied and the surface area covered. The Contractor shall record the ambient temperature, relative humidity, dewpoint and applicator. These reports shall be provided to the Inspector each day and shall be submitted to the Owner.

1.11 WARRANTY

A. The Contractor and manufacturers shall warrant the coating system applications for a period of no less than two years after final acceptance of the Work. The Contractor shall submit to the Owner a two-year warranty for the complete coating system. The Contractor shall perform all Work and supply all equipment and materials to repair any and all failures identified as a part of the warranty inspection at no cost to the Owner.

1.12 SAFETY AND HEALTH

A. The Contractor shall at all times conduct his work so as to assure the least possible inconvenience to the general public and adequate protection of persons and property in the work vicinity. Attention shall be paid to prevailing winds to reduce drifting of abrasive blast residue, dust, and paint or coating overspray. At no time should drifting materials exceed any governmental agency's laws, codes, or guidelines. Public noise exposure shall be limited to hours of operation specified and delineated by the Owner.

B. Ventilation: All solvent vapors shall be completely removed by suction type, explosion-proof exhaust fans and blowers, as described in AWWA Section 7-Safety precautions. Air shall not be forced from the outside into the enclosure. Care should be taken to remove toxic vapors and atomized particles with special attention given to the lowest and coolest areas.

C. Ventilation systems shall remain in service during coating application and for a minimum of seven days after completion of final coating application or coating repair, or until coating has fully cured, whichever is longer. Fuel or electricity costs, general maintenance and operations, shall be the responsibility of the Contractor unless specified otherwise.

D. Illumination: Adequate illumination shall be provided while work is in progress, including explosion-proof lights and electrical equipment. Whenever required by the ENGINEER, Contractor shall provide additional illumination and necessary supports to cover areas to be inspected.

E. Temporary Ladders and Scaffolding: All temporary ladders and scaffolding shall conform to applicable safety standards. They shall be erected where requested by the ENGINEER to facilitate inspection and be moved by the Contractor to locations requested by the ENGINEER.

F. Grounding: Blasting and painting hoses shall be grounded to prevent accumulation of a charge of static electricity.

G. Fire Hazard: Flammable, volatile solvents in paint and coating constitute a major hazard with regard to fire and explosions wherever flame or spark exposure is possible. All flames, smoking, and welding, etc., are strictly prohibited. Fire abatement devices shall be readily available and in operating condition. All paints and coatings shall be stored in conformance with applicable State, County and/or Local Fire Codes pertaining to flammable materials.

H. The Contractor shall take necessary precautions to keep fire hazard to a minimum, removing from the area daily all oily rags, waste, and other combustibles not in covered containers.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Heavy-Duty Industrial Coatings and Architectural Paints:
   1. Ameron Protective Coatings, Brea, CA.
   2. Carboline Coatings Co., St. Louis, MO.
   3. ICI Devoe Coatings, Louisville, KY.
   4. International Protective Coatings, Houson, TX
   5. Sherwin Williams, Cleveland, OH.
   6. Tnemec Coatings, Kansas City, MO.
   7. Raven Lining System, Broken Arrow, OK.
   8. PPG Protective & Marine Coatings
   9. Approved Equal

B. Architectural and Institutional Paints:
   1. Ameritone, Long Beach, CA.
   2. Benjamin Moore Paints, New York, NY.
   3. Dunn-Edwards Paint Co.
   4. Fuller/O'Brien Paint Co., San Francisco, CA.
   5. Pratt and Lambert, Inc., Buffalo, NY.
   6. Samuel Cabot, Inc., Boston, MA.
   7. Approved Equal

2.2 MATERIALS - GENERAL DESCRIPTION

A. Comply with EPA and local Air Pollution Control District (APCD) requirements limiting volatile organic compounds.

B. Materials used in painting interior walls of Class I structures shall be latex based.

C. Materials selected for each paint system shall be products of the same manufacturer, and shall be compatible with each other.

D. Abrasives: The type and size of abrasive shall be selected to produce a surface profile that meets the coating manufacturer's recommendations.
   1. All abrasives shall be new, clean, and delivered to the project in unopened, weather resistant containers.
   2. Abrasive materials shall not be recycled for further use on this project.
   3. All abrasives shall meet the requirements of the local Air Quality Management District.
   4. At no time will abrasives containing more than 1% free silica be allowed on the job site. All abrasives shall be disposed of in accordance with all federal, state, and local laws
   5. Abrasive material used for interior tank areas shall be silica free sand.
   6. Abrasive material used for areas other than tank interiors shall be Kleen-Blast, or approved equal.
   7. Abrasive shall produce a profile as recommended by the paint manufacturer. The abrasive to be used shall be sharp, angular, properly graded and brought to the job site in moisture-proof bags or airtight bulk containers, and shall be capable of producing the depth of profile specified by the paint manufacturer.

8. Copper slag abrasives are not suitable.
    a. All surfaces in the ceiling, rafters, beams and columns shall be blown down with high-pressure air until all surfaces are deemed dust free by the Engineer. No coatings shall be applied until the surfaces have been inspected and approved. The entire floor surface shall be vacuumed clean prior to the floor coating application.

E. Coatings: Ready mixed, except field-catalyzed coatings. Process pigments to a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating; good flow and brushing properties; capable of drying or curing free of streaks or sags.

F. Accessory Materials: Linseed oil, shellac, turpentine, paint thinners and other materials as recommended by each manufacturer for his respective product not specifically indicated but required to achieve the finishes specified, of commercial quality. Do not use mixed materials beyond manufacturer's recommended pot life.

G. Patching Materials: Fillers compatible with coatings.

H. Wood Filler: Paste filler recommended by manufacturer for wood type used, in color according to color of stain finish scheduled or selected.

I. General Purpose Filler: Standard spackling compound or gypsum wallboard joint compound or latex patching compound; for patching plaster, gypsum wallboard, and wood surfaces to receive opaque paint finishes.

J. Equipment: Provide scaffolding, staging, drop cloths, covers, brushes, rollers, and spraying and other equipment of the type, grade, and size required for proper execution of the Work.

2.3 PAINT MATERIALS

A. Paint products are specified in the following table:

Product	Definition
Potable Grade Polyamide Epoxy Coatings	Polyamide epoxy coatings approved for potable water or conforming to NSF Standards 60 and 61 contact MANUFACTURERS: See paragraph 2.1.A
Polyamide, Anti-Corrosive, Epoxy Primer	Converted epoxy primer coating rust-inhibitive pigments MANUFACTURERS: See paragraph 2.1.A
Organic Zinc Rich Primer	Converted epoxy, epoxy/phenolic or urethane type, minimum 10 lb metallic zinc content per gallon MANUFACTURERS: See paragraph 2.1.A
Alkyd Enamel	Optimum quality, gloss finish, medium long oil MANUFACTURERS: See paragraph 2.1.A or 2.1.B
Wash Primer	Vinyl butyryl acid MANUFACTURERS: See paragraph 2.1.A
Inorganic Zinc Primer	Solvent or water based, 14 lbs metallic zinc content per gallon minimum; follow manufacturer's recommendation for top coating

Product	Definition
	MANUFACTURERS: See paragraph 2.1.A
Silicone/Silicone Acrylic	Elevated temperature silicone or silicone/acrylic based
	MANUFACTURERS: See paragraph 2.1.A or 2.1.B
Cementitious Acrylic Emulsion	Two-component (liquid and aggregate) filler
	MANUFACTURERS: See paragraph 2.1.A or 2.1.B
Synthetic Resin Primer	Resin primer
	MANUFACTURERS: See paragraph 2.1.A
Amine Epoxy	Amine epoxy, capable of 6 MDFT per coat.
High Build	MANUFACTURERS: See paragraph 2.1.A
Polyurethane Enamel	Two-component, aliphatic or acrylic based polyurethane; high gloss finish
	MANUFACTURERS: See paragraph 2.1.A
Bituminous Paint	Single-component, coal-tar pitch based
	MANUFACTURERS: See paragraph 2.1.A
DTM Acrylic Primer	DTM industrial acrylic primer for aluminum, ferrous metal, or galvanized metal.
	MANUFACTURERS: See paragraph 2.1.A
DTM Acrylic Enamel	DTM industrial acrylic enamel for ferrous metal or galvanized steel.
	MANUFACTURERS: See paragraph 2.1.A

2.4 COLORS

A. Provide as selected by Owner.

B. Formulate with colorants free of lead, lead compounds, or other materials which might be affected by presence of hydrogen sulfide or other gas likely to be present at the project.

C. Proprietary identification of colors is for identification only. Any authorized manufacturer may supply matches.

D. Colors

Item	Color
Potable Water Piping	Blue
Potable Water Piping, Valve V-1 See Plan Sheet C-601	Red
Exterior Wood Surfaces	Millet
Interior Underside of Roof	White

PART 3 EXECUTION

3.1 GENERAL

A. Surface Preparation Inspection

1. 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.
2. Provide City Representative minimum 3 days' advance notice prior to start of surface preparation work or coating application work.
3. Perform such work only in presence of City Representative, unless City Representative grants prior approval to perform such work in City Representative's absence.

B. For coatings subject to immersion, obtain full cure for completed system. Consult coatings manufacturer's written instructions for these requirements. Do not immerse coating for any purpose until completion of curing cycle.
   1. In the case of enclosed areas, forced air ventilation, using heated air if necessary, may be required until the coatings have fully cured.
   2. Forced air ventilation is required for the application and curing of coatings on the interior surfaces of steel reservoirs and enclosed hydraulic structures. During curing periods continuously exhaust air from a manhole in the lowest shell ring, or in the case of an enclosed hydraulic structure, from the lowest level of the structure using portable ducting. After all interior coating operations have been completed provide a final curing period for a minimum of 10 days, during which the forced ventilation system shall operate continuously.
   3. The Contractor shall provide curing time, temperature, and ventilation as specified by the manufacturer or this section, whichever is the highest requirement. Extend the curing time or ventilation time beyond the manufacturers requirements in order to comply with the regulatory agency requirements or to reduce the leached organic compounds to the required levels. All costs in connection with any extended curing times shall be borne by the Contractor.

C. Do not apply paint in temperatures exceeding manufacturer's recommended maximum or minimum allowable, or in dust, smoke-laden atmosphere, damp or humid weather.

D. Do not perform abrasive blast cleaning whenever relative humidity exceeds 85 percent, or whenever surface temperature is less than 5 degrees F above dewpoint of ambient air.

3.2 SURFACES NOT REQUIRING PAINTING

A. Unless otherwise stated herein or shown, the following areas or items will not require painting:
   1. Concrete and masonry surfaces except as specified elsewhere.
   2. Nonferrous and corrosion-resistant ferrous alloys such as copper, bronze, monel, aluminum, chromium plate, atmospherically exposed weathering steel, and stainless steel, except where:
      a. Required for electrical insulation between dissimilar metals.
      b. Aluminum and stainless steel are embedded in concrete or masonry, or aluminum is in contact with concrete or masonry.
      c. Color coding of equipment and piping is required.
   3. Nonmetallic materials such as glass, PVC, wood, porcelain, and plastic (FRP) except as required for architectural painting or color coding.

4. Prefinished electrical and architectural items such as motor control centers, switchboards, switchgear, panelboards, transformers, disconnect switches (if prefinished in OSHA yellow), acoustical tile, cabinets, elevators, building louvers, wall panels, etc.; color coding of equipment is required.
5. Nonsubmerged electrical conduits attached to unpainted concrete surfaces.
6. Cathodic protection anodes. The connection (weld) of the anode to the tank shall be coated after welding.
7. Items specified to be galvanized after fabrication unless specified elsewhere or subject to immersion.
8. Insulated piping and/or insulated piping with jacket will not require exterior coating, except as required for architectural painting or color coding.
9. Flow meters.

B. Prepare manufactured items and materials that are "factory" galvanized and coat as specified hereinafter for the exposure condition of the item and for architectural purposes, unless otherwise specified herein.

3.3 PROTECTION OF MATERIALS NOT TO BE PAINTED

A. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted.

B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.

C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.

D. Mask openings in motors to prevent paint and other materials from entering the motors.

3.4 APPLICATION SAFETY

A. Perform surface preparation and painting in accordance with recommendations of the following:
1. Paint manufacturer's instructions.
2. NACE, contained in the publication, Manual for Painter Safety.
3. Federal, state, and local agencies having jurisdiction.

B. Contractor shall be solely and completely responsible for conditions of the jobsite, including safety of all persons (including employees) and property during performance of the work. This requirement shall apply continuously and not be limited to normal working hours. Safety provisions shall conform to U.S. Department of Labor, Occupational Safety and Health Act, any equivalent state law, and all other applicable federal, state, county, and local laws, ordinances, and codes.

C. Contractor shall comply with all safety training requirements promulgated or required for this project.

3.5 PAINT MIXING

A. Multiple-Component Coatings
   1. Prepare using all the contents of the container for each component as packaged by paint manufacturer.
   2. No partial batches will be permitted.
   3. Do not use multiple-component coatings that have been mixed beyond their pot life.
   4. Provide small quantity kits for touchup painting and for painting other small areas.
   5. Mix only components specified and furnished by paint manufacturer.
   6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

B. Keep paint materials sealed when not in use.

C. 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.

3.6 PREPARATION OF SURFACES

A. Metal Surface Preparation
   1. General
      a. Do not perform a surface preparation blast prior to submission of samples. Workmanship for metal surface preparation as specified shall meet current SSPC Specifications.
      b. Wherever the words "solvent cleaning", "hand tool cleaning", "wire brushing", or "blast cleaning", or similar words of equal intent are used in these Specifications or in paint manufacturer's specifications, they shall be understood to refer to the applicable SSPC Specifications.
      c. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. Coating manufacturers' recommendations for wet blast additives and first coat application shall apply.
      d. Hand tool clean areas that cannot be cleaned by power tool cleaning.
   2. Preblast Cleaning Requirements
      a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.
      b. Cleaning Methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing.
      c. Clean small isolated areas as above or solvent clean with suitable solvents and clean cloths.
      d. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.
      e. Welds and Adjacent Areas
         1) Prepare such that there is:
            a) No undercutting or reverse ridges on weld bead.
            b) No weld spatter on or adjacent to weld or any other area to be painted.
            c) No sharp peaks or ridges along weld bead.

f. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.

3. Blast Cleaning Requirements
   a. Type of Equipment and Speed of Travel: Design to obtain specified degree of cleanliness. Minimum surface preparation is as specified herein and takes precedence over coating manufacturer's recommendations.
   b. Select type and size of abrasive to produce a surface profile that meets coating manufacturer's recommendations for particular primer to be used.
   c. Use only dry blast cleaning methods.
   d. Do not reuse abrasive, except for designed recyclable systems.
   e. Meet applicable federal, state, and local air pollution and environmental control regulations for blast cleaning and disposition of spent aggregate and debris.
4. Post-Blast Cleaning and Other Cleaning Requirements
   a. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wipe with a tack cloth.
   b. Paint surfaces the same day they are sandblasted. Reblast surfaces that have started to rust before they are painted.

B. Preparation of Existing Coated or Primed Surfaces
1. To be Repainted or Final Coated: Detergent wash and freshwater rinse.
2. Clean loose, abraded, or damaged coatings to substrate by Hand or Power Tool, SP 2 or SP 3.
3. Feather surrounding intact coating.
4. Apply one spot coat of the specified primer to bare areas, overlapping prepared existing coating.
5. Apply one full finish coat of the specified primer or finish coat(s) overall.
6. If an aged, plural-component material is to be topcoated, contact coating manufacturer concerned for additional surface preparation requirements.
7. Preprimed ductile iron pipe requires application of a seal coat prior to application of a cosmetic finish coat.
8. Unknown or Temporary Coatings:
   a. The exact nature of existing coatings is not known in all cases. Completely remove all such coatings by appropriate method and replace with specified coating.
   b. If acceptability of existing coating is in question, request disposition from City Representative.

3.7 APPLICATION OF PAINT

A. General
1. Inspection: Schedule with City Representative in advance for cleaned surfaces and all coats prior to succeeding coat.
2. Apply coatings in accordance with paint manufacturer's recommendations. Allow sufficient time between coats to assure thorough drying of previously applied paint.
3. Fusion Bonded Coatings Method Application: Electrostatic, fluidized bed, or flocking.

4. Paint units to be bolted together and to structures prior to assembly or installation.

B. Shop Primed or Factory Finished Surfaces
   1. Inspection: Schedule with City Representative in advance for shop primed or factory finished items delivered to jobsite for compliance with Specifications.
   2. Hand or power sand areas of chipped, peeled, or abraded coating, feathering the edges. Follow with a spot primer using specified primer.
   3. For two-package or converted coatings, consult coatings manufacturer for specific procedures as relates to manufacturer's products.
   4. Prior to application of finish coats, clean shop primed surfaces free of dirt, oil, and grease and apply mist coat of specified primer, 1-mil dry film thickness.
   5. After welding, prepare and prime holdback areas as required for specified paint system. Apply primer in accordance with manufacturer's instructions.

C. Manufacturer Applied Paint Systems
   1. Repair abraded areas on factory finished items in accordance with the equipment manufacturer's directions.
   2. Carefully blend repaired areas into original finish.

D. Film Thickness
   1. Coverage is listed as either total minimum dry film thickness in mils (MDFT) or the spreading rate in square feet per gallon (SFPG). Per coat determinations are listed as MDFTPC or SFPGPC.
   2. Number of Coats: Minimum required irrespective of coating thickness. Additional coats may be required to obtain minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric conditions.
   3. Maximum film build per coat shall not exceed coating manufacturer's recommendations.
   4. Film Thickness Measurements and Electrical Inspection of Coated Surfaces
      a. Performed by trained operators with properly calibrated instruments.
      b. Recoat and repair as necessary for compliance with the Specifications.
      c. All coats will be subject to inspection by City Representative and coating manufacturer's representative.
   5. Visually inspect concrete, nonferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.
   6. Give particular attention to edges, angles, flanges, and other similar areas, where insufficient film thicknesses are likely to be present, and ensure proper millage in these areas using stripe coats as required.
   7. Thickness Testing
      a. After repaired and recoated areas have dried sufficiently, final tests shall be conducted by the Contractor in the presence of the City Representative.
      b. Measure coating thickness specified in mils with a magnetic type dry film thickness gauge as specified.
      c. Test finish coat, except zinc primer, galvanizing, and elastomeric coatings in excess of 25 mils dry, for holidays and discontinuities with an electrical holiday detector, low voltage, wet sponge type as specified.
      d. Holiday detect coatings in excess of 25 mils dry with high voltage units recommended by the coating manufacturer.

e. Check each coat for correct millage. Do not make measurement before a minimum of 8 hours after application of coating.
f. All interior surfaces of tanks, reservoirs, and containers shall have holiday detection performed on 100 percent of the coated surfaces.

E. Damaged Coatings, Pinholes, and Holidays
1. Feather edges and repair in accordance with recommendations of paint manufacturer.
2. Repair fusion bonded coatings as recommended by original applicator. Applicator shall provide liquid repair kits for this purpose as recommended by coating manufacturer.
3. Apply finish coats, including touchup and damage-repair coats in a manner which will present a uniform texture and color-matched appearance.

F. Unsatisfactory Application
1. If item has an improper finish color, or insufficient film thickness, clean and top coat surface with specified paint material to obtain specified color and coverage. Obtain specific surface preparation information from coating manufacturer.
2. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather the edges. Follow with primer and finish coat in accordance with the Specifications. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.
3. Evidence of runs, bridges, shiners, laps, or other imperfections shall be cause for rejection.
4. Repair defects in coating system per written recommendations of coating manufacturer.
5. Leave all staging up until City Representative has inspected surface or coating. Replace staging removed prior to approval by City Representative. Provide additional illumination and staging if requested by the City Representative to facilitate inspection.

3.8 CLEANUP

A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at the end of each day.

B. Upon completion of the work, remove staging, scaffolding, and containers from the site or destroy in a legal manner.

C. Completely remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.

3.9 PROTECTIVE COATINGS SYSTEMS

A. System No. 1 Building Interior/Exterior – Wood Surfaces

Surface Prep.	Paint Material	Min. Coats, Cover
Remove Unused Nails, Hooks, Hardware, Etc. SSPC-SP2, Hand Tool Cleaning	Exterior Grade Latex Paint	1 coat, 3-4 MDFT

B. System No. 2 Internal Building Piping and Final Field Coating of New Equipment

Surface Prep.	Paint Material	Min. Coats, Cover
NAPF 500-03 Hand Tool Cleaning	Polyamide Anti-corrosive Epoxy Primer	2 coats, 4-6 MDFT

C. System No. 3 External Exposed Ductile Iron Piping

Surface Prep.	Paint Material	Min. Coats, Cover
NAPF 500-03 Hand Tool Cleaning	Polyamide Anti-corrosive Epoxy Primer	1 coat, 4-6 MDFT
	Polyurethane Enamel	1 coat, 3-4 MDFT

D. System No. 4 Building Interior/Exterior – Metal Surfaces

Surface Prep.	Paint Material	Min. Coats, Cover
See Section 3.6.A	DTM Acrylic Primer	1 coat, 2-4 MDFT
	DTM Acrylic Enamel	2 coats, 2-4 MDFT

E. Contact Engineer for systems covering other areas.

3.10 PAINT APPLICATION SCHEDULE

A. Unless otherwise shown or specified in these Specifications paint or coat the work in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from City Representative before starting work in question. Other applications are specified in individual Specification sections.

B. System No. 1 Building Interior/Exterior: Remove all unused equipment, nails, hooks, 2x4's, ropes and other unused items from the walls and coat the building interior/exterior including:
   1. Facia board, rafter ends, underside of eave, and other exterior wood surfaces
   2. Underside of roof inside the building
   3. Doors

C. System No. 2 Building Piping and Final Field Coating of New Equipment: Use on exposed metal surfaces, located inside or outside of structures and exposed to weather, highly humid atmosphere, such as pipe galleries and similar areas, and the following specific surfaces:
   1. Exterior of pipes, valves, fittings and appurtenances.

3.11 MANUFACTURERS' SERVICES

A. Furnish paint manufacturer's representative to visit jobsite at intervals during surface preparation and painting as may be required for product application quality assurance, and to determine compliance with manufacturer's instructions and these Specifications, and as may be necessary to resolve field problems attributable to, or associated with, manufacturer's products furnished under this Contract.

(See Paint System Data Sheet form following this section)

PAINT SYSTEM DATA SHEET

Attached products' Technical Data Sheet (if applicable) to this sheet for each paint system submittal.

Paint System Number (from Spec.):		
Paint System Title (from Spec.):		
Coatings Supplier:		
Representative:		
Surface Preparation:		
Paint Material (Generic)	Product Name/Number (Proprietary)	Min. Coats Coverage

END OF SECTION

SECTION 22 05 17

SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sleeves
   2. Sleeve-seal systems
   3. Grout

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS

A. 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:
   1. Advance Products & Systems, Inc.
   2. CALPICO, Inc.
   3. Metraflex Company (The).
   4. Pipeline Seal and Insulator, Inc.

5. Proco Products, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
   1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Stainless steel.
   3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Non-shrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
   1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
   2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."

E. 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 for firestopping specified in Division 07 Section "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:
   1. Exterior Concrete Walls above Grade:
      a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
      b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.
   2. Exterior Concrete Walls below Grade:
      a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves with sleeve-seal system.
         1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
      b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves with sleeve-seal system.
         1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
   3. Concrete Slabs-on-Grade:
      a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves with sleeve-seal system.
         1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
      b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.
         1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
   4. Concrete Slabs above Grade:
      a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
      b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.
   5. Interior Partitions:
      a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
      b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION

SECTION 22 05 18

ESCUTCHEONS FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Escutcheons.
   2. Floor plates.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. Escutcheons for New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.

c. Insulated Piping: One-piece, stamped-steel type.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type.
h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type.
j. Bare Piping in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated finish.
k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
1. New Piping: One-piece, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION

SECTION 22 05 23

GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Bronze ball valves.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve indicated.

1.4 QUALITY ASSURANCE

A. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

B. NSF Compliance: NSF 61 for valve materials for potable-water service.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:
   1. Hand lever: For quarter-turn valves NPS 6 and smaller.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
   1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

F. Valve-End Connections:
   1. Flanged: With flanges according to ASME B16.1 for iron valves.
   2. Solder Joint: With sockets according to ASME B16.18.
   3. Threaded: With threads according to ASME B1.20.1.

2.2 BRONZE BALL VALVES

A. One-Piece, Reduced-Port, Bronze Ball Valves with Bronze Trim:
   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. American Valve, Inc.
      b. Conbraco Industries, Inc.; Apollo Valves.
      c. NIBCO INC.
   2. Description:
      a. Standard: MSS SP-110.
      b. CWP Rating: 400 psig.
      c. Body Design: One piece.
      d. Body Material: Bronze.
      e. Ends: Threaded.
      f. Seats: PTFE or TFE.
      g. Stem: Bronze.
      h. Ball: Chrome-plated brass.
      i. Port: Reduced.

B. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
   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. American Valve, Inc.
      b. Conbraco Industries, Inc.; Apollo Valves.
      c. Crane Co.; Crane Valve Group; Crane Valves.
      d. Hammond Valve.
      e. Lance Valves; a division of Advanced Thermal Systems, Inc.
      f. Legend Valve.
      g. Milwaukee Valve Company.
      h. NIBCO INC.
      i. Red-White Valve Corporation.
      j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Description:
      a. Standard: MSS SP-110.
      b. SWP Rating: 150 psig.
      c. CWP Rating: 600 psig.
      d. Body Design: Two piece.
      e. Body Material: Bronze.
      f. Ends: Threaded.
      g. Seats: PTFE or TFE.
      h. Stem: Bronze.
      i. Ball: Chrome-plated brass.
      j. Port: Full.

C. Two-Piece, Regular-Port, Bronze Ball Valves with Bronze Trim:
   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. American Valve, Inc.

b. Conbraco Industries, Inc.; Apollo Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Division.
e. DynaQuip Controls.
f. Hammond Valve.
g. Lance Valves; a division of Advanced Thermal Systems, Inc.
h. Milwaukee Valve Company.
i. NIBCO INC.

2. Description:
   a. Standard: MSS SP-110.
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Two piece.
   e. Body Material: Bronze.
   f. Ends: Threaded.
   g. Seats: PTFE or TFE.
   h. Stem: Bronze.
   i. Ball: Chrome-plated brass.
   j. Port: Regular.

PART 3 EXECUTION

3.1 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Install shutoff valve on each water supply to equipment and on each water supply to plumbing fixtures without supply stops.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full stem movement.

3.2 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
   1. Shutoff Service: Ball valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:
   1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
   4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
   5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

3.4 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
   1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Ball Valves: One or Two piece, full, regular, or reduced port, bronze with bronze trim.

END OF SECTION

SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Metal pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Thermal-hanger shield inserts.
   4. Fastener systems.
   5. Pipe positioning systems.
   6. Equipment supports.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
   1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
   2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
   3. Design seismic-restraint hangers and supports for piping and equipment.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
   1. Trapeze pipe hangers.
   2. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.6 QUALITY ASSURANCE

A. Structural Steel 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.

PART 2 PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
   3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
   4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
   5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
   3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe Hangers:
   1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
   2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.5 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.6 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.7 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
   1. Properties: Nonstaining, noncorrosive, and nongaseous.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than .4 inches. thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
   2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, .NPS 2-1/2. and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

M. Insulated Piping:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and 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. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 09 80 00.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.

3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
9. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
   2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
   2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
   2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
   3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
   4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
   5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
   6. C-Clamps (MSS Type 23): For structural shapes.
   7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
      a. Light (MSS Type 31): 750 lb.
      b. Medium (MSS Type 32): 1500 lb.
      c. Heavy (MSS Type 33): 3000 lb.

8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
   2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
   3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
   2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
   3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.

P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

R. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION

SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:
   1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Letter Color: White.
   3. Background Color: Black.
   4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
   6. Fasteners: Stainless-steel rivets or self-tapping screws.
   7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:
   1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
   2. Letter Color: White.
   3. Background Color: Black.
   4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
   5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: Size letters according to ASME A13.1 for piping.

PART 3 EXECUTION

3.1 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.2 PIPE LABEL INSTALLATION

A. Piping Color Coding: Painting of piping is specified in Section 099123 "Interior Painting."

B. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
   7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Pipe Label Color Schedule:
   1. Domestic Cold and Hot Water Piping
      a. Background: Safety white.
      b. Letter Colors: Black.
   2. Sanitary Waste Piping:
      a. Background Color: Safety white.

b. Letter Color: Black.

END OF SECTION

SECTION 22 07 19

PLUMBING PIPING INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes insulating the following plumbing piping services:
   1. Domestic hot-water piping.
   2. Supplies and drains for handicap-accessible lavatories and sinks.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   3. Detail removable insulation at piping specialties, equipment connections, and access panels.
   4. Detail application of field-applied jackets.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

B. Comply with the following applicable standards and other requirements specified for miscellaneous components:
   1. Supply and Drain Protective Shielding Guards: ICC A117.1.

PART 2 PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   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. Pittsburgh Corning Corporation; Foamglas.
   2. Special-Shaped Insulation: ASTM C 552, Type III.
   3. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
   4. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
   5. Factory-fabricate shapes according to ASTM C 450 and ASTM C 585.

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
   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. Aeroflex USA, Inc.; Aerocel.
      b. Armacell LLC; AP Armaflex.
      c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

H. Mineral-Fiber, Preformed Pipe Insulation:
   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. Fibrex Insulations Inc.; Coreplus 1200.
      b. Johns Manville; Micro-Lok.
      c. Knauf Insulation; 1000-Degree Pipe Insulation.
      d. Manson Insulation Inc.; Alley-K.
      e. Owens Corning; Fiberglas Pipe Insulation.
   2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, without factory-

applied jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
   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. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
   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. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84.

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   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. Aeroflex USA, Inc.; Aeroseal.
      b. Armacell LLC; Armaflex 520 Adhesive.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
      d. K-Flex USA; R-373 Contact Adhesive.

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
      b. Eagle Bridges - Marathon Industries; 225.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
      d. Mon-Eco Industries, Inc.; 22-25.

E. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
   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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.

b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-20.
d. Mon-Eco Industries, Inc.; 22-25.

F. PVC Jacket Adhesive: Compatible with PVC jacket.
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. Dow Corning Corporation; 739, Dow Silicone.
b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. P.I.C. Plastics, Inc.; Welding Adhesive.
d. Speedline Corporation; Polyco VP Adhesive.

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
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. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
b. Vimasco Corporation; 749.
2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
b. Eagle Bridges - Marathon Industries; 550.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
d. Mon-Eco Industries, Inc.; 55-50.
e. Vimasco Corporation; WC-1/WC-5.
2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.5 SEALANTS

A. Joint Sealants:
   1. Joint Sealants for Cellular-Glass Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
      b. Eagle Bridges - Marathon Industries; 405.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
      d. Mon-Eco Industries, Inc.; 44-05.
      e. Pittsburgh Corning Corporation; Pittseal 444.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Permanently flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 100 to plus 300 deg F.
   5. Color: White or gray.

B. FSK and Metal Jacket Flashing Sealants:
   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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
      b. Eagle Bridges - Marathon Industries; 405.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
      d. Mon-Eco Industries, Inc.; 44-05.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F.
   5. Color: Aluminum.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
   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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F.
   5. Color: White.

2.6 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.
   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. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Mast-A-Fab.
      b. Vimasco Corporation; Elastafab 894.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   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. Johns Manville; Zeston.
      b. P.I.C. Plastics, Inc.; FG Series.
      c. Proto Corporation; LoSmoke.
      d. Speedline Corporation; SmokeSafe.
   2. Adhesive: As recommended by jacket material manufacturer.
   3. Color: White.
   4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
      a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

C. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
   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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
      b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
      c. RPR Products, Inc.; Insul-Mate.
   2. Finish and thickness are indicated in field-applied jacket schedules.
   3. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.
   4. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
   5. Factory-Fabricated Fitting Covers:
      a. Same material, finish, and thickness as jacket.
      b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      c. Tee covers.
      d. Flange and union covers.
      e. End caps.
      f. Beveled collars.
      g. Valve covers.
      h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

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. ABI, Ideal Tape Division; 428 AWF ASJ.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
   c. Compac Corporation; 104 and 105.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   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. ABI, Ideal Tape Division; 491 AWF FSK.
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
      c. Compac Corporation; 110 and 111.
      d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
   2. Width: 3 inches.
   3. Thickness: 6.5 mils.
   4. Adhesion: 90 ounces force/inch in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
   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. ABI, Ideal Tape Division; 370 White PVC tape.
      b. Compac Corporation; 130.
      c. Venture Tape; 1506 CW NS.
   2. Width: 2 inches.
   3. Thickness: 6 mils.
   4. Adhesion: 64 ounces force/inch in width.
   5. Elongation: 500 percent.
   6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
   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. ABI, Ideal Tape Division; 488 AWF.
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
      c. Compac Corporation; 120.
      d. Venture Tape; 3520 CW.
   2. Width: 2 inches.
   3. Thickness: 3.7 mils.

4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.9 SECUREMENTS

A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
   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. ITW Insulation Systems; Gerrard Strapping and Seals.
      b. RPR Products, Inc.; Insul-Mate Strapping and Seals.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

C. Wire: 0.080-inch nickel-copper alloy.
   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. C & F Wire.

2.10 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:
   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. Engineered Brass Company.
      b. Insul-Tect Products Co.; a subsidiary of MVG Molded Products.
      c. McGuire Manufacturing.
      d. Plumberex.
      e. Truebro; a brand of IPS Corporation.
      f. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.
   2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

PART 3 EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. For above-ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   4. Cleanouts.

3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
   4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
   1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:
   1. Pipe: Install insulation continuously through floor penetrations.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.4 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
   5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
   6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
   7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
   8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
   9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and

around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
   1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
   2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
   3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
   4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
   5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.5 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF MINERAL-FIBER PREFORMED PIPE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:
1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.9 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
   1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
      a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by State's Representative. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Inspect pipe, fittings, strainers, and valves, randomly selected by State's Representative, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.11 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.12 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Hot Water: Insulation shall be one of the following:
   1. Flexible Elastomeric: 3/4 inch thick.
   2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

B. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities: Insulation shall be one of the following:
   1. Flexible Elastomeric: 1/2 inch thick.
   2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

3.13 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Domestic Water Piping: Insulation shall be one of the following:
   1. Cellular Glass: 2 inches thick.
   2. Flexible Elastomeric: 2 inches thick.
   3. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

3.14 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:
   1. None.
   2. PVC: 20 mils thick.
   3. Aluminum, Smooth: 0.016 inch thick.

D. Piping, Exposed:
   1. PVC: 20 mils thick.
   2. Aluminum, Smooth: 0.016 inch thick.

3.15 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:
   1. None.
   2. PVC: 20 mils thick.
   3. Aluminum, Smooth: 0.016 inch thick.

D. Piping, Exposed:

1. PVC: 20 mils thick.
2. Aluminum, Smooth: 0.016 inch thick.

3.16 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION

SECTION 22 11 16

DOMESTIC WATER PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 ACTION SUBMITTALS

A. Product Data: For transition fittings and dielectric fittings.

1.4 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

B. Field quality-control reports.

PART 2 PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

B. Soft Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

F. Copper Unions:
   1. MSS SP-123.
   2. Cast-copper-alloy, hexagonal-stock body.
   3. Ball-and-socket, metal-to-metal seating surfaces.
   4. Solder-joint or threaded ends.

G. Copper Pressure-Seal-Joint Fittings:
   1. Fittings for NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
   2. Fittings for NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

H. Copper Push-on-Joint Fittings:
   1. Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22.
   2. Stainless-steel teeth and EPDM-rubber, O-ring seal in each end instead of solder-joint ends.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:
   1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
   2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.4 TRANSITION FITTINGS

A. General Requirements:
   1. Same size as pipes to be joined.
   2. Pressure rating at least equal to pipes to be joined.
   3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

2.5 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:
   1. Standard: ASSE 1079.
   2. Pressure Rating: 125 psig minimum at 180 deg F.
   3. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:
   1. Standard: ASSE 1079.
   2. Factory-fabricated, bolted, companion-flange assembly.
   3. Pressure Rating: 125 psig minimum at 180 deg F.
   4. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:
   1. Non-conducting materials for field assembly of companion flanges.
   2. Pressure Rating: 150 psig.
   3. Gasket: Neoprene or phenolic.
   4. Bolt Sleeves: Phenolic or polyethylene.
   5. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:
   1. Standard: IAPMO PS 66.
   2. Electroplated steel nipple complying with ASTM F 1545.
   3. Pressure Rating and Temperature: 300 psig at 225 deg F.
   4. End Connections: Male threaded or grooved.
   5. Lining: Inert and noncorrosive, propylene.

PART 3 EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. 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.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance.

E. Install shutoff valve immediately upstream of each dielectric fitting.

F. Install seismic restraints on piping.

G. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

H. 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.

I. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

J. Install piping to permit valve servicing.

K. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

L. Install piping free of sags and bends.

M. Install fittings for changes in direction and branch connections.

N. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

G. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

H. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:
   1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
   2. Fittings for NPS 2 and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.5 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices.

B. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
   1. Vertical Piping: MSS Type 8 or 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
   3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
   2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
   3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
   4. NPS 2-1/2: 108 inches with 1/2-inch rod.
   5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.

F. Install supports for vertical copper tubing every 10 feet.

G. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
   1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
   2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.

3.8 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Label pressure piping with system operating pressure.

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Piping Inspections:
      a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
      b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
         1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.

2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

c. Re-inspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for re-inspection.

d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:
   a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
   b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
   c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
   e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
   f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 ADJUSTING

A. Perform the following adjustments before operation:
   1. Open shutoff valves to fully open position.
   2. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
   3. Remove and clean strainer screens. Close drain valves and replace drain plugs.
   4. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
   5. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING

A. Clean and disinfect potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system according to either of the following:
   1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
   2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Repeat procedures if biological examination shows contamination.
e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller, shall be the following:
   1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.

E. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be the following:
   1. Hard or soft copper tube, ASTM B 88, Type L; wrought-copper, solder-joint fittings; and brazed joints.

F. Aboveground domestic water piping, NPS 2 and smaller, shall be the following:
   1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and brazed joints.

END OF SECTION

SECTION 22 11 19

DOMESTIC WATER PIPING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Hose bibbs.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF 61 Annex G.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 HOSE BIBBS

A. Hose Bibbs:
   1. Standard: ASME A112.18.1 for sediment faucets.
   2. Body Material: Bronze.
   3. Seat: Bronze, replaceable.
   4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
   5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
   6. Pressure Rating: 125 psig.
   7. Vacuum Breaker: Integral, non-removable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
   8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.

9. Finish for Service Areas: Rough bronze.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Operating key.
12. Operation for Service Areas: Operating key.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include wall flange with each chrome- or nickel-plated hose bibb.

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

A. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

B. Prepare test and inspection reports.

END OF SECTION

SECTION 22 13 16

SANITARY WASTE AND VENT PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe, tube, and fittings.
   2. Specialty pipe fittings.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

PART 2 PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service class.

B. Gaskets: ASTM C 564, rubber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. CISPI, Hubless-Piping Couplings:
   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. ANACO-Husky.
      b. Dallas Specialty & Mfg. Co.
      c. Fernco Inc.
      d. Matco-Norca, Inc.
      e. MIFAB, Inc.
      f. Mission Rubber Company; a division of MCP Industries, Inc.
      g. Stant.
      h. Tyler Pipe.
   2. Standards: ASTM C 1277 and CISPI 310.
   3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Hubless-Piping Couplings:
   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. ANACO-Husky.
      b. Clamp-All Corp.
      c. Dallas Specialty & Mfg. Co.
      d. MIFAB, Inc.
      e. Mission Rubber Company; a division of MCP Industries, Inc.
      f. Stant.
      g. Tyler Pipe.
   2. Standards: ASTM C 1277 and ASTM C 1540.
   3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

C. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
   1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
   2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

D. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.5 SPECIALTY PIPE FITTINGS

A. Transition Couplings:
   1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
   2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
   3. Unshielded, Non-pressure Transition Couplings:
      a. 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:
         1) Dallas Specialty & Mfg. Co.
         2) Fernco Inc.
         3) Mission Rubber Company; a division of MCP Industries, Inc.
         4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
      b. Standard: ASTM C 1173.
      c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
      d. Sleeve Materials:
         1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
         2) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
   4. Shielded, Non-pressure Transition Couplings:
      a. 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:
         1) Cascade Waterworks Mfg. Co.
         2) Mission Rubber Company; a division of MCP Industries, Inc.
      b. Standard: ASTM C 1460.
      c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

PART 3 EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. 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.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping at indicated slopes.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Install seismic restraints on piping.

I. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

J. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

K. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 2 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

L. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

M. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

N. Plumbing Specialties:
1. Install backwater valves in sanitary waste gravity-flow piping. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."
2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
3. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."

O. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

C. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

D. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:
   1. Install transition couplings at joints of piping with small differences in OD's.
   2. In Drainage Piping: Unshielded, non-pressure transition couplings.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices.

B. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
   1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
   2. Install [stainless-steel pipe hangers for horizontal piping in corrosive environments.
   3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
   4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
   5. Vertical Piping: MSS Type 8 or Type 42, clamps.
   6. Install individual, straight, horizontal piping runs:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
   7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   8. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
   2. NPS 3: 60 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
   4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
   5. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4: 72 inches with 3/8-inch rod.

2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with 3/4-inch rod.

I. Install supports for vertical copper tubing every 10 feet.

J. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:
1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Comply with requirements for cleanouts and drains specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
6. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections according to the following unless otherwise indicated:
1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.7 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
   4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
   5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   6. Prepare reports for tests and required corrective action.

3.9 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.10 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:
   1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
   3. Dissimilar Pipe-Material Couplings: Unshielded, non-pressure transition couplings.

C. Aboveground, soil and waste piping [NPS 5 and larger] <Insert pipe size range> shall be[any of] the following:
   1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
   3. Dissimilar Pipe-Material Couplings: Unshielded, non-pressure transition couplings.

D. Aboveground, vent piping NPS 4 and smaller shall be any of the following:
   1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
   3. Copper DWV tube, copper drainage fittings, and soldered joints.
   4. Dissimilar Pipe-Material Couplings: Unshielded, non-pressure transition couplings.

E. Aboveground, vent piping NPS 5 and larger shall be any of the following:
   1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
   3. Dissimilar Pipe-Material Couplings: Unshielded, non-pressure transition couplings.

F. Aboveground drain piping NPS 4 and smaller shall be the following:
   1. Copper DWV tube, copper drainage fittings, and soldered joints.

G. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:
   1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
   2. Hubless, cast-iron soil pipe and fittings; heavy-duty cast-iron hubless-piping couplings; and coupled joints.
   3. Dissimilar Pipe-Material Couplings: Unshielded, non-pressure transition couplings.

H. Underground, soil and waste piping NPS 5 and larger shall be any of the following:
   1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
   2. Hubless, cast-iron soil pipe and fittings; heavy-duty cast-iron hubless-piping couplings; coupled joints.

3. Dissimilar Pipe-Material Couplings: Unshielded, non-pressure transition couplings.

END OF SECTION

SECTION 22 13 19

SANITARY WASTE PIPING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Cleanouts.
   2. Floor drains.
   3. Roof flashing assemblies.
   4. Miscellaneous sanitary drainage piping specialties.
   5. Flashing materials.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for grease interceptors.

1.4 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 PRODUCTS

2.1 CLEANOUTS

A. Exposed Cast-Iron Cleanouts:
   1. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
   2. Size: Same as connected drainage piping
   3. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
   4. Closure: Countersunk plug.
   5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cast-Iron Floor Cleanouts:
   1. Standard: ASME A112.36.2M for heavy-duty, adjustable housing cleanout.
   2. Size: Same as connected branch.
   3. Type: Heavy-duty, adjustable housing.
   4. Body or Ferrule: Cast iron.
   5. Clamping Device: Not required.
   6. Outlet Connection: Inside calk.
   7. Closure: Brass plug with straight threads and gasket.

8. Adjustable Housing Material: Cast iron with threads.
9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
10. Frame and Cover Shape: Round.
11. Top Loading Classification: Heavy Duty.
12. Riser: ASTM A 74, Extra-Heavy class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:
1. Standard: ASME A112.36.2M. Include wall access.
2. Size: Same as connected drainage piping.
3. Body: Hub-less, cast-iron soil pipe test tee as required to match connected piping.
4. Closure: Countersunk plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access: Round, deep, chrome-plated bronze cover plate with screw.
7. Wall Access: Round, nickel-bronze wall-installation frame and cover.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:
1. Standard: ASME A112.6.3.
2. Pattern: Floor drain.
3. Body Material: Gray iron.
4. Seepage Flange: Not required.
5. Anchor Flange: Not required.
6. Clamping Device: Required.
7. Outlet: Bottom.
8. Backwater Valve: Not required.
9. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel.
10. Sediment Bucket: Required.
11. Vandal Proof Grate: Required.
12. Top or Strainer Material: Bronze.
13. Top of Body and Strainer Finish: Nickel bronze.
14. Top Shape: Square.
15. Top Loading Classification: Heavy Duty.
16. Trap Material: Cast iron.
17. Trap Pattern: Standard P-trap.
18. Trap Features: Trap-seal primer valve drain connection.

2.3 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:
1. Description: Manufactured assembly made of 4.0-lb/sq. ft., 0.0625-inch- thick, lead flashing collar and skirt extending at least 6 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
a. Low-Silhouette Vent Cap: With vandal-proof vent cap.

2.4 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.
3. Outlet: Larger than inlet.
4. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

B. Sleeve Flashing Device:
1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

C. Stack Flashing Fittings:
1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

D. Vent Caps:
1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

2.5 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Fasteners: Metal compatible with material and substrate being fastened.

C. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

D. Solder: ASTM B 32, lead-free alloy.

E. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
   a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
   b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
   c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

E. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

F. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

G. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

H. Install vent caps on each vent pipe passing through roof.

I. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

A. Comply with requirements in Section 22 13 16 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
   1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
   1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
   2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
   3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 07 62 00 "Sheet Metal Flashing and Trim."

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

3.4 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each grease interceptor.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.5 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 22 33 00

ELECTRIC, DOMESTIC-WATER HEATERS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Thermostat-control, electric, tankless, domestic-water heaters.
   2. Domestic-water heater accessories.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Commercial domestic-water heaters shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.4 ACTION SUBMITTALS

A. Product Data: For each type and size of domestic-water heater indicated.

B. Shop Drawings:
   1. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For commercial domestic-water heaters, accessories, and components, from manufacturer.

B. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

C. Source quality-control reports.

D. Field quality-control reports.

E. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.
   1. Warranty Periods: From date of Substantial Completion.
      a. Electric, Tankless, Domestic-Water Heaters: Five year(s).

PART 2 PRODUCTS

2.1 ELECTRIC, TANKLESS, DOMESTIC-WATER HEATERS

A. Thermostat-Control, Electric, Tankless, Domestic-Water Heaters:
   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. Bosch Water Heating.
      b. Chronomite Laboratories, Inc.
      c. Niagara Industries, Inc.
      d. Stiebel Eltron.
   2. Standard: UL 499 for electric, tankless, (domestic-water heater) heating appliance.
   3. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.
      a. Connections: ASME B1.20.1 pipe thread.
      b. Pressure Rating: 150 psig.
      c. Heating Element: Resistance heating system.
      d. Temperature Control: Thermostat.
      e. Safety Control: High-temperature-limit cutoff device or system.
      f. Jacket: Aluminum or steel with enameled finish or plastic.
   4. Support: Bracket for wall mounting.

2.2 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 Section "Quality Requirements" for retesting and re-inspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.

D. Prepare test and inspection reports.

PART 3 EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Electric, Tankless, Domestic-Water Heater Mounting: Install electric, tankless, domestic-water heaters on wall bracket.
   1. Maintain manufacturer's recommended clearances.
   2. Arrange units so controls and devices that require servicing are accessible.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.
   5. Anchor domestic-water heaters to substrate.

B. Install electric, domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
   1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

C. Install commercial, electric, domestic-water heaters with seismic-restraint devices.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Division 22 Section "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
   2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 Section "Quality Requirements" for retesting and re-inspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.

C. Prepare test and inspection reports.

END OF SECTION

SECTION 22 42 16.16

COMMERCIAL SINKS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Handwash sinks.
   2. Sink faucets.
   3. Supply fittings.
   4. Waste fittings.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

PART 2 PRODUCTS

2.1 HANDWASH SINKS

A. Handwash Sinks: Stainless steel, wall mounted.
   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. Advance Tabco.
      b. AERO Manufacturing Company.
      c. Amtekco Industries, Inc.
      d. Eagle Group; Foodservice Equipment Division.
      e. Elkay Manufacturing Co.
      f. Griffin Products, Inc.
      g. Just Manufacturing.
   2. Fixture:
      a. Standards: ASME A112.19.3/CSA B45.4 and NSF/ANSI 2.
      b. Type: Basin with radius corners, back for faucet, and support brackets.
      c. Nominal Size: 17-1/4 by 15-1/4 by 5 inches.

3. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
4. Waste Fittings: Comply with requirements in "Waste Fittings" Article.

2.2 SINK FAUCETS

A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for faucet-spout materials that will be in contact with potable water.

B. Sink Faucets: Manual type, mixing valve, integral with sink.
1. Standard: ASME A112.18.1/CSA B125.1.
2. General: Include hot- and cold-water indicators.
3. Body Material: Commercial, solid brass.
4. Finish: Chrome plated.
5. Maximum Flow Rate: 2.25 gpm.
6. Handle(s): Wrist blade.
7. Mounting Type: Splash mounted.
8. Spout Type: Gooseneck.
9. Spout Outlet: Aerator.
10. Eye wash faucet attachment.

2.3 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless-steel wall flange.

D. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

E. Operation: Loose key.

F. Risers:
1. NPS 3/8
2. ASME A112.18.6, braided or corrugated stainless-steel flexible hose.

2.4 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid type with NPS 1-1/2 offset and straight tailpiece.

C. Trap:
1. Size: NPS 1-1/2.
2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch- thick brass tube to wall and chrome-plated brass or steel wall flange.
3. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch- thick stainless-steel tube to wall; and stainless-steel wall flange.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.

B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install sinks level and plumb according to roughing-in drawings.

B. Install supports, affixed to building substrate, for wall-hung sinks.

C. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.

D. Set floor-mounted sinks in leveling bed of cement grout.

E. Install water-supply piping with stop on each supply to each sink faucet.
   1. Exception: Use ball, gate, or globe valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping."
   2. Install stops in locations where they can be easily reached for operation.

F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

G. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 22 07 19 "Plumbing Piping Insulation."

3.3 CONNECTIONS

A. Connect sinks with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

A. After completing installation of sinks, inspect and repair damaged finishes.

B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed sinks and fittings.

END OF SECTION

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Metal pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Thermal-hanger shield inserts.
   4. Fastener systems.
   5. Equipment supports.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
   1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
   2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
   3. Design seismic-restraint hangers and supports for piping and equipment.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
   1. Trapeze pipe hangers.
   2. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.6 QUALITY ASSURANCE

A. Structural Steel 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.

PART 2 PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
   3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
   4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
   5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
   3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe Hangers:
   1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
   2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.5 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.6 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
   1. Properties: Nonstaining, noncorrosive, and nongaseous.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

H. Install lateral bracing with pipe hangers and supports to prevent swaying.

I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

L. Insulated Piping:
1. Attach clamps and spacers to piping.
    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:

a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
b. NPS 4: 12 inches long and 0.06 inch thick.
c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and 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. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 09 80 00 “Painting and Coating”.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
   3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
   4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
   5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.

6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
9. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
   a. Light (MSS Type 31): 750 lb.
   b. Medium (MSS Type 32): 1500 lb.
   c. Heavy (MSS Type 33): 3000 lb.
8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
   2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
   3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.

P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Use powder-actuated fasteners instead of building attachments where required in concrete construction.

END OF SECTION

SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Duct labels.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:
   1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Letter Color: White.
   3. Background Color: Black.
   4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
   6. Fasteners: Stainless-steel rivets or self-tapping screws.
   7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:
   1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
   2. Letter Color: White.
   3. Background Color: Black.
   4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
   5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Black.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 DUCT LABEL INSTALLATION

A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
   1. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

B. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Balancing Air Systems:
      a. Constant-volume air systems.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

F. TDH: Total dynamic head.

1.4 INFORMATIONAL SUBMITTALS

A. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

B. Certified TAB reports.

1.5 QUALITY ASSURANCE

A. TAB Specialists Qualifications: Certified by AABC, NEBB or TABB.
   1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC, NEBB or TABB.
   2. TAB Technician: Employee of the TAB specialist and certified by AABC, NEBB or TABB as a TAB technician.

B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4 "Instrumentation."

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan and pump curves.
   1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
   2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

G. Examine test reports specified in individual system and equipment Sections.

H. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

I. Examine operating safety interlocks and controls on HVAC equipment.

J. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures for balancing the systems.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, where applicable, the following:
   1. Airside:
      a. Duct systems are complete with terminals installed.
      b. Volume, smoke, and fire dampers are open and functional.
      c. Clean filters are installed.
      d. Fans are operating, free of vibration, and rotating in correct direction.
      e. Variable-frequency controllers' startup is complete and safeties are verified.
      f. Automatic temperature-control systems are operational.
      g. Ceilings are installed.
      h. Windows and doors are installed.
      i. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
   1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

D. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Verify that air duct system is sealed as specified in Section 23 31 13 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
   1. Measure total airflow.
      a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
      b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
      c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
      d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
   2. Measure fan static pressures as follows:
      a. Measure static pressure directly at the fan outlet or through the flexible connection.
      b. Measure static pressure directly at the fan inlet or through the flexible connection.
      c. Measure static pressure across each component that makes up the air-handling system.
      d. Report artificial loading of filters at the time static pressures are measured.
   3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
   4. Obtain approval from State's Representative for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
   5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
   1. Measure airflow of submain and branch ducts.
   2. Adjust submain and branch duct volume dampers for specified airflow.
   3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
2. Measure inlets and outlets airflow.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

3.6 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
   2. Air Outlets and Inlets: Plus or minus 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.7 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
   1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
   2. Include a list of instruments used for procedures, along with proof of calibration.
   3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:
   1. Fan curves.
   2. Manufacturers' test data.
   3. Field test reports prepared by system and equipment installers.
   4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:
   1. Title page.
   2. Name and address of the TAB specialist.
   3. Project name.
   4. Project location.
   5. State’s name and address.
   6. Engineer's name and address.
   7. Contractor's name and address.
   8. Report date.
   9. Signature of TAB supervisor who certifies the report.
   10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
   11. Summary of contents including the following:
      a. Indicated versus final performance.
      b. Notable characteristics of systems.
      c. Description of system operation sequence if it varies from the Contract Documents.
   12. Nomenclature sheets for each item of equipment.
   13. Data for terminal units, including manufacturer's name, type, size, and fittings.

14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fan performance forms including the following:
    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Fan drive settings including settings and percentage of maximum pitch diameter.
    c. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Duct, outlet, and inlet sizes.
3. Balancing stations.
4. Position of balancing devices.

E. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data:
    a. System identification.
    b. Location.
    c. Make and type.
    d. Model number and size.
    e. Manufacturer's serial number.
    f. Arrangement and class.
    g. Sheave make, size in inches, and bore.
    h. Center-to-center dimensions of sheave and amount of adjustments in inches.
2. Motor Data:
    a. Motor make, and frame type and size.
    b. Horsepower and rpm.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.
    e. Sheave make, size in inches, and bore.
    f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
    g. Number, make, and size of belts.
3. Test Data (Indicated and Actual Values):
    a. Total airflow rate in cfm.
    b. Total system static pressure in inches wg.
    c. Fan rpm.
    d. Discharge static pressure in inches wg.
    e. Suction static pressure in inches wg.

F. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
1. Report Data:
    a. System and air-handling-unit number.
    b. Location and zone.
    c. Traverse air temperature in deg F.
    d. Duct static pressure in inches wg.
    e. Duct size in inches.
    f. Duct area in sq. ft.

g. Indicated airflow rate in cfm.
h. Indicated velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

G. Instrument Calibration Reports:
1. Report Data:
a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.8 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of State’s Representative.

B. State’s Representative shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

E. If TAB work fails, proceed as follows:
1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
3. If the second verification also fails, State’s Representative may contact AABC Headquarters regarding the AABC National Performance Guaranty.

F. Prepare test and inspection reports.

3.9 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION

SECTION 23 11 26

FACILITY LIQUEFIED-PETROLEUM GAS PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.
6. Storage containers.
7. Pumps.
8. Vaporizers.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:
1. For Piping Containing Only Vapor:
a. Piping and Valves: **125 psig** unless otherwise indicated.
2. For Piping Containing Liquid:
a. Piping between Shutoff Valves: **350 psig** unless otherwise indicated.
b. Piping Other Than Above: **250 psig** unless otherwise indicated.
c. Valves and Fittings: **250 psig** unless otherwise indicated.

B. LPG System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig and is reduced to secondary pressure of 0.5 psig or less.

C. Delegated Design: Design restraints and anchors for LPG piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

D. Seismic Performance: Vaporizers and storage container supports shall withstand the effects of earthquake motions determined according to **SEI/ASCE 7**.
1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For facility LPG 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.

C. Delegated-Design Submittal: For LPG 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.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: Submit certification that vaporizer, storage container supports, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Welding certificates.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.7 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.

PART 2 PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedules 40 and 80, 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. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
      a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

B. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.
   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. OmegaFlex, Inc.
      b. Parker Hannifin Corporation; Parflex Division.
      c. Titeflex.
      d. Tru-Flex Metal Hose Corp.
   2. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
   3. Coating: PE with flame retardant.
      a. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
         1) Flame-Spread Index: 25 or less.
         2) Smoke-Developed Index: 50 or less.
   4. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
   5. Striker Plates: Steel, designed to protect tubing from penetrations.
   6. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
   7. Operating-Pressure Rating: 5 psig.

C. Annealed-Temper Copper Tube: Comply with **ASTM B 88, Type K**.
   1. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
   2. Flare Fittings: Comply with ASME B16.26 and SAE J513.
      a. Copper fittings with long nuts.
      b. Metal-to-metal compression seal without gasket.
      c. Dryseal threads complying with ASME B1.20.3.
   3. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of 0.022 inch thick.

D. 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 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 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.

2.2 PIPING SPECIALTIES

A. Flexible Piping Joints:
   1. Approved for LPG service.
   2. Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
   3. Minimum working pressure of [250 psig] and [250 deg F] operating temperature.
   4. Threaded-end connections to match equipment connected and shall be capable of minimum [3/4-inch] misalignment.
   5. Maximum [36-inch] length for liquid LPG lines.

B. 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].

C. 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.

D. 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.
3. Strainer Screen: **40**-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

E. 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.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for LPG.

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.

C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M.

2.4 MANUAL GAS SHUTOFF VALVES

A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

B. Metallic Valves, NPS 2 and Smaller for Liquid Service: Comply with ASME B16.33 and UL 842.
1. CWP Rating: **250 psig**.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Socket ends for brazed joints.
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 by CSA or agency acceptable to authorities having jurisdiction for valves 1 inch and smaller.
6. Valves 1-1/4 inch and larger shall be suitable for LPG service, with "WOG" indicated on valve body.

C. General Requirements for Metallic Valves, NPS 2 and Smaller for Vapor Service: 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 inch to NPS 2 shall have initials "WOG" permanently marked on valve body.

D. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
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. 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.
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 LPG service with "WOG" indicated on valve body.

E. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
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. 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.
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 LPG service with "WOG" indicated on valve body.

F. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.
   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. 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.
   2. Body: Bronze, complying with ASTM B 584.
   3. Ball: Chrome-plated bronze.
   4. Stem: Bronze; blowout proof.
   5. Seats: Reinforced TFE.
   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 LPG service with "WOG" indicated on valve body.

G. Bronze Plug Valves: MSS SP-78.
   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. Lee Brass Company.
      b. McDonald, A. Y. Mfg. Co.
   2. Body: Bronze, complying with ASTM B 584.
   3. Plug: Bronze.
   4. Ends: Threaded or socket 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 LPG service with "WOG" indicated on valve body.

H. PE Ball Valves: Comply with ASME B16.40.
   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. Kerotest Manufacturing Corp.
      b. Lyall, R. W. & Company, Inc.
      c. Perfection Corporation; a subsidiary of American Meter Company.
   2. Body: PE.
   3. Ball: PE.
   4. Stem: Acetal.
   5. Seats and Seals: Nitrile.
   6. Ends: Plain or fusible to match piping.

7. CWP Rating: **80 psig**.
8. Operating Temperature: **Minus 20 to plus 140 deg F**.
9. Operator: Nut or flat head for key operation.
10. Include plastic valve extension.
11. Include tamperproof locking feature for valves where indicated on Drawings.

I. Valve Boxes:
1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head and with stem of length required to operate valve.

2.5 EARTHQUAKE VALVES

A. Earthquake Valves: Comply with ASCE 25.
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. Pacific Seismic Products, Inc.
2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
3. Maximum Operating Pressure: **10 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.

2.6 PRESSURE REGULATORS

A. General Requirements:
1. Single stage and suitable for LPG.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller.

B. Line Pressure Regulators: Comply with ANSI Z21.80.
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. 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: **10 psig**.

C. Appliance Pressure Regulators: Comply with ANSI Z21.18.
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. Canadian Meter Company Inc.
b. Eaton Corporation; Controls Div.
c. Harper Wyman Co.
d. Maxitrol Company.
e. SCP, Inc.
2. Body and Diaphragm Case: Die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
9. Maximum Inlet Pressure: **13 inches wg**.

2.7 DIELECTRIC UNIONS

A. Dielectric Unions:
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. Capitol Manufacturing Company.
b. Central Plastics Company.
c. Hart Industries International, Inc.
d. Jomar International Ltd.
e. Matco-Norca, Inc.
f. McDonald, A. Y. Mfg. Co.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

h. Wilkins; a Zurn company.

2. Description:
   a. Standard: ASSE 1079.
   b. Pressure Rating: **125 psig** minimum at **180 deg F**.
   c. End Connections: Solder-joint copper alloy and threaded ferrous.

2.8 STORAGE CONTAINERS

A. Description: Factory fabricated, complying with requirements in NFPA 58 and ASME Boiler and Pressure Vessel Code and bearing the ASME label. Tanks shall be rated for 250-psig minimum working pressure.
   1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. American Welding & Tank.
      b. Hanson, Roy E. Jr. Mfg.
      c. Trinity Industries, Inc.
      d. United Industries Group, Inc.
   2. Liquid outlet and vapor inlet and outlet connections shall have shutoff valves with excess-flow safety shutoff valves and bypass and back-pressure check valves with smaller than 0.039-inch drill-size hole to equalize pressure. Liquid-fill connection shall have backflow check valve.
      a. Connections: Color-code and tag valves to indicate type.
         1) Liquid fill and outlet, red.
         2) Vapor inlet and outlet, yellow.
   3. Level gage shall indicate current level of liquid in the container. Gages shall also indicate storage container contents; e.g., "Butane," "50-50 LPG Mix," or "Propane."
   4. Pressure relief valves, type and number as required by NFPA 58, connected to vapor space and having discharge piping same size as relief-valve outlet and long enough to extend at least 84 inches directly overhead. Identify relief valves as follows:
      a. Discharge pressure in psig.
      b. Rate of discharge for standard air in cfm.
      c. Manufacturer's name.
      d. Catalog or model number.
   5. Container pressure gage.
   6. For outdoor installation, exposed metal surfaces mechanically cleaned, primed, and painted for resistance to corrosion.
   7. Ladders for access to valves more than 72 inches aboveground.
   8. Stainless-Steel Nameplate: Attach to aboveground storage container or to adjacent structure for underground storage container.
      a. Name and address of supplier or trade name of container.
      b. Water capacity in gallons and liters.
      c. Design pressure in psig.
      d. Statement, "This container shall not contain a product having a vapor pressure in excess of **10 psig at 100 deg F**."
      e. Outside surface area in sq. ft.
      f. Year of manufacture.
      g. Shell thickness in inches.
      h. Overall length in feet.

i. OD in feet.
j. Manufacturer's serial number.
k. ASME Code label.

9. Felt support pads and two concrete or painted-steel saddles per storage container. Corrosion protection required at container-to-felt contact.
10. Tie straps for each saddle.
11. Straps and anchors for tie-down slab.
12. Asphalt-based coating for corrosion protection.
13. Container connections and valves protected in manway at top of storage container.
14. Manway equipped with ventilation louvers.

2.9 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

3.1 EARTHWORK

A. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 OUTDOOR PIPING INSTALLATION

A. Comply with NFPA 58 and **NFPA 54** requirements for installation and purging of LPG piping.

B. Install underground, LPG piping buried at least **36 inches** below finished grade. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.
   1. If LPG piping is installed less than 36 inches below finished grade, install it in containment conduit.

C. Install underground, PE, LPG piping according to ASTM D 2774.

D. Steel Piping with Protective Coating:
   1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
   2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
   3. Replace pipe having damaged PE coating with new pipe.

E. Copper Tubing with Protective Coating:
   1. Apply joint cover kits over tubing to cover, seal, and protect joints.
   2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.

F. Install fittings for changes in direction and branch connections.

G. Install pressure gage **upstream and downstream** from each service regulator.

3.3 INDOOR PIPING INSTALLATION

A. Comply with **NFPA 54** for installation and purging of LPG piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were 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 LPG 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. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where readily 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.

N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

O. 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.

P. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

Q. Connect branch piping from top or side of horizontal piping.

R. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment.

S. Do not use LPG piping as grounding electrode.

T. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

U. Install pressure gage **upstream and downstream** from each line regulator.

V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section "Escutcheons for HVAC Piping."

3.4 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, 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.

3.5 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. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full ID of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. 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.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Ch. 22, "Pipe and Tube."

F. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

G. 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.

3.6 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.

D. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:
   1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
   2. NPS 1/2: Maximum span, 72 inches; minimum rod size, 3/8 inch.
   3. NPS 3/4 and Larger: Maximum span, 96 inches; minimum rod, 3/8 inch.

3.7 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install LPG 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 appliances 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.

3.8 STORAGE CONTAINER INSTALLATION

A. Fill storage container to at least 80 percent capacity with **propane**.

B. Install piping connections with swing joints or flexible connectors to allow for storage container settlement and for thermal expansion and contraction.

C. Ground containers according to NFPA 780. Grounding is specified in Division 26 Section "Lightning Protection for Structures."

D. Set storage containers in felt pads on concrete or steel saddles. Install corrosion protection at container-to-felt contact.

E. Install tie-downs over storage containers on saddles with proper tension.

F. Set concrete saddles on dowels set in concrete base. Anchor steel saddles to concrete base.

G. Set storage container on concrete ballast base large enough to offset buoyancy of empty storage container immersed in water.

H. Install tie-down straps over container anchored in ballast base and repair damaged coating.

I. Backfill with a minimum coverage for underground or mounded storage containers according to NFPA 58.

J. Backfill with pea gravel as required in Division 31 Section "Earth Moving."

K. Install cathodic protection for storage container. Cathodic protection is specified in Division 26 Section "Cathodic Protection."

3.9 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 FIELD QUALITY CONTROL

A. Test, inspect, and purge LPG according to NFPA 58 and **NFPA 54** and requirements of authorities having jurisdiction.

B. LPG piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.11 OUTDOOR PIPING SCHEDULE

A. Underground LPG liquid piping shall be **one of** the following:
   1. Schedule 40 steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
   2. Annealed-temper copper tube, **Type K** with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.

B. Aboveground LPG liquid piping shall be **one of** the following:
   1. **NPS 2** and Smaller: **Schedule 80** steel pipe, malleable-iron threaded fittings and threaded joints. Coat pipe and fittings with protective coating for steel piping.
   2. Annealed-temper copper tube, Type L, with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.

C. Underground LPG vapor piping shall be **one of** the following:
   1. PE pipe and fittings joined by heat-fusion; service-line risers with tracer wire terminated in an accessible location.
   2. Schedule 40, steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
   3. Annealed-temper copper tube, Type L with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.

D. Aboveground LPG vapor piping shall be **one of** the following:
   1. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
   2. Schedule 40, steel pipe with wrought-steel fittings and welded joints.
   3. Annealed-temper copper tube, Type L, with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.

E. Containment Conduit: Schedule 40, steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.12 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

A. Aboveground, branch piping **NPS 1** and smaller shall be **one of** the following:
   1. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
   2. Annealed-temper copper tube with wrought-copper fittings and **brazed** joints.
   3. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be **one of** the following:
   1. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
   2. Schedule 40, steel pipe with wrought-steel fittings and welded joints.

C. Underground, below building, piping shall be **one of** the following:
   1. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
   2. Schedule 40, steel pipe with wrought-steel fittings and welded joints.

D. Containment Conduit: Schedule 40, steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

E. Containment Conduit Vent Piping: Schedule 40, 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.

3.13 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN 5 PSIG

A. Aboveground, branch piping **NPS 1** and smaller shall be **one of** the following:
   1. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
   2. Annealed-temper copper tube, Type L with wrought-copper fittings and **brazed** joints.
   3. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be **one of** the following:
   1. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
   2. Schedule 40, steel pipe with steel welding fittings and welded joints.

C. Underground, below building, piping shall be **one of** the following:
   1. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
   2. Schedule 40, steel pipe with wrought-steel fittings and welded joints.

D. Containment Conduit: Schedule 40, steel pipe with wrought-steel fittings and welded joints. Coat underground pipe and fittings with protective coating for steel piping.

E. Containment Conduit Vent Piping: Schedule 40, 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.

3.14 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.

B. Underground Vapor Piping: **PE ball** valve.

3.15 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Aboveground Liquid Piping:
   1. Two-piece, **full**-port, bronze ball valves with bronze trim.

B. Valves for pipe NPS 2 and smaller at service meter shall be **one of** the following:
   1. One-piece, bronze ball valve with bronze trim.
   2. Two-piece, **full**-port, bronze ball valves with bronze trim.
   3. Bronze plug valve.

C. Distribution piping valves for pipe NPS 2 and smaller shall be **one of** the following:
   1. One-piece, bronze ball valve with bronze trim.
   2. Two-piece, **full**-port, bronze ball valves with bronze trim.
   3. Bronze plug valve.

D. Valves in branch piping for single appliance shall be **one of** the following:
   1. One-piece, bronze ball valve with bronze trim.
   2. Two-piece, **full**-port, bronze ball valves with bronze trim.
   3. Bronze plug valve.

END OF SECTION

SECTION 23 31 13

METAL DUCTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Rectangular ducts and fittings.
   2. Round ducts and fittings.
   3. Sheet metal materials.
   4. Sealants and gaskets.
   5. Hangers and supports.
   6. Seismic-restraint devices.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".
   1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
   2. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
   3. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:
   1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   2. Factory- and shop-fabricated ducts and fittings.
   3. Duct layout indicating sizes, configuration, and static-pressure classes.
   4. Elevation of top of ducts.
   5. Dimensions of main duct runs from building grid lines.
   6. Fittings.
   7. Reinforcement and spacing.
   8. Seam and joint construction.
   9. Penetrations through fire-rated and other partitions.

10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
   2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
   3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

PART 2 PRODUCTS

2.1 RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements,

materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
1. Fabricate round ducts larger Than 90 inches in diameter with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

C. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

D. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 3 inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with stainless steel or aluminum.

C. Water-Based Joint and Seam Sealant:
1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with stainless steel or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.
1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with poly-isobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.5 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

G. Trapeze and Riser Supports:
   1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
   2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
   3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

2.6 SEISMIC-RESTRAINT DEVICES

A. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
   1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

B. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.

C. Restraint Cables: ASTM A 603, galvanized-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.

D. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod.

E. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
   1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   2. Outdoor, Supply-Air Ducts: Seal Class A.
   3. Outdoor, Exhaust Ducts: Seal Class C.
   4. Outdoor, Return-Air Ducts: Seal Class C.
   5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
   6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
   7. Unconditioned Space, Exhaust Ducts: Seal Class C.
   8. Unconditioned Space, Return-Air Ducts: Seal Class B.
   9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
   10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
   11. Conditioned Space, Exhaust Ducts: Seal Class B.
   12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.
   2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
   5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
   1. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
   2. Brace a change of direction longer than 12 feet.

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install cable restraints on ducts that are suspended with vibration isolators.

E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.

F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

G. Drilling for and Setting Anchors:
   1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the State’s Representative if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
   2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
   3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
   4. Set anchors to manufacturer's recommended torque, using a torque wrench.
   5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.6 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.
   1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
   2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
   3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:
   1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
   2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:
   1. Air outlets and inlets (registers, grilles, and diffusers).
   2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
   3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
   4. Coils and related components.
   5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
   6. Supply-air ducts, dampers, actuators, and turning vanes.
   7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:
   1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
   2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
   3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
   4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
   5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
   6. Provide drainage and cleanup for wash-down procedures.

7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.8 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.9 DUCT SCHEDULE

A. Exhaust Ducts:
   1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
      a. Pressure Class: Negative 1-inch wg.
      b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
      c. SMACNA Leakage Class for Rectangular: 12.
      d. SMACNA Leakage Class for Round and Flat Oval: 6.

B. Intermediate Reinforcement:
   1. Stainless-Steel Ducts: Stainless steel.
   2. Aluminum Ducts: Aluminum.

C. Elbow Configuration:
   1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
      a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
      b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
      c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
   2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
      a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
         1) Radius-to Diameter Ratio: 1.5.
      b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
      c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

D. Branch Configuration:
   1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
      a. Rectangular Main to Rectangular Branch: 45-degree entry.
      b. Rectangular Main to Round Branch: Spin in.
   2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
      a. Velocity 1000 fpm or Lower: 90-degree tap.
      b. Velocity 1000 to 1500 fpm: Conical tap.

c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION

SECTION 23 33 00

AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Backdraft and pressure relief dampers.
   2. Flange connectors.
   3. Flexible connectors.
   4. Duct-mounted access doors.
   5. Duct accessory hardware.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
   1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
      a. Special fittings.
      b. Manual volume damper installations.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and No. 2 finish for exposed ducts.

B. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

C. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

D. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

E. Tie Rods: Stainless steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Description: Gravity balanced.

B. Maximum Air Velocity: 1000 fpm.

C. Maximum System Pressure: 1-inch wg.

D. Frame: Hat-shaped, 0.05-inch- thick, stainless sheet steel, with welded corners or mechanically attached.

E. Blades: Multiple single-piece blades, center pivoted, maximum 6-inch width, 0.025-inch- thick, roll-formed aluminum with sealed edges.

F. Blade Action: Parallel.

G. Blade Seals: Felt.

H. Blade Axles:
1. Material: Nonferrous metal.
2. Diameter: 0.20 inch.

I. Tie Bars and Brackets: Aluminum.

J. Return Spring: Adjustable tension.

K. Bearings: Steel ball.

L. Accessories:
1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Screen Mounting: Rear mounted.
4. Screen Material: Stainless steel.
5. Screen Type: Insect.
6. 90-degree stops.

2.4 FLANGE CONNECTORS

A. Description: Add-on, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

B. Material: Stainless steel.

C. Gage and Shape: Match connecting ductwork.

2.5 DUCT-MOUNTED ACCESS DOORS

A. 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:
   1. Ductmate Industries, Inc.
   2. Flexmaster U.S.A., Inc.
   3. Greenheck Fan Corporation.
   4. McGill AirFlow LLC.
   5. Nailor Industries Inc.
   6. Pottorff.
   7. Ventfabrics, Inc.
   8. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
   1. Door:
      a. Double wall, rectangular.
      b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
      c. Vision panel.
      d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
      e. Fabricate doors airtight and suitable for duct pressure class.
   2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
   3. Number of Hinges and Locks:
      a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
      b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
      c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches.
      d. Access Doors Larger than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

2.6 FLEXIBLE CONNECTORS

A. Materials: Flame-retardant or noncombustible fabrics.

B. Coatings and Adhesives: Comply with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
   1. Minimum Weight: 26 oz./sq. yd..
   2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
   3. Service Temperature: Minus 40 to plus 200 deg F.

2.7 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install test holes at fan inlets and outlets and elsewhere as indicated.

E. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. As indicated on drawings.

F. Install access doors with swing against duct static pressure.

G. Access door sizes:
   1. One-Hand or Inspection Access: 8 by 5 inches.
   2. Two-Hand Access: 12 by 6 inches.
   3. Head and Hand Access: 18 by 10 inches.
   4. Head and Shoulders Access: 21 by 14 inches.
   5. Body Access: 25 by 14 inches.
   6. Body plus Ladder Access: 25 by 17 inches.

H. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

I. Install flexible connectors to connect ducts to equipment.

J. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Operate dampers to verify full range of movement.

2. Inspect locations of access doors and verify that purpose of access door can be performed.

END OF SECTION

SECTION 23 34 23

HVAC POWER VENTILATORS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Centrifugal roof ventilators.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

PART 2 PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

A. 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:
   1. Acme Engineering & Manufacturing Corporation.
   2. Carnes Company.
   3. Greenheck Fan Corporation.
   4. Loren Cook Company.

B. Housing: Removable, galvanized steel, mushroom-domed top; square, one-piece, aluminum base with venturi inlet cone.
   1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Accessories:
   1. Disconnect Switch: Non-fusible type, with thermal-overload protection mounted inside or outside fan housing, factory wired through an internal aluminum conduit.
   2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
   3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
   4. Adjustable line voltage thermostat.

E. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
   1. Overall Height: 8 inches.
   2. Pitch Mounting: Manufacture curb for roof slope.
   3. Metal Liner: Galvanized steel.
   4. Mounting Pedestal: Galvanized steel with removable access panel.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

B. Enclosure Type: Totally enclosed, fan cooled.

2.3 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. See Division 07 Section "Roof Accessories" for installation of roof curbs.

B. Install units with clearances for service and maintenance.

C. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   3. Verify that cleaning and adjusting are complete.
   4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
   5. Adjust belt tension.
   6. Adjust damper linkages for proper damper operation.
   7. Verify lubrication for bearings and other moving parts.
   8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
   9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.

10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

B. Lubricate bearings.

END OF SECTION

SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Provide labor, materials, equipment, transportation and perform operations necessary or incidental to the proper execution and completion of the electrical work, whether specifically mentioned or not, and as directly indicated or reasonably implied by the Drawings and Specifications.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 WORK NOT INCLUDED

A. Refer to the specific electrical specification sections for a detailed listing of work that is not included in this Contract.

B. In any case, cooperate with the other trades who may or may not be party to this Contract for the purpose of coordinating the electrical requirements and installation of equipment, materials, and furnishings provided by those other trades, including the Owner.

1.4 CODES AND STANDARDS

A. Provide equipment and materials which conform to, and perform the installation thereof in accordance with the following codes and industry standards. The applicable version of each shall be that in effect as of the date of the Contract:
   1. California Electrical Code (CEC).
   2. Titles 8, 19 and 24 of the California Code of Regulations (CCR).
   3. American National Standards Institute (ANSI).
   4. California State Fire Marshal (CSFM).
   5. Underwriters' Laboratories (UL).
   6. National Electrical Manufacturers' Association (NEMA).
      a. Institute of Electrical and Electronics Engineers (IEEE).
         1) National Electrical Safety Code (NESC).
            a) Electrical Safety Orders.
            b) Other applicable local codes and ordinances.

B. Where the authority-having-jurisdiction makes an interpretation or decision, as is their prerogative in accordance with the Code, such direction shall be considered a part of these Contract Documents as if contained herein. With respect to completing the intent of the Contract Documents, comply with any and all requirements of the authority-having-jurisdiction and utility company field inspectors, at no additional cost.

C. The above referenced codes and standards are considered to be absolute minimum requirements. The Drawings and Specifications shall take precedence over the above referenced codes and standards where materials or workmanship of higher quality or larger size is indicated. Nothing in these Drawings or Specifications shall be construed to allow work not conforming to the applicable codes and standards.

1.5 REVIEW OF CONTRACT DOCUMENTS

A. Examine all relevant Contract Documents including Drawings, Specifications, and Shop Drawings in order to become acquainted with the Work of other installers whose activities will adjoin or be affected by the Electrical Work.

1.6 PERMITS, LICENSES, AND FEES

A. Procure and pay for all permits, licenses and fees that are required to carry out and complete the Electrical Work.

1.7 SITE VERIFICATION OF INFORMATION

A. Visit the project site prior to submitting a bid and verify the condition, location and dimensions of buildings, equipment, and facilities. Become acquainted with conditions under which the Work is to be performed and which may affect the cost thereof.

B. Verify at the project site, the accuracy of information shown on the Drawings regarding existing equipment, materials, and facilities. This includes, but is not limited to, size, type, rating, quality, age, and serviceability. No allowance will be made on behalf of the Contractor for extra expenses resulting from the failure to discover conditions affecting the Work.

1.8 WORKING SPACE

A. Maintain adequate work space around, and access to, electrical and mechanical equipment in strict accordance with the applicable Codes. Verify during the course of construction that sufficient space will be available for the installation equipment, fixtures, etc.

1.9 MATERIALS AND SUBSTITUTIONS

A. Materials shall be new, high quality, free from defects, of standard make, and of the brand or grade as shown on the Drawings or specified herein. Specific trade names are used in the Drawings and Specifications in order to establish the standard grade and characteristics of said items. This does not imply the right upon the part of the Contractor to use other materials or methods without the approval of the Architect.

B. Electrical materials and equipment shall bear the label of, or be listed by, the Underwriters' Laboratories (UL) wherever standards have been established and label service is regularly furnished by that agency. Comply with the installation and application requirements of UL as documented in their published directories.

C. Unless specifically noted, equipment and systems shall be the product of a manufacturer who has been in the manufacture of, and has nationally distributed

catalogs covering the ratings and specifications of, said equipment or systems, for a period of not less than five (5) years.

D. Maintain uniformity throughout the Project by making use of only one make or brand of material for each material used.

E. Substitutions of materials or methods will only be allowed if such items are approved in writing by the Engineer as equal in quality and utility to the specified items. Submit a list of proposed substitutions within ten (10) days of the award of the Contract. Include on the list the original manufacturer's name and model number, the proposed manufacturer's name and model number, catalog cut sheets, ratings, sizes, performance curves, shop drawings, and other data as may be required to demonstrate equality to the specified item.

F. The approval of a substitution does not authorize any deviation from the utility, size, function, or durability of the specified item unless specifically pointed out and requested in the proposed substitution list, and said deviation is approved in writing by the Engineer. Responsibility of the Contractor for dimensional considerations or space conflicts is not relieved by the approval of a substitution.

G. If requested by the Engineer, submit samples of materials and equipment for approval prior to installation.

1.10 ELECTRICAL SUBMITTALS

A. See the General Conditions for conditions of submittal approval and general requirements for submission of shop drawings.

B. Submit a minimum of five copies (or more as required by the General Conditions) of electrical shop drawings and manufacturer's cut sheets for equipment and materials as noted in each electrical specification section. Bind the submittals as complete volumes according to classification of equipment such as power, lighting, fire alarm, etc. When possible, make all electrical submittals at the same time.

C. Submit shop drawings and supporting data as instruments of the Contractor. Stamp each item in the submittal documents with the Contractor's stamp, thereby stating that the equipment meets all requirements and conditions of the Drawings and Specifications. In particular, certify that the items shown on the shop drawings conform to the dimensional, environmental, and space restrictions as pertains to all work under this Contract and the work of other parties in conjunction with this Project.

D. Provide a blank space on the title page of each submittal classification for the Engineer's or Engineers approval stamp and comment field. The minimum size of such space shall be eight inches wide by five inches high.

E. Arrange panelboard submittals to show bussing, circuit numbering, and branch circuit protective devices similar the schedules on the Drawings. Show elevations of switchboards, motor control centers, and distribution centers indicating the layout of devices, meters, handles, etc. Provide device ratings, circuit numbers, and nameplate descriptions in table form. Include terminal strip mounting arrangements on elevations for terminal cabinets.

1.11 DRAWINGS AND SPECIFICATIONS

A. The data and information contained on the Drawings is as accurate as was reasonably possible at the time they were produced, but absolute accuracy is not guaranteed. Exact locations, distances, elevations, etc., will be dictated by the actual building and the conditions at the site.

B. The layout of electrical equipment, wiring, and accessories is shown in a diagrammatic fashion (not pictorially) in order to achieve clarity and legibility. Although the size and location of electrical equipment is drawn to scale wherever possible, refer to all data in the Contract Documents and field verify this information as the project progresses. Examine architectural, structural, mechanical, and other drawings to determine the exact location of conduits, outlets, fixtures, and equipment and to note any conditions which may affect the electrical work.

C. The Drawings and Specifications may be superseded by later detail drawings and specifications prepared by the Engineer. Conform to such detail drawings, specifications, addenda, change orders, other reasonable changes as if they are contained herein. See the General Conditions for change order cost considerations.

D. Because the Electrical Drawings may be distorted for clarity of representation, it may be necessary to field verify the exact location of electrical outlets, lights, switches, etc. in order to conform to the architectural elements. The Engineer reserves the right to make minor changes to the locations of equipment, devices, and wiring shown on the Drawings, at no additional cost, providing the changes are ordered before the rough-in of conduit, boxes, or related items is completed, and no extra material are required.

E. For dimensional and locational purposes, the Architectural Drawings take precedence over the Electrical Drawings. Determine the appropriate location of lighting fixtures, outlets, wall-mounted devices, etc. by studying the reflected ceiling plans, building sections, and interior elevations. Report conflicting conditions to the Engineer before rough-in for adjustments to the locations.

F. Conduit quantities, sizes, termination points, and wiring are depicted on the Electrical Drawings. However, not all conduit bends or routing details are necessarily shown. Route conduit so as to conform to the structural conditions, avoid obstructing other trades, maintain space restrictions and keep circulation areas and access openings clear.

G. Thoroughly examine the Contract Documents prior to submitting a bid in order to determine electrical requirements which are not necessarily indicated on the Electrical Drawings. Include sufficient allowance in the bid sum to cover the costs of these other requirements.

H. Should the Contractor perceive that the Drawings and Specifications do not sufficiently define the intent of electrical work, contact the Engineer for clarification or additional information. The absence of such contact will be considered as evidence of understanding, on the part of the Contractor, of the intended Electrical Work and the required installation thereof.

1.12 WORKMANSHIP

A. Constantly supervise the work personally or through an authorized and competent representative. Keep the same foreman or supervisor on the project from commencement through completion.

B. Perform the Electrical work using the highest caliber craftsman available. Workmanship shall be first class and of the best quality available to insure a long and trouble free service life. Allow only experienced and competent workmen on the job.

1.13 COOPERATION AND COORDINATION

A. Consult with the other installers and trades in coordinating the Work so as to avoid conflicts, omissions and delays. Cooperate with other contractors, third parties, and the Owner in order to expedite the project and provide for the proper execution of the building as a whole. Work performed without regard to other trades or the overall project scheme, may necessarily be required to be moved at the Contractor's expense.

1.14 MANUFACTURER'S DIRECTIONS

A. Adhere to the manufacturer's directions regarding the proper installation and configuration of electrical equipment where those directions cover points not included in these Drawings and Specifications.

1.15 PROTECTION AND STORAGE

A. Deliver electrical materials to the site new, and in unbroken packages. Provide for the temporary storage of such materials, equipment, and construction tools in accordance with the General Conditions. Protect electrical equipment and materials during transit, storage and handling to prevent damage, soiling and deterioration.

B. During shipping storage and handling protect electrical materials from damage of any type including dust, water, over-spray, and temperature. Avoid damage during construction to the work and materials of other trades as well as the electrical work and material. Repair or replace, at the Contractor's expense, defective or damaged items such that the entire Work is completed in a condition satisfactory to the Engineer.

1.16 EXCAVATION, CUTTING, PATCHING, AND REPAIR

A. Cut, core-drill, and demolish existing walls, floors, ceilings and other building surfaces as required for the installation of Electrical Work. Obtain the approval of the Engineer prior to performing any operation which may affect any structural elements of the building.

B. Patch and repair wood, plaster, tile, or concrete surfaces which have been damaged by the installation of the Electrical Work so that the finished surface matches the surrounding conditions.

1.17 FLASHING, WATERPROOFING, SEALING, AND FIREPROOFING

A. In general, install in an approved watertight manner, Electrical Work which pierces exterior walls or waterproofing membranes. Flash and counter-flash roof and wall penetrations in a manner described in other applicable sections of this Specification and as approved by the Engineer.

B. Fit conduits passing through finished walls with steel escutcheon plates of brass, chrome, or painted finish as directed by the Engineer. Grout penetrations of floor slabs, concrete or masonry walls with an approved grout or silicone elastomeric caulk.

C. Fire-Rated Surface:
   1. Where conduit penetrates fire rated surface, install fire-stopping product in accordance with manufacturer's published instructions.
   2. All openings through fire rated wall, floor, ceiling or roof must be sealed.
   3. Install galvanized sheet metal sleeves (minimum 12-gage) through opening and extending beyond minimum of one (1) inch on each side of building element.
   4. Pack void between sleeve and building element with backing material.
   5. Seal ends of sleeve with UL listed fire-resistive silicone compound to meet fire rating of structure penetrated.

D. Non-Rated Surfaces:
   1. Opening through a non-fire rated wall, floor, ceiling or roof must be sealed using an approved type of material.
   2. Use galvanized sheet metal sleeves in hollow wall penetrations to provide a backing for the sealant. Grout area around sleeve in masonry construction.
   3. Install escutcheons or floor/ceiling plates where raceway, penetrates non-fire rated surfaces in occupied spaces.
   4. Install rubber links of mechanical seal tightened in place and sized for the pipe, in exterior wall openings below grade, in accordance with the manufacturer's instructions.
   5. All pipe penetrations at interior partitions and/or walls, laboratory spaces, telephone, data and communication rooms and similar spaces where the room pressure or odor transmission must be controlled, shall be sealed. Sealant shall be applied to both sides of the penetration in such a manner that the annular space between the pipe sleeve and the pipe is completely filled.

1.18 CLEANING, ADJUSTING, AND TOUCH-UP

A. Remove on a daily basis electrical debris, scraps, packaging material and other rubbish. Dispose of such items off-site in an approved manner and debris. Maintain the site free from physical hazards at all times in accordance with OSHA regulations. See the General Conditions for additional requirements.

B. After installation, completely clean electrical equipment, fixtures, and materials of excess paint, over-spray, plaster, cement, insulating products, and other foreign matter. Leave the Electrical Work in a clean, finished, dry, level, like new condition.

C. Touch-up paint scratches and scuffs on electrical equipment and lighting fixtures with paint recommended by the manufacturer and matching the original item finish.

D. Make setting, adjustments, and programming in accordance with the manufactures' operating and installation instructions. Settings and program variables will be issued by the Engineer prior to commissioning of the electrical system.

1.19 AS-BUILT DRAWINGS

A. Throughout the project, maintain accurate and current record documents. Show on the record drawings deviations from the Electrical Drawings, locations of underground conduits and pull-boxes, and concealed equipment which is not readily apparent. Dimension the record drawings using permanent, readily identified benchmarks such as column or wall lines.

B. At the completion of the project, present one clearly legible set of the record drawings to the Engineer.

1.20 INSPECTIONS AND TESTING

A. Arrange for the inspection of the Work at various stages of completion by the Authority Having Jurisdiction, utility company representatives, and the Engineer. Comply with all directions and remedial measures issued thereby. Any objections to these orders on the part of the Contractor must be presented to the Engineer in writing within forty eight (48) hours of the inspection report.

B. Coordinate the installation of the Work so that observation of all rough-in, concealed, or underground Work can take place by the Engineer. Provide a minimum of seventy two (72) hours notice to the Engineer prior to covering up the work. Uncover Work that has not been properly observed and make repairs to restore the Work and adjoining surfaces to their proper condition at no additional cost.

C. Perform tests of the electrical system during the course of the project and at project completion to ensure safe and proper function in accordance with the Contract Documents, manufacturers' recommendations, and applicable codes. Provide complete documentation of all test results to the Engineer prior to project completion. Testing shall include, but not necessarily be limited to, the following:
   1. Test for short circuits, open circuits, neutral leakage, and improper grounds on feeders and branch circuits. Perform this test with mains in disconnect from feeders, branch circuits closed, fixtures and devices permanently connected, lamps removed from sockets and wall switches closed.
   2. Provide insulation resistance tests of all phase and neutral circuit conductors using a 500 Volt Megger for circuits of 240 Volt rating and below, and a 1000 Volt Megger for circuits of 277 volts and above. Minimum acceptable insulation resistance is one (1) megohm.
   3. Perform a ground resistance test of each main grounding electrode system, ground rod, and supplemental grounding electrode. Utilize a calibrated, direct reading, earth ground test set and make the tests using the "Three-terminal, Fall-of-Potential" method. The maximum allowable earth ground resistance is 25 ohms.
   4. Test for proper phase-to-phase and phase-to-neutral operating voltage on the main service and on each separately derived system. Perform this test at full load and at no load. With all circuits at full operating conditions, test the phase and neutral load currents using a clamp-on ammeter.

5. Tests as required by other sections of these Specifications.
6. Tests as prescribed by individual equipment manufacturers whether or not described in these Specifications.

D. At project completion, demonstrate to the Engineer that the entire installation is complete, in proper operation condition and that the Contract has been properly and fully executed. Activate all circuits, lights, devices, and controls under full load and normal operating conditions. Identify faulty items and immediately replace or repair defective equipment, workmanship, and materials to like new condition and retest in the presence of the Engineer.

E. At the completion of the Project, demonstrate to the Engineer that the entire electrical system is free from short circuits and improper grounds, or upon request of the Engineer anytime, make necessary tests under the observation of the Engineer which will ensure that electrical equipment, materials and installation methods are as specified.

1.21 GUARANTEE

A. In accordance with Division 1 requirements.

1.22 WARRANTIES, CERTIFICATES, AND OPERATING MANUALS

A. Properly fill out and deliver to the Engineer, all warranties, guarantees, certificates, etc. for equipment and materials that are furnished and installed under this Section of the Work. The effective date on each item shall be the date of acceptance of the work by the Owner.

B. Deliver to the Engineer, a minimum of two (2) copies of the manufacturers' operating and maintenance manuals for major items of equipment.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

END OF SECTION

SECTION 26 05 19

CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SUMMARY

A. This section covers all labor, material, tools, equipment and services required to install building wire and cable, instrumentation cable, telephone cable, control cable, wiring connectors and connections.

B. All circuits shall be installed in conduit unless specifically noted otherwise on the drawings. Type MC or AC cable shall not be used on this project.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. ASTM B 3 Soft or Annealed Copper Wire

B. ASTM B 496 Compact Round Concentric-Lay-Stranded Copper Conductors

C. ASTM B 8 Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

D. ANSI C 2 National Electrical Safety Code – latest edition

E. IEEE 242 Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.

F. IEEE 399 Recommend Practice for Industrial and Commercial Power System Analysis.

G. NECA (National Electrical Contractors Association) - Standard of Installation.

H. NEMA WC-26 Wire and Cable Packaging

I. NETA ATS National Electrical Testing Association Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

J. NFPA 70 National Electrical Code – latest edition.

K. UL 83 Thermoplastic-Insulated Wires and Cables.

L. UL 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors.

M. UL 510 Polyvinyl Chloride, Polyethylene and Rubber Insulating Tapes.

1.4 SYSTEM DESCRIPTION

A. The applications for cable, wire and connectors required, but not limited to, are as follows:
   1. Power distribution circuitry.
   2. Lighting circuitry.
   3. Appliance and equipment circuitry.
   4. Wiring for motors of mechanical equipment
   5. Wiring from the motor(s) of mechanical equipment to the disconnect switches or junction boxes, including wiring for pushbuttons, pilot lights, interlocks and similar devices as directed, shown, or specified.
   6. Wiring from the motors of mechanical equipment to motor starters, including other auxiliary wiring as may be required, directed, or shown.
   7. Line voltage wiring as required by other Divisions 2 thru 15, and interlocking to motor starters.
   8. Control wiring for motors, mechanical equipment, relays and switches, and similar mechanical-electrical devices.
   9. Line voltage wiring to thermostats, alarm systems and other miscellaneous equipment.

1.5 PROJECT CONDITIONS

A. All wire and cables shall be minimum No. 12 AWG copper conductor unless otherwise shown on drawings.

B. All conductor sizes are based on copper.

C. Wire and cable routing shown on Drawings is diagrammatic unless dimensioned.

D. Route wire and cable as required to accommodate project conditions.

E. The contractor shall be responsible for any and all raceways and raceway/cable supports in accordance with all other sections of these specifications.

1.6 REGULATORY REQUIREMENTS

A. Furnish products listed and classified by Underwriters Laboratories, Inc. (UL), Electrical Testing Laboratories, Inc. (ETL), or other recognized, acceptable testing and listing agencies as suitable for the purpose specified and shown.

1.7 CONTRACTOR SUBMITTALS

A. Product Data:
   1. Submit manufacturer’s catalog cuts and technical data for building wire and cables.

B. Field Test Report:
   1. Measure overall insulation resistance to ground. Provide certified test report for Engineer’s Review.

1.8 CLOSEOUT SUBMITTALS

A. Provide project record documents showing actual locations of components and circuits.

B. Submit final certified test reports of all insulation resistance tests.

1.9 QUALIFICATIONS

A. Manufacturer shall be a Company specializing in manufacturing products specified in this section with a minimum of five (5) years' experience.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products on site in accordance with Division 1 requirements.

B. Accept cable and accessories on site in manufacturer's packaging. Inspect for damage.

C. Store and protect cable and accessories from the environment in accordance with manufacturer's published instructions. Provide adequate heating and ventilation to prevent condensation.

D. Damaged items shall be replaces at no additional cost to Owner.

1.11 COORDINATION

A. Where wire and cable destination is indicated and routing is not shown, determine exact routing and lengths required.

B. Wire and cable routing indicated is approximate unless dimensioned. Include wire and cable lengths within 10 feet of length shown.

PART 2 PRODUCTS

2.1 MANUFACTURERS:

A. Domestic manufacturer regularly engaged in the manufacture of Building Wire and Cable products for at least five (5) years as follows:
   1. American Wire and Cable.
   2. Cerro Wire and Cable Co.
   3. General Cable Corp.
   4. Okonite Co.
   5. Or Approved Equal.

2.2 BUILDING WIRE AND CABLE

A. Building wire and cable shall be UL83 compliant, insulated, single conductor, copper, solid or stranded, rated for 600-volts AC. The insulation shall be thermoplastic

material rated for 90 degrees Celsius dry locations, 75 or 90 degrees Celsius wet locations, THW, THHN/THWN, RHW or XHHW, per ANSI/NFPA 70.

B. For Interior Dry Location: Use only building wire, THHN/THWN insulation rated 90 degree Celsius, in raceway.

C. For Exterior Wet or Dry Locations: Use THHN/THWN-2 or XHHW insulation rated for 90 degree Celsius, in raceway.

D. For Underground Dry or Wet Locations: Use THHN/THWN-2 or XHHW insulation rated 90 degree Celsius, in raceway.

E. For connections to electrical equipment, coordinate wire type with equipment manufacturer.

2.3 INSTRUMENTATION AND CONTROL CABLES

A. Instrumentation cables for equipment and devices shall be minimum two (2) conductor No. 16 AWG, tin-coated copper, stranded, shielded twisted pair, 80 degree Celsius, PVC insulation foil shield with overall heavy duty polyethylene jacketing, rated for 600-volt AC.

B. Control cables to field mounted equipment and devices shall be a single conductor, insulated, No. 14 AWG minimum, copper, solid or stranded, rated for 600-volts AC. The insulation shall be thermoplastic material rated for 90 degrees Celsius dry locations, 75 degrees Celsius wet locations, THHN/THWN or XHHW, per ANSI/NFPA 70 and compliant with UL 83.

C. Multi-conductor control cables for field mounted equipment and devices shall consist of several single conductor, insulated No. 16 AWG minimum, copper, solid or stranded, rated for 600-volts AC with an overall protective PVC jacket. The insulation shall be thermoplastic material rated for 90 degrees Celsius dry locations, 75 degrees Celsius wet locations, THHN/THWN or XHHW, per ANSI/NFPA 70 and compliant with UL 83. Circuit identification shall consist of Method 1 - color coding in accordance with ICEA S-66-524, Appendix K Table K-2.

D. Instrumentation and control cable connected to equipment or devices within control panels shall be sized per requirements of equipment manufacturer (minimum #16 AWG).

2.4 UNDERGROUND TELEPHONE CABLE

A. Unshielded, 4 twisted-pair, 24 AWG copper, Category 6, gel-filled type, tested to 550MHz. Listed for direct burial application by manufacturer, Commscope #6NF41KRLBLK Cat 6, or equal.

2.5 WIRING CONNECTORS

A. Split Bolt Connectors:
   1. FCI Burndy Corp.

2. Cooper Crouse Hinds.
3. O.Z./Gedney Co.
4. Thomas & Betts Co.
5. 3-M Co.

B. Solderless Pressure Connectors:
1. FCI Burndy Corp.
2. Ideal Industries Co.
3. Thomas & Betts Co.
4. 3-M Co.

C. Spring Wire Connectors:
1. Ideal Industries Co.
2. 3-M Co.

D. Compression Connectors:
1. FCI Burndy Corp.
2. Thomas & Betts Co.
3. 3-M Co.

2.6 WIRE COLOR CODE

A. Color-code all conductors:
1. Wire sizes No. 10 AWG and smaller shall have integral color-coded insulation.
2. Wire sizes No. 8 AWG and larger may have black insulation but shall be identified by color-coded electrical tape at all junction, splice, pull, or termination points.
3. Color tape shall be applied to at least 3 inches of the conductor at the termination ends and in junction or pull boxes or where readily accessible.
4. Conductors for all systems shall not change color at splice points.
5. Where there are two or more neutrals in one conduit, each shall be individually identified with the proper circuit.
6. For No. 4 AWG and larger ground conductors, identify with green tape at both ends and all visible points, included in all junction boxes.

B. Each phase wire shall be uniquely color-coded as indicated below:
1. 120/240-Volts
   a. Phase A – Black
   b. Phase B – Red
   c. Neutral - White
   d. Ground - Green
2. Isolated Grounds: Green with Yellow Stripes

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that mechanical work likely to damage wire and cable has been completed.

C. Verify that raceway installation is complete and supported as required by the specifications.

3.2 PREPARATION

A. Test raceway with a mandrel and thoroughly swab out to remove foreign material before pulling cables.

B. For conduits sizes less than 3 inches, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel.

C. For conduits sizes 3 inches and larger, draw a flexible testing mandrel approximately 12 inches long with a diameter less than the inside diameter of the conduit through the conduit. Then draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel.

3.3 EXISTING WORK

A. Disconnect and remove exposed and/or abandoned wire and cable. Patch surfaces where removed cable pass through building finishes.

B. Disconnect abandoned circuits and remove wire and cable. Remove abandoned boxes if wire and cable servicing them is abandoned and/or removed. Provide blank cover for abandoned boxes that are not removed.

C. Ensure access to existing wiring connections which remain active and which require access. Modify installation or provide access panel as appropriate.

D. Extend existing circuits using materials and methods and compatible with existing electrical installations, or as otherwise specified.

E. Tag and repair existing wire and cable that remain or are being reused.

3.4 INSTALLATION

A. General:
   1. Install wire and cable in accordance with manufacturer's instructions and NECA “Standard of Installation”.
   2. Route wire and cable as required to meet project conditions.
   3. Identify and color code wire and cable. Identify each conductor with its circuit number or other designation indicated.
   4. Protect exposed cable from damage.
   5. Pull all conductors into raceway at same time.
   6. Use suitable wire pulling lubricant for building wire No. 4 AWG and larger. Lubricant shall not be deleterious to the cable sheath, jacket or outer covering.
   7. Do not exceed cable manufacturer’s recommended pulling tension limits when installing wire or cable.

8. Support cables above accessible ceiling using standard support methods to support cables from structure. Do not rest cable on ceiling panels.
9. Neatly train and lace wiring inside boxes, equipment, and panelboards

B. Cable and Wire Size:
1. Conductor sizes are based on copper unless specifically indicated as aluminum or “AL”.
2. Use conductor no smaller than No. 12 AWG for power and lighting circuits.
3. Use conductor no smaller than No. 14 AWG for control circuits.
4. Use No. 10 AWG conductors for 20 ampere, 120-volt branch circuits longer than 75 feet.
5. Use No. 10 AWG conductors for 20 ampere, 277-volt branch circuits longer than 200 feet.
6. Use stranded conductor for all feeders, branch and control circuits.

C. Cable Identification
1. Identify all wires and cables as specified in other Sections of these Specifications.

D. Special Techniques - Wiring Connections:
1. Clean conductor surfaces before installing lugs and connectors. Where an anti-oxidation lubricant is used, apply liberally, coating all exposed conductor surfaces.
2. Use suitable cable fittings and connectors.
3. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
4. Use split bolt connectors for copper conductor splices and taps, No. 8 AWG and larger.
5. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, No. 8 AWG and smaller.
6. Tape un-insulated conductors and connector with two layers of half-lapped rubber insulating compound tape and two layers of half-lapped, 7-mil electrical tape, Scotch 33+, or equal.
7. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, No. 10 AWG and smaller.
8. Stranded conductors for control circuits shall have fork or ring terminals crimped on for all device terminations. Bare stranded conductors shall not be placed directly under the screws.

3.5 FIELD QUALITY CONTROL

A. Field inspection and test shall be performed under provisions of NETA ATS section 7.3 (2) - Low Voltage Cables, 600-Volt Maximum as follows.
1. Visual and Mechanical Inspection:
   a. Compare cable data with drawings and specifications.
   b. Inspect exposed sections of cable for physical damage and correct connection in accordance with single-line diagram.
   c. Inspect all bolted electrical connections for high resistance using one of the following methods:

1) Use of low-resistance ohm-meter in accordance with NETA section 7.3.2.2 (Electrical Tests).
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data from NETA ATS Table 10.12.

d. Inspect compression-applied connectors for correct cable match and indentation.
e. Verify cable color coding with applicable specifications and National Electrical Code.

2. Electrical Tests
   a. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Test duration shall be one minute.
   b. Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable, in accordance with Section 7.3.2.1 (Visual and Mechanical Inspection).
   c. Perform continuity test to insure correct cable connection.
   d. Correct malfunctions and/or deficiencies immediately as detected at no additional cost to the District, including additional verification testing.
   e. Subsequent to final wire and cable terminations, energize all circuitry and demonstrate functional adequacy in accordance with system requirements.
3. Test Values
   a. Compare bolted connection resistance to values of similar connections.
   b. Bolt-torque levels should be in accordance with NETA ATS Table 10.12 unless otherwise specified by the manufacturer.
   c. Micro-ohm or milli-volt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer’s published data. If manufacturer’s data is not available, investigate any values which deviate from similar connections by more than 50 percent of the lowest value.
   d. Minimum insulation-resistance values should not be less than 50 meg-ohms.
   e. Investigate deviations between adjacent phases.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. This section includes:
   1. Furnishing of grounding electrodes and conductors; equipment grounding conductors; bonding methods and materials.
   2. Inspection and testing of the Grounding and Bonding System.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. The standards referenced herein, except as modified in the Contract Documents, shall have full force and effect as though included in these Specifications. These standards are not furnished to the Contactor since manufacturers and trades involved are assumed to be familiar with these requirements. The Contractor shall obtain copies of reference standards direct from publication sources as needed for proper performance and completion of the work.
   1. ASTM B 187 Specifications for Copper Bus, Rod, and Shapes.
   2. ASTM A 653 Standard Specifications for Sheet Steel, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated(Galvannealed) by Hot Dip Process
   3. IEEE 142 Recommended Practice for Grounding of Industrial and Commercial Power Systems.
   4. IEEE 1100 Recommended Practice for Powering and Grounding Electronic Equipment.
   5. NECA (National Electrical Contractors Association) – Standard of Installation.
   6. NETA ATS Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
   7. NFPA 70 National Electrical Code (NEC). Latest edition adopted by the State of California (CEC).
   8. UL 467 Electrical Grounding and Bonding Equipment.

1.4 SYSTEM DESCRIPTION

A. Grounding electrode system consist of the following elements:
   1. Metal frame of the building
   2. Service equipment
   3. Enclosures
   4. Separately derived systems.

B. Anchor and fasten electrical products to building elements and finishes as follows:
   1. Concrete Structural Elements: Provide preset inserts.

2. Concrete Surfaces: Provide epoxy or expansion anchors.
3. Interior Structural Steel: Provide appropriate size beam clamps.
4. Solid Masonry Walls: Use expansion anchors and preset inserts.
5. Sheet Metal: Provide sheet metal screws.

1.5 DESIGN REQUIREMENTS

A. Furnish products listed and classified by Underwriters Laboratories, Inc. (UL), Electrical Testing Laboratories, Inc. (ETL), or other recognized, acceptable testing and listing agencies as suitable for purpose specified and shown.

B. Grounding shall be in accordance with the National Electrical Code (NEC). Where size, type, rating and quantities indicated or specified are in excess of NEC requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.

C. Select materials, sizes, and types of anchors, fasteners, and supports to carry at least twice the loads of equipment and raceway, including weight of wire and cable in raceway.

1.6 CONTRACTOR SUBMITTALS

A. Product Data:
   1. Submit product data for grounding electrodes and connections for fastening components.

B. Test Report:
   1. Grounding & Bonding: Provide certified test report for Engineer's Review.

1.7 CLOSEOUT SUBMITTALS

A. Record actual locations of components and grounding electrodes.

B. Submit final certified five (5) copies of the test reports of all grounding.

1.8 QUALIFICATIONS

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

B. Installer: A firm with at least five (5) years of installation experience on projects with electrical grounding work similar to that required for this project.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

B. Field testing shall be performed by a third party testing firm with certification from a recognized testing agency, with a minimum of five (5) years of testing experience.

PART 2 PRODUCTS

2.1 GROUNDING SYSTEM

A. Except as indicated elsewhere, provide materials for electrical grounding system, including, but not limited to, cables, wires, connectors, terminals (solderless lugs) and exothermic welds, grounding rods and electrodes, bonding jumper and braided straps, and other items and accessories required for a complete installation. Where more than one type of material or equipment meets indicated requirements, selection shall be at Installer's option. Where materials or components are not otherwise indicated, provide products as recommended by the accessories manufacturers and in compliance with the NEC and established industry standards.

B. All grounding materials required shall be furnished new and undamaged in accordance with the requirements of these specifications:

2.2 WIRE

A. Electrical Equipment Grounding Conductor: Insulated, soft-drawn copper, Class B stranding or solid, with green colored polyvinyl chloride insulation per Section 26 05 19. Size per NEC Article 250-122, unless otherwise noted.

2.3 MECHANICAL CONNECTORS

A. Bolt-on bronze connectors, suitable for grounding and bonding applications in configurations required for the particular installation.

B. Manufacturer
1. Burndy Corp.
2. Anderson
3. Thomas & Betts
4. 3-M Co.

2.4 GROUNDING WELL COMPONENTS

A. Well Pipe: 8 inches NPS (DN200) by maximum 12 inches (300-mm) long, precast concrete or fiberglass pipe with belled end.

B. Well Cover: Cast iron, high impact traffic rated cover with legend "GROUND" embossed on outer face.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that abandoned wiring and equipment serve only abandoned facilities.

3.2 EXISTING WORK

A. Modify existing grounding system to maintain continuity to accommodate renovations.

B. Extend existing grounding system using materials and methods as specified.

C. Install temporary wiring and connections to maintain existing grounding systems in service during construction.

D. Perform work on energized equipment or circuits with experienced and trained personnel following all safety rules and procedures.

E. Remove, relocate, and extend existing installations to accommodate new construction.

F. Repair adjacent construction and finishes that are damaged during demolition and extension work.

G. Remove exposed and/or abandoned grounding and bonding components, fasteners, supports and electrical identification labels. Cut embedded support elements below surface of walls and floors. Patch surfaces damaged by removal of existing components to match surrounding finishes.

3.3 GROUNDING AND BONDING INSTALLATION:

A. Verify that final backfill and compaction has been completed before driving rod electrodes.

B. Install grounding well with cover at rod locations as indicated on Drawings. Install well top flush with finished grade.

C. Installation:
1. Remove paint, rust, mill-oils, and surface contaminants at connection points.
2. Install grounding electrode conductor and connect to reinforcing steel in slab or foundation.
3. Connect to site grounding system.
4. Install branch circuits feeding isolated ground receptacles with separate insulated grounding conductor, connected only at isolated ground receptacle, ground terminals, and at ground bus of serving panel in accordance with IEEE 1100.
5. Accomplish grounding of electrical system by installing insulated grounding conductor with each feeder and branch circuit conductor in conduit. Install separate insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing. Size grounding conductor in accordance with the NEC.
6. Install grounding conductor from ground bus of serving panel to ground bus of served panel, grounding screw of receptacles, and metal enclosures of service equipment.
7. Bond all metallic conduits to grounding bus at service panel by means of grounding bushings using minimum No. 12 AWG conductor.
8. Ground electrical system using continuous metal raceway system enclosing circuit conductors in accordance with NEC. Bond together each metallic raceway, pipe, duct and other metal object entering enclosures and exiting slabs.
9. Permanently bond all equipment, grounding conductors, lightning protection system and grounding system prior to energizing equipment.

3.4 GROUND CONDUCTORS

A. Grounding conductors shall be located and connected as indicated on drawings or as required by Code.

B. Ground conductors under buildings or structures shall be buried with at least 6 inches of earth cover. Buried grounding conductors extending beyond the foundations of buildings or structures shall have at least 18 inches of earth cover.

C. Exposed conductors shall be installed inconspicuously in vertical or horizontal positions on supporting structures. When located on irregular supporting surfaces or equipment, the conductors shall run parallel to or normal to dominant surfaces.

D. Conductors routed over concrete, steel, or equipment surfaces shall be kept in close contact with those surfaces by using fasteners located at intervals not to exceed 3 feet.

E. Provide a separate equipment-grounding conductor for low voltage distribution systems, single or three phase feeder circuit and each branch circuit with single or three phase protective devices. Install a grounding conductor in conduit with phase and neutral conductors. Single-phase branch circuits for 120 and 277 volt lighting, receptacles, and motors shall have a phase, neutral, and ground conductors installed in the common conduit. Provide suitable bonding jumpers and approved grounding type bushings for flexible conduits used for equipment connection utilized in conjunction with the above branch circuits. Single-phase circuits for equipment and all branch circuits installed in non-metallic or flexible conduits shall be provided with a separate grounding conductor.

3.5 CONNECTIONS

A. All contact surfaces of bolted and screwed connections shall be thoroughly cleaned and coated with oxide inhibitor before being securely tightened.

3.6 CONDUIT GROUNDING

A. All grounding bushings within all enclosures, including equipment enclosures, shall be wired together and connected internally to the enclosure grounding lug or grounding bus with a bare copper conductor. Grounding bushings shall be grounded with conductors sized in accordance with NEC, but not smaller than No. 8 AWG.

3.7 EQUIPMENT GROUNDING

A. Comply with NEC 250, except where larger sizes or more conductors are indicated.
   1. All electrical equipment shall be connected to the grounding system with an insulated, green, stranded or solid copper equipment-grounding conductor.
   2. Terminate each end on suitable lug, bus, or bushing. The term "electrical equipment", as used in this article, shall include, but not be limited to, all enclosures containing electrical connections or bare conductors, except that individual devices, such as solenoids, pressure switches, and limit switches, shall be exempt from this requirement, unless the device requires grounding for proper operation.

3. Contractor shall furnish all grounding material required, if not furnished with the equipment.

B. Install equipment grounding system such that all metallic structures, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, portable equipment and other conductive items in close proximity with electrical circuits will operate continuously at ground potential and provide a low impedance path for possible ground fault currents.

C. Where grounding system extension stingers are indicated on the drawings to be provided for connection to electrical equipment, the Contractor shall connect the bare grounding conductor to the equipment ground bus, pad, or lug. Except where otherwise indicated on the drawings, all equipment ground conductors that are not an integral part of a cable assembly, shall be sized in accordance with the requirements of NEC. All ground conductors installed in conduit shall be insulated.

D. Suitable grounding facilities, acceptable to the Engineer, shall be furnished on electrical equipment not so equipped. The grounding facilities shall consist of compression type terminal connectors bolted to the equipment frame or enclosure and providing a minimum of joint resistance.

E. The conduit system is not considered to be a grounding conductor. No grounding conductor shall be smaller in size than No. 12 AWG, unless it is a part of an acceptable cable assembly.

3.8 GROUND SYSTEM RESISTANCE

A. Ground resistance of the system shall be no greater than five (5) ohms.

3.9 ACCEPTANCE TESTING

A. Grounding and Bonding: Perform inspections and tests as outlined below (NETA ATS, Section 7.13 – Grounding Systems).
   1. Visual and Mechanical Inspection
      a. Verify ground system is in compliance with drawings and specifications.
      b. Electrical Tests
      c. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.
   2. Test Values
      a. Investigate point-to-point resistance values which exceed 0.5 ohm.

END OF SECTION

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Steel slotted support systems.

1.6 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   1. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   2. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
   1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
   3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
   4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
   5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
   6. Toggle Bolts: All-steel springhead type.
   7. Hanger Rods: Threaded steel.

PART 3 EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
   1. Secure raceways and cables to these supports with two-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   1. To Wood: Fasten with lag screws or through bolts.
   2. To New Concrete: Bolt to concrete inserts.
   3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   4. To Existing Concrete: Expansion anchor fasteners.
   5. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

C. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

END OF SECTION

SECTION 26 05 33

RACEWAYS AND BOXES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes conduit and tubing, surface and buried raceways, wireways, outlet boxes, pull boxes, and junction boxes.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCES - CODES AND STANDARDS

A. ANSI C80.1 Rigid Steel Conduit, Zinc Coated.

B. ANSI C80.3 Electrical Metallic Tubing, Zinc Coated.

C. ASTM A 48 Standard Specification for Grey Iron Castings.

D. NECA (National Electrical Contractors Association) – “Standard of Installation.”

E. NEMA FB 1 (National Electrical Manufacturers Association) – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.

F. NEMA OS 1 (National Electrical Manufacturers Association) – Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

G. NEMA OS 2 (National Electrical Manufacturers Association) – Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports.

H. NEMA RN 1 (National Electrical Manufacturers Association) – Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.

I. NEMA TC 2 – Electrical Polyvinyl Chloride (PVC) Conduit.

J. NEMA TC 3 (National Electrical Manufacturers Association) – PVC Fittings for Use with Rigid PVC Conduit and Tubing.

K. NEMA TC 6 - Non-Metallic Conduit.

L. NEMA 250 (National Electrical Manufacturers Association) – Enclosures for Electrical Equipment (1,000 Volts Maximum).

M. NFPA 70 National Electrical Code (NEC). Latest approved edition

N. UL 1 Flexible Metal Conduit

O. UL 6 Rigid Metal Conduit

P. UL 514B Conduit, Tubing and Cable Fittings.

Q. UL 651 Rigid Non-Metallic Conduit

R. UL 797 Electrical Metallic Tubing

1.4 SYSTEM DESCRIPTION

A. Raceway, boxes and manholes located as indicated on drawings and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway, boxes and manholes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.

B. Underground more than 5 feet (1,500 mm) outside foundation wall: Provide Schedule 40 non-metallic conduit encased in concrete.

C. Underground within 5 feet from foundation wall: Provide rigid steel or Schedule 40 non-metallic conduit encased in concrete.

D. In or Under Slab on Grade: Provide Schedule 40 non-metallic conduit encased in concrete. Provide Galvanized with tape wrap rigid steel factory bends greater than 22.5 degrees and for stub-ups through concrete slabs.

E. Outdoor Locations, Above Grade: Provide rigid steel conduit. Provide cast metal outlet, pull, and junction boxes.

F. In Slab above Grade: Provide galvanized rigid steel conduit. Provide cast or concrete-tight sheet metal boxes.

G. Exposed Dry Locations: Provide galvanized rigid steel conduit. Provide cast boxes.

H. Concealed Dry Locations: Provide electrical metallic tubing for sizes less than 2-inches. Provide galvanized rigid steel conduit in sizes 2-inches or larger. Provide cast or sheet metal boxes.

1.5 DESIGN REQUIREMENTS

A. Minimum Raceway Size: 3/4 inch (19 mm) unless otherwise specified.

1.6 SUBMITTALS

A. Manufacturer’s Installation Instructions: Submit application conditions and limitations of use stipulated by product testing agency having jurisdiction. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

B. Submit detailed conduit routing plan, for review and approval, prior to installation as follows:

1. Exposed and/or concealed in building walls for conduits larger than 2-inch outside diameter.
2. All underground conduits (3/4-inch and larger) in duct bank; concealed in floor slabs, equipment pads and concrete slabs.

C. Product Data: Submit for the following:
1. Rigid Steel Conduit.
2. PVC Coated galvanized rigid steel conduit.
3. Electrical Metallic Tubing (EMT).
4. Liquid tight flexible metal conduit.
5. Nonmetallic conduit.
6. Raceway fittings.
7. Conduit bodies.
8. Surface raceway.
9. Pull boxes, junction boxes.

D. Manufacturer's Installation Instructions:
1. Submit application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.
2. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.7 CLOSEOUT SUBMITTALS

A. Project Record Documents:
1. Record actual routing of conduits. Provide record (as-built) drawings marked in red to show actual routing of the underground raceway and cable when different from the original contract drawings. Prepare on new, clean set of contract drawings.
2. Record actual locations and mounting heights of outlet, pull boxes, junction boxes and manholes.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

B. Protect PVC and PVC-coated metallic conduit from sunlight.

PART 2 PRODUCTS

2.1 CONDUIT

A. Galvanized Rigid Steel Conduit (GRSC or RGS), couplings and elbows shall be hot-dip galvanized, rigid mild steel in accordance with ANSI C80.1 and UL 6. The conduit interior and exterior surfaces shall have a continuous zinc coating with a transparent overcoat of enamel, lacquer, or zinc chromate. Conduit shall be formed with continuous welded seams with a uniform wall thickness, in minimum 10-foot lengths, with threaded ends.

B. Polyvinyl Chloride (PVC) coated galvanized rigid steel conduit shall be in accordance with NEMA RN 1. Coating shall be applied under controlled factory conditions. Prior to coating, conduit shall meet requirements of ANSI C80.1 and UL 6 or ANSI C80.6 and UL 1242 as appropriate. PVC coated conduits shall have ultra-violet (UV) inhibitor in the coating material.

C. Electrical Metallic Tubing (EMT). Electrical metallic tubing, including elbows and bends, shall be zinc coated, mild steel in accordance with the requirements of ANSI C80.3 and UL 797. The interior and exterior surfaces of the tubing shall have a continuous zinc coating. Conduit shall be formed with a continuous welded seam, with a uniform wall thickness, in minimum 10-foot lengths.

D. Liquid-Tight Flexible Metal Conduit shall be plastic-jacketed, galvanized steel, "Sealtite" Type EF for general service areas or Type HC for high-temperature when used under raised floor or in air plenums. Conduit shall be UL listed.

E. Non-Metallic Conduit shall be as follows:
   1. Schedule 40: Conduit shall be 90 degree Celsius, polyvinyl chloride in conformance with NEMA TC-2 and UL 651 requirements.
   2. Spacers used in duct bank installations shall be high impact plastic, interlocking bases, and intermediate type spacers. Place spacers between 6 and 10 feet apart.

2.2 RACEWAY FITTINGS

A. Couplings and Thread Protectors. Each length of threaded conduit shall be provided complete from the manufacturer with a coupling on one end and a thread protector on the other. The thread protector shall have sufficient mechanical strength to protect the threads during normal handling and storage.

B. Metal Conduit Fittings shall conform to the requirements of UL 514B where this standard applies. Galvanized iron or galvanized steel fittings shall be used with steel conduit. Threaded fittings shall engage a minimum of five threads made up wrench-tight and be compatible with conduit.

C. EMT Conduit Fittings shall be set screw steel with insulated throat for indoor applications and compression type, UL approved for rain tight applications for outdoor use. Die-cast or indent style fittings are not acceptable.

D. Liquid-Tight Flexible Conduit Fittings shall be galvanized steel, T&B 53XX series insulated throat, and shall bear the UL label. Die-cast malleable fittings are not acceptable.

E. Liquid-Tight Flexible Metal Conduit Fittings shall be galvanized steel similar to T&B “Tite-Bite”.

F. Non-Metallic Conduit Fittings shall be of same material and strength characteristics as the conduit and shall be solvent welded as recommended by manufacturer. End bells shall be plastic, high impact, tapered to fit. Where conduit transition from non-metallic to metallic is required, provide non-metallic female “terminal” adapter. Non-metallic “male” adapters are not acceptable.

G. Bushings shall be provided for the termination of all conduits not terminated in hubs, couplings or insulated throat connectors. Grounding type insulated bushings with insulating inserts in metal housings shall be provided for conduit 1-1/4 inches and larger. Standard bushings shall be galvanized steel or malleable iron in all sizes.

H. Locknuts. One interior and one exterior locknut shall be provided for all conduit terminations not provided with threaded hubs and couplings. Locknuts shall be designed to securely bond with the conduit to the box when tightened. Locknuts shall be so constructed that they will not be loosened by vibration.

I. Unions. Watertight conduit unions shall be Appleton or Crouse-Hinds Type UNF or UNY, or approved equal.

J. Raintight conduit terminating hubs, where indicated on the drawings or required by these specifications, shall be Meyer's rigid conduit hubs, or approved equal.

2.3 CONDUIT BODIES

A. Malleable iron conduit bodies shall be cast malleable iron with tensile strength meeting ASTM A 48, Class 30A requirements. Malleable conduit bodies shall be finished with an epoxy powder coating. Cover shall be malleable iron with captive screws.

B. All conduit bodies' entrances shall be machined NPT threads with a smooth, rounded, internal conduit stop bushing.

C. All conduit bodies shall be equipped with a sealed and gasketed cover. Cover shall be secured using stainless steel machine screws.

2.4 CONDUIT SUPPORTS

A. Conduit supports shall be furnished and installed in accordance with other section of these specifications. Conduits shall be supported so that fittings are accessible. Support systems shall be limited to electrical conduits only.

B. Hanger rods shall be 3/8-inch diameter galvanized threaded steel rods, minimum. Conduit racks over 18-inch wide, over one level, or supporting 2-inch RSC or larger, shall be 1/2-inch diameter rod minimum.

C. Conduit Clamps. Conduits in single runs or groups of two shall be supported by steel clamps and clamp backs. They shall be galvanized malleable iron or approved equal cast ferrous metal for steel conduit or tubing.

D. Support Channels. Supports for banks of three of more conduits shall be constructed of formed steel support channels (Unistrut, Kindorf, Superstrut, B-Line or approved equal) with associated conduit or tubing clips. Support channels shall be steel, hot-dip galvanized after fabrication with galvanized steel clips for steel conduit or tubing.

E. Wall Penetrations. All conduits, raceways, cables and sleeve penetrations through fire rated and hazardous location walls, shafts, floor, ceilings, etc., shall be sealed with a UL-approved fire stopping system.

2.5 OUTLET BOXES AND SWITCH BOXES

A. Manufacturers: Firms regularly engaged in the manufacturing of electrical raceways of the types and capacities required, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1, galvanized flat rolled sheet steel outlet 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.

C. Outlet boxes used in wet outdoor locations, surface mounted shall be cast metal (FS or FD type) with mounting lugs and gasketed covers.

D. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported, per NEC requirements.

E. Outlet Box Accessories: Provide outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used and meeting requirements of individual wiring situations.

2.6 PULL BOXES, JUNCTION BOXES

A. Sheet Metal Boxes shall be NEMA OS 1, NEMA rating as indicated on drawings. Minimum 16 gauge galvanized steel construction with stainless steel hinged cover and neoprene gasket. Cover shall be secured to the body with a continuous, full length, piano type hinge and stainless steel pin on one side and captive screw on the other side. Door shall be equipped with padlock hasp with sealing hole provisions.
   1. Provide #10-32 tapped hole provisions for optional ground lug kit.
   2. Provide 0.375-16 collar studs for mounting optional panel.
   3. Provide external mounting feet for secure wall mounting.
   4. Finish: Wash and phosphate undercoat with ANSI 61 gray polyester power finish.

B. Surface-Mounted Cast Metal Box: NEMA 250, NEMA Type 3R or 4 as indicated, flat-flanged, surface- mounted junction box:
   1. Material: Cast Iron.
   2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify outlet locations and routing and termination locations of raceway prior to rough in.

3.2 EXISTING WORK

A. Extend existing raceway and box installations using materials and methods compatible with existing electrical installations, or as specified.

B. Clean and repair existing raceway and boxes to remain or to be reinstalled.

3.3 INSTALLATION OF RACEWAYS

A. Routing
   1. Install raceway and boxes in accordance with NECA “Standard of Installation.”
   2. Conduit routing shown on drawings is diagrammatic only. Contractor shall field route conduit and raceways between equipment and devices as required to obtain a complete wiring system.
   3. All exposed conduits shall be installed parallel or perpendicular to dominant surfaces with right-angle turns made of symmetrical bends or fittings.
   4. Conduit shall not be installed on the outside face of exposed columns, but shall be routed on the web or on the inside of a flange of the column.
   5. Except where prevented by the location of other work, a single conduit or a conduit group shall be centered on structural members.
   6. Conduit shall be located at least 6 inches from hot water or steam pipes and from other hot surfaces

B. Moisture Pockets
   1. Moisture pockets shall be eliminated from conduits. If water cannot drain to the natural opening in the conduit system, a hole shall be drilled in the bottom of a pull box or a "C-type" conduit fitting provided in the low point of the conduit run.

C. Couplings and Unions
   1. Metal conduit shall be joined by threaded conduit couplings, with the conduit ends butted.
   2. The use of running threads, Erickson type couplings, split couplings or similar unions are not permitted.

D. Conduit Bodies
   1. Conduit bends shall meet the requirements of NEC, minimum bend radius of the cable installed or as indicated on the drawings, whichever is greater.
   2. Conduits or tubing deformed or crushed in any way shall be removed from the job site.

E. Bends and Offsets
   1. Changes in direction of conduits shall be made with fittings or bends.
   2. Conduit bends shall meet the requirements of NEC, minimum bend radius of the cable installed or as indicated on the drawings, whichever is greater.
   3. Bends shall be made using appropriate tools or mechanical equipment. The use of a pipe tee or vise for bending conduit or tubing will not be permitted.
   4. For non-metallic conduit or plastic coated steel, approved factory bends and offsets shall be used.
   5. Conduits or tubing deformed or crushed in any way shall be removed from the job site.

6. Install no more than the equivalent of three 90 degree bends between boxes or outlets

F. Cutting and Threading
   1. The plane of all conduit ends shall be square with the centerline.
   2. Where threads are required, they shall be cut and cleaned prior to conduit reaming.
   3. The ends of all conduit and tubing shall be reamed to remove all rough edges and burrs.
   4. Cutting oil shall be used in threading operations; the dies shall be kept sharp, and provisions shall be made for chip clearance.
   5. Threads on conduits and fittings shall be lubricated with conducting and sealing compound.
   6. All steel conduits shall be coated after threading with cold-galvanized zinc coating. The Contractor shall supply this protective material and shall apply it in the field prior to installing conduit or fittings.

G. All steel conduit, exposed to weather or in contact with earth, shall be re-galvanized after threading with "Galvanizing Powder M-321" as manufactured by the American Solder and Flux Company of Philadelphia, Pennsylvania; "Zincilate 810" as manufactured by Industrial Metal Protectives, Inc., of Dayton, Ohio; "Zinc Rich" coating as manufactured by ZRC Chemical Products Company, Quincy, Massachusetts; or approved equal. The Contractor shall supply this protective material and shall apply it in the field.

H. Connections to Boxes and Cabinets
   1. Conduit shall be securely fastened to all boxes and cabinets.
   2. Threads on metallic conduit shall project through the wall of the box to allow the bushing to butt against the end of the conduit.
   3. The locknuts, both inside and outside, shall then be tightened sufficiently to bond the conduit securely to the box.
   4. Locknuts on connectors shall be tightened securely to bond the connectors.

I. All conduits entering enclosures outdoors or in wet areas shall enter through Meyer’s hubs, or approved equal, or threaded openings.

J. Cleaning
   1. Precautions shall be taken to prevent the accumulation of water, dirt, or concrete in the conduit.
   2. Conduit in which water or other foreign materials have been permitted to accumulate shall be thoroughly cleaned or, where such accumulation cannot be removed by methods acceptable to the Owner /Engineer, the conduit shall be replaced.
   3. For conduits sizes 3 inches and larger, draw a flexible testing mandrel approximately 12 inches long with a diameter less than the inside diameter of the conduit through the conduit. After which, draw a stiff bristle brush through until conduit is clear of particles of foreign materials. For conduits less than 3 inches, draw a stiff bristle brush through until conduit is clear of particles and foreign material.

K. Empty Conduit

1. All conduits installed for future use shall have a polypropylene pull line with a minimum tensile strength of 200 lbs., Jet Line, Cat. No. 232, polyolefin, or approved equal. Pull line shall be secures at both ends to ensure future accessibility.

L. Rooftop Conduits
   1. Provide redwood sleepers on waterproof mastic base for all conduit runs exposed on roofs.

M. Identification
   1. All conduits shall be identified in accordance with other section of these specifications.

N. Grounding
   1. All conduits shall be grounded in accordance with specification Section 26 05 00 – Common Work Results for Electrical.
   2. A solid or stranded bare copper or green insulated copper solid or stranded ground wire shall be provided in all conduits and raceways.

O. Galvanized Rigid Steel Conduit
   1. Galvanized rigid steel conduit shall be installed in areas exposed to weather, vehicle traffic, in hazardous classified areas, for penetrations through foundations, and 10 feet before transition from below grade to 8 feet above grade, unless otherwise noted on the drawings.
   2. Steel conduit in contact with earth shall be protected by "Scotchwrap" 10 mil tape applied in double thickness using 50 percent lap turns to 6 inches above grade and 6 inches beyond transition.
   3. Expansion joints shall be used where required.

P. Polyvinyl Chloride (PVC) Coated Galvanized Rigid Steel Conduits
   1. PVC -coated, steel conduit and fittings shall be installed where highly corrosive conditions exist, indoors or outdoors.
   2. The Contractor shall patch any damaged coating according to the manufacturer's instructions.

Q. Electrical Metallic Tubing
   1. Electrical metallic tubing shall be installed for all circuits, indoors above concrete slab, where not subject to conditions outlined for rigid galvanized steel conduits.

R. Rigid Aluminum Conduit
   1. Not acceptable on this project.

S. Flexible Metal Conduit
   1. Flexible conduit inserts not greater than 30 inches in length, shall be installed in all conduit runs, which are supported by both building steel and by structures subject to vibration or thermal expansion. This shall include locations where conduit supported by building steel enters or becomes supported by isolated structures on separate foundations.
   2. Flexible conduit shall be installed in conduit runs, which cross expansion joints.

3. Special areas, such as plant office control rooms in which external noise is to be minimized, shall have flexible conduit in conduit runs where the runs cross from the main building framing to the control room or office framing.
4. Flexible conduit shall be installed adjacent to all equipment and devices, which move in relation to the supply conduit due to vibration, normal operation of the mechanism, or thermal expansion.
5. Conduit shall be connected to pressure switches, thermocouples, solenoids, and similar devices with flexible conduit. Flexible conduit shall be installed adjacent to the motor terminal housing for motors requiring 4-inch and smaller conduit.
6. Flexible metal conduit inserts not greater than 6 feet in length shall be installed for light fixture tap conductors.

T. Liquid-Tight Flexible Metal Conduit
1. Liquid-tight flexible metal conduit shall be used in place of regular flexible conduit for connections to motors and transformers, in areas exposed to weather, moisture or oil, and under raised floors.
2. Liquid-tight flexible metal conduit may be used in place of flexible metal conduit where not otherwise required.

U. Non-Metallic Conduit
1. Schedule 40 shall be used for all power, signal feeders and branch circuits, in earth or enclosed in concrete, unless otherwise noted on the drawings. Conduits must be buried in earth in accordance with the NEC.

V. Conduit Support
1. Fasten conduit supports to building structures and surfaces in accordance with Section 16050 – Basic Electrical Materials and Methods.
2. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
3. Do not use wire, ceiling support wires or perforated pipe straps to support conduit. Remove any temporary installation support wire.

W. Spacing of Supports
1. All conduit runs shall be rigidly supported, except where buried in concrete,.
2. Each conduit shall be supported within one (1) foot of junction boxes and fittings.
3. Spacers used in duct bank installations shall be placed no more than 6 to 10 feet apart.
4. Support spacing along conduit runs shall be as follows.

Conduit Size	Maximum Distance Between Supports
½ inch through 1-1/4 inch	5 feet
1-1/2 inch and larger	8 feet

X. Ground and bond raceway and boxes in accordance with Section 26 05 00 – Common Work Results for Electrical.

3.4 CABINET AND BOX INSTALLATION

A. Install electrical boxes as shown on drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.

B. Locate boxes and conduit bodies so as to ensure ready accessibility of electrical wiring, maintain headroom and to present neat mechanical appearance.

C. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only. In inaccessible ceiling areas, install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.

D. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices with each other.

E. Use flush mounting outlet boxes in finished areas.
   1. Do not install flush mounting boxes back-to-back in walls.
   2. Provide minimum 6-inch separation between adjacent boxes.
   3. Provide minimum 24-inch separation in acoustic rated walls.
   4. Use stamped steel bridges to fasten flush mounting outlet box between studs.
   5. Secure flush mounting box to interior wall and partition studs.
   6. Accurately position to allow for surface finish thickness.
   7. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
   8. Use adjustable steel channel fasteners for hung ceiling outlet box.

F. Support boxes independently of conduits.

G. Use code sized gang box where more than one device is mounted together. Do not use sectional box. Use code sized gang box with plaster ring for single device outlets.

H. Use cast outlet box in exterior locations where exposed to the weather and wet locations (interior or exterior).

I. Coordinate installation of electrical boxes and fittings with cable and raceway installation work. Provide knockout closures to cap unused knockout holes where blanks have been removed.

J. Do not use round boxes where conduit must enter box through side of box, which would result in difficult and insecure connections where fastened with a locknut or bushing on rounded surface.

K. Fasten boxes rigidly to substrate or structural surfaces to which they are being mounted, or solidly embed electrical boxes in concrete or masonry as appropriate.

L. Except as prevented by the location of other work, all junction boxes and outlet boxes shall be centered on structures.

M. Conduit openings in boxes shall be made with a hole saw or shall be punched.

N. Cabinets and boxes shall be rigidly mounted.
   1. Mounting on concrete shall be secured by self-drilling anchors.
   2. Mounting on steel shall be by drilled and tapped screw holes, or by special support channels welded to the steel, or by both.
   3. Cabinets shall be leveled and fastened to the mounting surface with not less than ¼-inch air space between the enclosure and mounting surface.

4. All mounting holes in the enclosure shall be used.

O. Large Pull Boxes - Boxes larger than 100 cubic inches in volume or 12 inches in any dimension.
   1. Interior Dry Locations - Use hinged enclosure.
   2. Other Locations - Use surface mounted box of appropriate location classification.

3.5 ANCHORS

A. Where supports for raceways, boxes, and cabinets are mounted on concrete surfaces, they shall be fastened with self-drilling tubular expansion shell anchors with externally split expansion shells, single-cone expanders, and annular break-off grooved chucking cones. Anchors shall be Phillips "Red Head" or approved equal.

3.6 ADJUSTING

A. Install knockout closures in unused openings in boxes.

3.7 CLEANING

A. Clean interior of boxes to remove dust, debris, and other material.

B. Clean exposed surfaces and restore manufacturer’s finish.

END OF SECTION

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. The extent of the electrical systems and equipment requiring identification is shown on the drawings, and the extent of identification required is specified herein and in individual sections of work requiring identification. The types of electrical identification specified in this section include the following:
   1. Cable/conductor identification.
   2. Equipment/system identification signs.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCES - CODES AND STANDARDS

A. NFPA 70 National Electrical Code (NEC). Latest approved edition.

1.4 SYSTEM DESCRIPTION

A. Label the following electrical equipment with nameplates which clearly identify each item, the function or use of the item, and the circuit identification of the feed to the item:
   1. All transformers shall be identified by 1-inch high block letters cut in stencil and applied with yellow paint on a flat-black background. The transformer number, primary and secondary voltages, and the kVA shall be shown.
   2. All Local Control Panels, Terminal Cabinets and all electrical equipment enclosure shall be identified using laminated plastic nameplates.
   3. All underground raceway or cable shall be marked with buried warning tape along its entire length.
   4. Panelboard Directories: Furnish all panelboards with a complete 8-1/2-inch by 11-inch typewritten directory mounted in the inner door under a clear plastic cover set in a metal frame.

B. Branch circuits and devices:
   1. Label all individual receptacle outlets at the outlet faceplate to indicate the panelboard of origin and branch circuit number. Labels shall be self adhesive, thermal machine printed type such as Brothers, Panduit, or T&B and shall be clear plastic with black lettering.
   2. All branch circuits in outlet boxes shall be identified with circuit number using wrap-around labels (T&B, BRADY or 3M).
   3. As an alternative to separate nameplates, device plates may be engraved directly with lettering filled with black enamel.

1.5 SUBMITTALS

A. Catalog data for nameplates, labels, and markers.

B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation and installation of Product.

1.6 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70 – National Electrical Code.

B. Furnish products listed and classified by Underwriters' Laboratories, Inc. (UL), Electrical Testing Laboratories, Inc. (ETL), or other recognized, approved testing and listing agencies as suitable for the purpose specified and shown.

PART 2 PRODUCTS

2.1 NAMEPLATES AND LABELS

A. Nameplates
   1. Engraved three-layer laminated plastic, white letters on black background for normal power and white letters on red background for emergency power. Communications and control cabinets shall be labeled with white letters on green background.
   2. Locations
      a. Each electrical distribution and control equipment enclosure.
      b. Communication cabinets.
   3. Letter Size
      a. Use 1/8-inch letters for identifying individual equipment and loads.
      b. Use ¼-inch letters for identifying grouped equipment, loads, panelboards, and transfer switch.

B. Labels
   1. Embossed adhesive tape, with 3/16-inch white letters on colored background to match color scheme of plastic laminate labels in 2.1.1. Use only for identification of individual wall switches and receptacles, control device stations, and multi-outlet devices.
   2. Thickness
      a. 1/16-inch for units up to 20 square inches or 8-inch length; 1/8-inch for larger units.

2.2 WIRE MARKERS

A. Manufacturers
   1. Brady
   2. Thomas & Betts
   3. 3-M Co.

B. Description: Cloth, tape, split sleeve, or tubing type wire markers, self-adhesive.

C. Locations: Each conductor at panelboard gutters, pull boxes, outlet and junction boxes, control panels, motor controllers and starters, and each load connection.

D. Legend
   1. Power and Lighting Circuits: Branch circuit or feeder number indicated on contract drawings.
   2. Control Circuits: Control wire number indicated on shop drawings.
   3. Neutral Conductors: Clearly indicate the branch circuit or feeder number the neutral serves. In multi-wire circuits where the neutral is shared, mark the neutral with the circuit number of the “A” phase.

2.3 FASTENERS

A. Secure all labels and nameplates with self-tapping stainless steel screws. Use contact type permanent adhesive where screws cannot or should not penetrate the substrate.

2.4 LETTERING AND GRAPHICS

A. Coordinate names, abbreviations and other designations used in the electrical identification work, with the corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of the electrical systems and equipment.

2.5 UNDERGROUND WARNING TAPE

A. Three-inch minimum width, 5 mil thickness, foil bonded polyethylene tape, detectable type, with suitable continuous warning legend describing buried electrical lines. Tape color shall conform to APWA uniform color code using ANSI Z535.1 safety colors. Text shall be black, 2-inch minimum letters.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive nameplates and labels.

B. Coordination: Where identification is to be applied to surfaces that require finish, install identification after completion of painting.

C. Regulations: Comply with governing regulations and the requests of governing authorities for the identification of electrical work.

3.2 APPLICATION

A. Install nameplate and label parallel to equipment lines.

B. Secure nameplate to equipment front using screws, rivets, or adhesive.

C. Secure nameplate to outside moveable surface of door on panelboard.

D. Conduit Identification:
   1. Where electrical conduit is exposed in spaces with exposed mechanical piping, which is identified by a color-coded method, apply color-coded identification on the electrical conduit in a manner similar to the piping identification. Except as otherwise indicated, use orange as the coded color for conduit.

E. Cable/Conductor Identification:
   1. Apply cable/conductor identification on each cable and conductor in each box/enclosure/cabinet where the wires of more than one circuit or communication/signal system are present, except where another form of identification (such as color-coded conductors) is provided.
   2. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project electrical work.

F. Operational Identification and Warnings
   1. Wherever reasonably required to ensure safe and efficient operation and maintenance of the electrical systems, and electrically connected mechanical systems and general systems and equipment, including the prevention of misuse of electrical facilities by unauthorized personnel, install self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls, devices and covers of electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for the intended purposes.

G. Equipment/System Identification Signs
   1. Install an engraved plastic-laminate sign on each major unit of electrical equipment in the building; including the central or master unit of each electrical system and the communication/signal systems, unless the unit is specified with its own self-explanatory identification or signal system.
   2. Except as otherwise indicated or specified, provide single line of test, ½-inch high lettering on 1-1/2-inch high sign (2-inch high where two lines are required), white lettering in black field.
   3. Provide text matching terminology and numbering of the contract documents and shop drawings.

H. Install signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrata with fasteners, except use adhesive where fasteners should not or cannot penetrate the substrata.

I. Identify underground conduits using underground warning tape. Install one tape per trench at 12 inches below finished grade.

END OF SECTION

SECTION 26 09 23

LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Time switches.
   2. Indoor occupancy sensors.

B. Related Requirements:
   1. Division 26 Section "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show installation details for occupancy and light-level sensors.
   1. Interconnection diagrams showing field-installed wiring.
   2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

PART 2 PRODUCTS

2.1 TIME SWITCHES

A. 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:
   1. Cooper Industries, Inc.
   2. Intermatic, Inc.
   3. Invensys Controls.
   4. Leviton Mfg. Company Inc.
   5. NSi Industries LLC; TORK Products.
   6. Tyco Electronics; ALR Brand.

B. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Contact Configuration: SPST, 4-channel.
   3. Contact Rating: 20-A ballast load, 120-/240-V ac.
   4. Programs: Two on-off set points on a 24-hour schedule, allowing different set points for each day of the week.
   5. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.
   6. Astronomic Time: Available on selected channels.
   7. Automatic daylight savings time changeover.
   8. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

2.2 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Bryant Electric; a Hubbell company.
   2. Cooper Industries, Inc.
   3. Hubbell Building Automation, Inc.
   4. Leviton Mfg. Company Inc.
   5. Lightolier Controls.
   6. Lithonia Lighting; Acuity Lighting Group, Inc.
   7. Lutron Electronics Co., Inc.
   8. NSi Industries LLC; TORK Products.
   9. RAB Lighting.
   10. Sensor Switch, Inc.
   11. Square D; a brand of Schneider Electric.
   12. Watt Stopper.

C. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application, and shall comply with California Title 24.
   2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
   3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.

D. Wall-Switch Sensor Tag W2:
   1. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft..
   2. Sensing Technology: PIR.
   3. Switch Type: SP, manual "on," automatic "off."

4. Voltage: Match the circuit voltage type.
5. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
6. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
7. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

2.3 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 EXECUTION

3.1 SENSOR INSTALLATION

A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.

B. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

3.3 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."
   1. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches with a unique designation.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Lighting control devices will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Occupancy Adjustments: For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION

SECTION 26 22 19

CONTROL POWER TRANSFORMERS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Two-winding control power transformers.

B. Related Requirements:
   1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
   2. Section 26 05 29 - Hangers and Supports for Electrical Systems.
   3. Section 26 05 33 - Raceway and Boxes for Electrical Systems.
   4. Section 26 05 53 - Identification for Electrical Systems.

1.2 REFERENCES

A. Reference Standards:
   1. Section 01 40 00 - Quality Requirements: Requirements for references.
   2. National Electrical Manufacturers Association:
      a. NEMA ST 1 - Specialty Transformers (Except General Purpose Type).
   3. International Electrical Testing Association:
      a. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit outline and support point dimensions of enclosures and accessories, unit weight, voltage, VA, and impedance ratings and characteristics, tap configurations, insulation system type, and rated temperature rise.

C. Test Reports:
   1. Indicate results of CONTRACTOR furnished tests and inspections.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout submittals.

B. Project Record Documents: Record actual locations of transformers.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum 3 years [**documented**] experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle according to manufacturer's written instructions. Lift only with lugs provided. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 TWO-WINDING TRANSFORMERS

A. Manufacturers:
   1. Eaton Type MTE.
   2. Substitutions: According to Section 01 60 00.

B. Description: NEMA ST 20, factory-assembled, air-cooled, dry type control power transformers. Provide secondary fuse holder.

C. Operation:
   1. Primary Voltage: 120 volts (V), single phase.
   2. Secondary Voltage: 24 volts (V), single phase.
   3. Volt-Ampere Rating: 25
   4. Insulation system and average winding temperature rise for rated kVA as follows:
      a. 1 to 15 kVA: Class 105 with 55 degrees C rise.

D. Materials:
   1. Ground core and coil assembly to enclosure by means of visible flexible copper grounding strap.
   2. Coil Conductors: Continuous copper windings with terminations brazed or welded.
   3. Enclosure: NEMA ST 1, epoxy-encapsulated.

2.2 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Testing, inspection, and analysis requirements.

B. Production test each unit according to NEMA ST 20.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution Requirements: Verification of existing conditions before starting work.

B. Verify mounting supports are properly sized and located including concealed bracing in walls.

3.2 INSTALLATION

A. Set transformer plumb and level.

B. Use flexible conduit, according to Section 26 05 33 for connections to outer enclosure. Make conduit connections to side panel of enclosure.

C. Support transformers according to Section 26 05 29.
   1. Mount transformers Ain outer enclosure.

D. Install grounding and bonding according to Section 26 05 26.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Field inspecting and testing.

B. Inspect and test according to NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.2.1.

3.4 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Lighting and appliance branch-circuit panelboards.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.
   1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
   2. Detail enclosure types and details for types other than NEMA 250, Type 1.
   3. Detail bus configuration, current, and voltage ratings.
   4. Short-circuit current rating of panelboards and overcurrent protective devices.
   5. Include evidence of NRTL listing for series rating of installed devices.
   6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.5 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. Keys: Two spares for each type of panelboard cabinet lock.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. 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.

C. Comply with NEMA PB 1.

D. Comply with NFPA 70.

1.7 PROJECT CONDITIONS

A. Environmental Limitations:
   1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Owner no fewer than five days in advance of proposed interruption of electric service.
   2. Do not proceed with interruption of electric service without Owner's written permission.
   3. Comply with NFPA 70E.

1.8 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 PRODUCTS

2.1 DISTRIBUTION AND BRANCH CIRCUIT PANELBOARDS

A. Manufacturers:
   1. Square D Co.
   2. Or Approved Equal.

B. Product Description

1. NEMA PB 1, circuit breaker type distribution, lighting and appliance branch circuit panelboard.

C. Service Conditions:
   1. Temperature: 104 degrees F (40 degrees C) ambient
   2. Altitude: 100 feet (35 m) above sea level.

D. Panelboard Bus
   1. Silver plated copper current carrying components, ratings as indicated on drawings.
   2. Main bus ampacity shall be equal to the main circuit breaker frame size rating.
   3. Furnish copper ground bus in each panelboard.

E. Minimum integrated short circuit rating
   1. Panelboards rated 240-Volts - 10,000 amperes RMS symmetrical
   2. Panelboards rated 480-Volts - 42,000 amperes RMS symmetrical
   3. Circuit Breaker rating shall match or exceed the panel interrupting rating
   4. Series rated circuit breakers are not acceptable

F. Enclosure:
   1. Indoor Installation:
      a. NEMA PB 1, Type 1, gasketed, steel construction, minimum 6 inches deep, 20 inches wide suitable for flush or surface mounting as indicated on drawings.
      b. Flush or surface cabinet front with concealed trim clamps, concealed hinge, metal directory frame, and flush lock keyed alike. Finish in manufacturer's standard gray enamel.
      c. Fully hinged door with flush lock and metal directory frame.
      d. Finished in manufacturer's standard gray enamel (ANSI 61).

2.2 Branch Circuit Power Metering

A. Each panelboard shall include a sensors for metering at the branch circuit level and provisions for a metering display which can be used to review the current status, view any branch current/power level/consumption, and view overall power consumption.

B. The metering device shall be UL, cUL listed, and CE marked. The device will also meet ANSI standard C12.1-2001 energy revenue metering accuracy and IEC 61036 Class 1 accuracy.

C. The metering device shall provide direct reading metered or calculated values for up to forty-two (42) branch circuits with auxiliary inputs available for one (1) three-phase main device and one (1) neutral.

D. Monitored values for the main device to include:
   1. Current per phase
   2. Max current per phase
   3. Current demand per phase
   4. Max current demand per phase
   5. Energy (kWh) per phase
   6. Real power (kW) per phase

7. Power Factor Total based on three-phase breaker rotation
8. Power factor per phase
9. Voltage Line-to-Line and average
10. Voltage Line-to-Neutral and average
11. Phase A frequency

E. Monitored Values at the branch circuit level to include:
   1. Current
   2. Max current
   3. Current demand
   4. Max current demand
   5. Real power (kW)
   6. Real power (kW) demand
   7. Real power (kW) demand max

F. Each panel shall include two (2) solid-core strips with tombstone type current transformers for 42-circuits. The strips shall be connected to the main circuit board of the meter via a standard ribbon cable connection.
   1. The current transformers mounted on the circuit board based strips must be spaced to align with the panelboard branch circuit breakers.

2.3 MOLDED CASE CIRCUIT BREAKERS

A. NEMA AB 1, bolt-on type thermal magnetic and instantaneous magnetic trip circuit breaker. Circuit breaker thermal elements shall be of the bimetallic type and shall be capable of withstanding sustained overload and short-circuit currents without injury and without affecting the calibration of the bimetallic element. The thermal element shall have inverse time characteristics. The instantaneous elements shall trip the circuit breaker at the minimum standard trip setting.

B. Provide common trip handle for multiple pole circuit breakers.

C. Provide type SWD for lighting circuits and type HACR circuit breakers for air conditioning equipment circuits.

D. Provide Class A ground fault interrupter circuit breakers as indicated on drawings.

E. Trip rating shall be as indicated on drawings.

F. Minimum integrated short circuit rating
   1. Circuit Breakers rated 240-Volts - 10,000 amperes RMS symmetrical
   2. Circuit Breakers rated 480-Volts - 42,000 amperes RMS symmetrical
   3. Circuit Breaker rating shall match or exceed the panel interrupting rating
   4. Series rated breakers are not acceptable

2.4 Metering

A. Metering shall have the following functions
   1. Power: Instantaneous demand (kW)
   2. Power: Historical peak demand (kW)
   3. Energy: Cumulative, resettable (kWh)

2.5 Surge Protection Device:

A. IEEE C62.41-compliant, integrally mounted bolt-on, solid-state, parallel-connected, modular with field-replaceable modules type, with sine-wave tracking suppression and filtering modules, short-circuit current rating complying with UL 1449, second edition, and matching or exceeding the panelboard short-circuit rating, redundant suppression circuits, with individually fused metal-oxide varistors.
   1. Accessories:
      a. Fuses rated at 200-kA interrupting capacity.
      b. Fabrication using bolted compression lugs for internal wiring.
      c. Integral disconnect switch.
      d. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
      e. LED indicator lights for power and protection status.
      f. Six-digit, transient-event counter set to totalize transient surges.
   2. Peak Single-Impulse Surge Current Rating: 120 kA per mode/240 kA per phase.
   3. Minimum single-impulse current ratings, using 8-by-20-mic.sec. waveform described in IEEE C62.41.2.
      a. Line to Neutral: 70,000 A.
      b. Line to Ground: 70,000 A.
      c. Neutral to Ground: 50,000 A.
   4. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.
   5. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277; 208Y/120-V, three-phase, four-wire circuits shall be as follows:
      a. Line to Neutral: 800 V for 480Y/277; 400 V for 208Y/120.
      b. Line to Ground: 800 V for 480Y/277; 400 V for 208Y/120.
      c. Neutral to Ground: 800 V for 480Y/277; 400 V for 208Y/120.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

B. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

C. Mount panelboard cabinet plumb and rigid without distortion of box.

D. Install overcurrent protective devices and controllers not already factory installed.

E. Install filler plates in unused spaces.

F. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 26 05 53.

B. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 05 53.

3.4 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Wiring devices are defined as single discrete units of electrical distribution systems that are intended to carry but not utilize electric energy. The types of general purpose wiring devices required for the project include, but are not limited to the following line voltage devices:
   1. Connectors
   2. Plugs
   3. Receptacles
   4. Switches
   5. Wall plates

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. IEC 529 - Degrees of Protection provided by Enclosures.

B. NEMA WD 1 - General Purpose Wiring Devices

C. NEMA WD 6 - Wiring Device Configurations.

1.4 CONTRACTOR SUBMITTALS

A. Product Data:
   1. Catalog cut of each device showing Manufacturer name, catalog number, voltage and current rating and dimensions.

1.5 REGULATORY REQUIREMENTS

A. Furnish products listed and classified by UL, ETL, or other recognized, acceptable testing and listing agencies as suitable for the purpose specified and shown.

PART 2 PRODUCTS

2.1 GENERAL

A. Provide factory fabricated wiring devices in the type, color, electrical rating for service indicated, and/or as shown on the drawings.

2.2 MANUFACTURERS

A. Provide products produced by one of the following for each type of wiring device:
   1. Appleton
   2. Arrow-Hart, Inc.
   3. Bryant Electric Co.
   4. Crouse-Hinds Co.
   5. General Electric Co.
   6. Hubbell Wiring Device Division
   7. Pass & Seymour
   8. Pyle National
   9. Russell & Stoll
   10. Slater
   11. Wiremold (multi-outlet assemblies)
   12. Or Approved Equal

2.3 WALL SWITCHES

A. Provide specification grade, quiet type, flush, 1-pole, 2-pole, three and four-way toggle switches, 20 ampere, 120/277-volts AC, with mounting yoke insulated from mechanism equipped with plaster ears and side wired screw terminals, white plastic body with Decora rocker style action.
   1. Device Number: #5621-2W, #5622-2W, #5623-2W, #5624-2W
   2. Manufacturers: Leviton (or equal by Hubbell, Pass & Seymour, Cooper)

2.4 RECEPTACLES

A. Provide specification grade, grounding type, heavy-duty, Decora receptacles with white plastic body, green hexagonal equipment ground screw terminal and grounding poles internally connected to mounting yoke; metal plaster ears; side wiring as follows:
   1. Duplex Receptacle: Two pole, 3 wire, 20-ampere, 125-volt duplex receptacle, NEMA configuration 5-20R unless otherwise indicated. Leviton #5362-W (or equal by Hubbell, Pass & Seymour, Cooper).
   2. GFCI Receptacle: Two pole, 3 wire, 20-ampere, 125-volt duplex receptacle with integral ground fault circuit interrupter to meet regulatory requirements. Leviton #T7899-W (or equal by Hubbell, Pass & Seymour, Cooper)
   3. Special Purpose: Two pole, 3 wire, 20-ampere, 125-volt single receptacle, twist-lock, NEMA configuration L5-20R as indicated.
   4. Special Purpose Receptacle: Type as required meeting the requirements of this Section and the equipment shown on the drawings and elsewhere specified.

2.5 PLUGS AND CONNECTORS

A. Comply with NEMA Standards Publication No. WD-1. Provide 20 ampere, 125-volts, bakelite body connectors, 3-wire grounding, parallel blades, double wipe contact, with cord clamp.

B. Matching Insulgrip, corrosion resistant nylon plugs, IP20, shall be provided for each twist-lock type receptacles unless indicated otherwise.

C. Manufacturers: Hubbell, Pass & Seymour, Bryant, or Approved Equal.

2.6 WALL PLATES

A. Decorative Cover Plate: High impact, smooth nylon and smooth satin in finished areas. Color of nylon cover plate shall be ivory unless noted otherwise. Stainless steel cover plate in unfinished areas or where device is embedded in concrete.

B. For areas where two separate power sources are provided, each power source receptacle shall have a different color cover plate such as black, gray, or brown. Emergency power source receptacles shall have a red cover plate.

C. Weatherproof Cover Plate: Gasketed cast metal with hinged gasketed device cover. Cover for duplex devices shall be designed such that each device is independently covered.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify outlet boxes are installed at proper height.

B. Verify wall openings are neatly cut and will be completely covered by wall plates.

C. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

D. Inspect each item of materials or equipment immediately prior to installation, and reject damaged and defective items.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface, if necessary.

B. Clean debris from all boxes.

3.3 INSTALLATION

A. Install wiring devices where indicated, in accordance with the manufacturer's written instructions, the applicable requirements of the NEC and the NECA "Standard of Installation", and in accordance with recognized industry practices to ensure that products serve the intended function.

B. Comply with the manufacturer's applicable instructions and recommendations for installation, to whatever extent these are more explicit or more stringent than applicable requirements indicated in the contract documents.
   1. Install devices plumb and level. Install switches with OFF position down
   2. Install vertically oriented grounded receptacles with grounding pole on top
   3. Connect wiring device grounding terminal to equipment grounding conductor.
   4. Connect isolated ground (IG) receptacle equipment (yoke) grounding terminal only at metallic box with bonding jumper

5. Install decorative plates on switch, receptacle, and blank outlets in finished areas
6. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets in utility areas. (Does not include multi-outlet assemblies, other similar locations.).
7. Identify wiring devices as specified in Section 262726.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Coordinate locations of outlet boxes to obtain mounting heights compliant with ADA. See drawings for specific mounting heights

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 and data jack is properly connected and circuit is operational.

3.6 ADJUSTING

A. Adjust devices and wall plates to be flush, plumb and level.

END OF SECTION

SECTION 26 28 19

DISCONNECT SWITCHES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Section includes fusible and non-fusible switches.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCES

A. National Electrical Manufacturers Association:
   1. NEMA FU 1 - Low Voltage Cartridge Fuses.
   2. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

B. International Electrical Testing Association:
   1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.4 SUBMITTALS

A. Product Data: Submit switch ratings and enclosure dimensions.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of enclosed switches and ratings of installed fuses.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

PART 2 PRODUCTS

2.1 FUSIBLE SWITCH ASSEMBLIES

A. Manufacturer: Square D Company, or approved equal.

B. Fusible Switch Assemblies: Horsepower rated, heavy-duty type; quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.
   1. Fuse Clips: Designed to accommodate Class R fuses only and reject all others.

C. Non-fusible Switch Assemblies: Horsepower rated, heavy-duty type; quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

D. Product Description: NEMA KS 1, Type HD with externally operable handle interlocked to prevent opening front cover with switch in ON position, enclosed load interrupter knife switch. Handle lockable in OFF position.

E. Fuse clips: Designed to accommodate NEMA FU 1, Class J fuses.

F. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
   1. Interior Dry Locations: Type 1.
   2. Exterior Locations: Type 3R.

G. Service Entrance: Switches identified for use as service equipment are to be labeled for this application. Furnish solid neutral assembly and equipment ground bar.

H. Furnish switches with entirely copper current carrying parts.

2.2 NON-FUSIBLE SWITCH ASSEMBLIES

A. Manufacturer: Square D Company, or approved equal.

B. Non-fusible Switch Assemblies: Horsepower rated, heavy-duty type; quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

C. Product Description: NEMA KS 1, Type HD with externally operable handle interlocked to prevent opening front cover with switch in ON position enclosed load interrupter knife switch. Handle lockable in OFF position.

D. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from [steel finished with manufacturer's standard gray enamel.
   1. Interior Dry Locations: Type 1.
   2. Exterior Locations: Type 3R.

E. Service Entrance: Switches identified for use as service equipment are to be labeled for this application. Furnish solid neutral assembly and equipment ground bar.

F. Furnish switches with entirely copper current carrying parts.

2.3 FUSES

A. Manufacturers:
   1. Bussmann.
   2. Gould Shawmut.
   3. Littelfuse.

B. Fuses 600 Amperes and Less: UL 198E, Class RK5, sized as indicated on Drawings.

C. Interrupting Rating: 200,000 RMS amperes.

2.4 SWITCH RATINGS

A. Switch Rating: Horsepower rated for AC or DC as indicated on Drawings.

B. Short Circuit Current Rating: UL listed for 10,000 rms symmetrical amperes when used with or protected by Class H or K fuses (30-600 ampere) 200,000 rms symmetrical amperes when used with or protected by Class R or Class J fuses (30-600 ampere switches employing appropriate fuse rejection schemes). 200,000 rms symmetrical amperes when used with or protected by Class L fuses (800-1200 ampere).

PART 3 EXECUTION

3.1 EXISTING WORK

A. Disconnect and remove abandoned enclosed switches.

B. Maintain access to existing enclosed switches and other installations remaining active and requiring access. Modify installation or provide access panel.

C. Clean and repair existing enclosed switches to remain or to be reinstalled.

3.2 INSTALLATION

A. Install enclosed switches plumb.

B. Height: 4 feet (1500 mm) to operating handle.

C. Install fuses for fusible disconnect switches.

D. Install engraved plastic nameplates

E. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

3.3 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 7.5.

END OF SECTION

SECTION 26 29 13

ENCLOSED MOTOR CONTROLLERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes manual and magnetic motor controllers in individual enclosures.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCES

A. National Electrical Manufacturers Association:
   1. NEMA FU 1 - Low Voltage Cartridge Fuses.
   2. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
   3. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
   4. NEMA ICS 6 - Industrial Control and Systems: Enclosures.
   5. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

B. International Electrical Testing Association:
   1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

C. Underwriters Laboratories Inc.:
   1. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.

C. Test Reports: Indicate field test and inspection procedures and test results.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations and ratings of enclosed controllers.

C. Operation and Maintenance Data: Submit Replacement parts list for controllers.

D. Furnish as-built elementary and schematic drawings with all manufacturer's equipment, control panels, devices, etc., in detail on the elementary diagram with all terminal points of such equipment indicated.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years' experience.

B. Supplier: Authorized distributor of specified manufacturer with minimum three years' experience with that manufacturer's products.

1.7 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. The following is a list of acceptable manufacturers for the motor control center.
   1. Allen-Bradley
   2. Cutler Hammer
   3. Siemens Energy & Automation, Inc.
   4. Square D Company

2.2 MOTOR STARTER UNITS

A. Motor Starter Units shall be full-voltage, single-speed, non-reversing, combination motor starter units and shall include disconnecting and branch circuit over-current protective devices; dry-type control power transformers; contactors, overload relays, auxiliary control devices, door mounted pilot devices, control relays and accessories as indicated and required for the system provided.

B. Disconnecting and Branch Circuit Over-current Protective Devices for all motor starters shall be magnetic, instantaneous trip-only type, motor circuit protector circuit breakers sized and rated in accordance with the latest NEC and the manufacturer's recommendations based on the service conditions and contractor-supplied motor data.

C. Starter Contactors shall have rated continuous current carrying capacity as listed in NEMA ICS 2, Table 2-210-1 for that size contactor. The interrupting capacity of each starter contactor shall be not less than 10 times the rated continuous current-carrying capacity listed in NEMA ICS 2, Table 2-210-1 for that size contactor.

D. Overload Relays. Thermal overload relays shall be furnished in each phase leg of each motor starter. The overload capacity of the relays shall be manually adjustable through a range of 85 to 115 percent of the normal trip rating. The relays shall not be temperature compensated. Provisions shall be made for manually resetting the thermal relays without opening the starter door.

E. Control power transformer shall be furnished with fuses in both of the primary and one of the secondary phase wires. It shall have a rating of 250 Volt-Amps, minimum.

F. Mechanically Operated Auxiliary Contacts. Each magnetic motor starter shall be furnished with a total of two (2) mechanically operated auxiliary contacts, normally open, convertible in the field, and mounted on the main contactor. The use of auxiliary relays to furnish the specified quantities of auxiliary contacts will not be acceptable. Combination starter units that require line voltage to energize the main contactor operating coils shall be equipped with a total of eight (8) mechanically operated auxiliary contacts.

G. Each starter will be controlled by remote pilot devices. All necessary internal wiring for this feature shall be furnished and connected to terminal blocks.

H. Verify required control voltage with mechanical drawings or driven equipment manufacturers requirements and furnish starter with compatible coil voltage, or replacement coil.

2.3 FULL-VOLTAGE NON-REVERSING CONTROLLERS

A. Enclosure: NEMA ICS 6, Type 1 or 4 to meet conditions of installation.

B. Control Voltage: 120 volts, 60 Hertz, or as indicated on the Drawings.

C. Overload Relay: NEMA ICS 2; bimetal.

D. Product Features:
1. Auxiliary Contacts: NEMA ICS 2, 2 each field convertible contacts in addition to seal-in contact.
2. Cover Mounted Pilot Devices: NEMA ICS 5, standard duty type.
3. Pilot Device Contacts: NEMA ICS 5, Form Z, rated A150.
4. Pushbuttons: Lockable type.
5. Indicating Lights: LED type.
6. Selector Switches: Rotary type.
7. Relays: NEMA ICS 2, as required per Drawings.
8. Control Power Transformers: 120 volt secondary, 250 VA minimum, in each motor starter. Furnish fused primary and secondary, and bond unfused leg of secondary to enclosure.

E. Combination Controllers: Combine motor controllers with disconnect in common enclosure, using thermal magnetic circuit breaker conforming to UL 489, with integral thermal and instantaneous magnetic trip in each pole.

F. Enclosure: NEMA ICS 6, Type 1 or 4 to meet conditions of installation.

PART 3 EXECUTION

3.1 EXISTING WORK

A. Disconnect and remove abandoned enclosed motor controllers.

B. Maintain access to existing enclosed motor controllers and other installations to remain active and to require access. Modify installation or provide access panel.

C. Clean and repair existing enclosed motor controllers to remain or to be reinstalled.

3.2 INSTALLATION

A. Install enclosed controllers plumb. Provide supports in accordance with Section 26 05 29.

B. Height: 5 feet maximum, 3 feet minimum to operating handle.

C. Select and install overload heater elements in motor controllers to match installed motor characteristics.

D. Install engraved plastic nameplates. Refer to Section 26 05 53 for product requirements and location.

E. Neatly type label and place inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating. Place label in clear plastic holder.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements, 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.16.1.

D. Check phase-to-phase and phase-to-ground insulation for proper resistance levels. Check motor control center electrical circuits for continuity and for short circuits.

E. Subsequent to wire and cable hookups, energize motor control centers and demonstrate functioning in accordance with requirements.

F. All control devices including interlocks, indicating lights, control relays, timers, time delay relays, and push buttons shall be checked for correct operation.

END OF SECTION

SECTION 26 32 13

ENGINE GENERATORS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes equipment and services necessary for the design, manufacture, factory testing, installation, and site testing of a complete and operable on-site emergency generator unit including radiator, exhaust silencer, fuel piping, control panel, battery and charger.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. The standards referenced herein, except as modified in the Contract Documents, shall have full force and effect as though included in these Specifications. These standards are not furnished to by the Engineer since manufacturers and trades involved are assumed to be familiar with these requirements. The Contractor and/or Installer shall obtain copies of reference standards direct from publication sources as needed for proper performance and completion of the work. General codes, such as the National and State Electric Codes, Building Codes, and Fire Codes are to be followed without specific reference in these specifications.
   1. IEC 8528 Control Systems for Generator Sets - Part 4.
   2. IEC Standards 801.2, 801.3, and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions.
   3. IEEE 446 Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
   4. IEEE 587 Voltage surge resistance.
   5. NEMA AB 1 Molded Case Circuit Breakers.
   6. NEMA ICS 10 AC Generator sets, Industrial Control and Systems: AC Transfer Switch Equipment.
   7. NEMA MG 1 Motors and Generators.
   8. NEMA 250 Enclosures for Electrical Equipment (1,000 Volts Maximum.)
   9. NETA ATS Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
   10. NFPA 58 Liquified Petroleum Gas Code.
   11. NFPA 70 National Electrical Code, 2014 Edition (2016 California Electrical Code).
   12. NFPA 110 Emergency and Standby Power Systems.
   13. CFC California Fire Code, 2016 Edition
   14. UL 508 Standard for Industrial Control Equipment
   15. UL 2200 Standards for Stationary Engine Generator Assemblies

1.4 SUBMITTALS

A. Shop Drawings:
   1. Electrical characteristics and connection requirements.
   2. Plan and elevation views of unit including overall dimensions.
   3. Electrical and Fuel piping interconnection point with dimensions.
   4. Fuel consumption rate curves at various loads.
   5. Ventilation and combustion air requirements.
   6. Electrical schematic and interconnection diagrams.
   7. Overall unit dimensions and seismic anchoring points with dimensions.
   8. Emissions report.

B. Product Data:
   1. Submit data showing dimensions, weights, ratings, interconnection points, and internal wiring diagrams for engine, generator, control panel, battery, battery rack, battery charger, exhaust silencer, vibration isolators, and radiator.
   2. Submit two (2) sets of product data, certification, test reports and other necessary information, for engine-generator unit, to the local city Fire Marshal for approval and permit.
   3. Submit calculations and pad-mount anchoring method (anchor bolt size, embedment and assembly details) to meet 2016 California Building Code seismic requirements, site class D.

C. Certification and Test Reports:
   1. Provide results of manufacturer's certification of performance testing. Certification and Test Reports (Includes inspections, findings, and recommendations).
   2. Certification that the Engine-Generator unit is designed to meet emission limits and operate correctly for the application.

1.5 NCUAQMD PERMITTING

A. Complete and Submit the North Coast Unified Air Quality Management District (NCUAQMD) “Permit Application” according to Regulation 1 provisions. Pay application fees (standard response, or expedited review as necessary), complete forms, and provide applicable drawings and equipment cutsheets. Obtain Permit to construct prior to ordering generator. Obtain permit to operate prior to final acceptance by Owner.

B. Complete and submit the NCUAQND Rule 102 forms “Authority to construct”, General Supplemental Information”, “Supplemental Information Internal Combustion Engines” prior to ordering unit.

C. Complete and submit the NCUAQND Rule 102 forms required to obtain the “Permit to Operate” prior to initial checkout and testing of the generator unit.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Shop Drawings and Product Data as described under Submittals.

B. Operation and Maintenance Manuals (3 complete sets):

1. Instructions and service manuals for normal operation, routine maintenance, oil sampling and analysis for engine wear and engine maintenance procedures.
2. Manufacturer's standard manuals for EG Unit.
3. "As Built" elementary and schematic drawings; wiring diagrams; and panel drawings, in conformance with construction record.
4. Troubleshooting procedures, with a cross-reference between symptoms and corrective recommendations.
5. Connection data to permit removal and installation of recommended smallest field-replaceable parts.
6. Information on testing of electronic circuit boards and an explanation of the EG unit diagnostics.
7. List special tools, maintenance materials, and replacement parts. Include complete information for tightening of all electrical connections secured with bolts or studs.

1.7 QUALIFICATIONS

A. Manufacturer: Company specialized in manufacturing the products specified in this section with recent minimum five (5) years experience and with service facilities within 50 miles of project site.

B. Supplier: Authorized distributor of specified manufacturer with recent minimum five (5) years experience.

C. Prepare anchor bolt calculations under direct supervision of a professional civil or structural engineer experienced in the design of this work and licensed in the State of California.

1.8 WARRANTY

A. Furnish two (2) year manufacturer's warranty from date of substantial completion for defective parts and labor.

1.9 MAINTENANCE MATERIALS

A. Furnish one (1) set of tools required for preventive maintenance of engine-generator system. Package tools in adequately sized metal toolbox.

B. Furnish two (2) of each: fuel, oil and air filter elements.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver mounted on shipping skids.

B. 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. Provide space heaters if required, to prevent condensation and keep the equipment dry.

1.11 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication

PART 2 PRODUCTS

2.1 ENGINE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cummins Power Generation
   2. Caterpillar; Engine Div.
   3. Kohler Co; Generator Div.
   4. Generac Power Systems.

B. EPA Tier 3 emissions compliant

C. Product Description: 4-cycle, radiator- and fan-cooled, spark-ignition internal combustion engine with regulator, and control equipment

D. Fuel System: Liquid petroleum gas (LPG).

E. Engine speed: 1,800 rpm.

F. Safety Devices: Engine shutdown on high water temperature, high oil temperature, low oil pressure, over speed, and engine over crank. Limits as selected by manufacturer.

G. Engine Starting: DC starting system with positive engagement, voltage of starter motors in accordance with manufacturer's instructions. Furnish remote starting control circuit with MANUAL-OFF-REMOTE selector switch or pushbuttons on engine-generator control panel.

H. Engine Jacket Heater: Thermal circulation-type water heater with integral thermostatic control, sized to maintain engine jacket water at 90 degrees F (32 degrees C), and suitable for operation on 120-Volt, single-phase power supply. Provide 20-amp 120-volt power circuit, including conduit and wire, from nearest available panelboard.

I. Radiator: Radiator using glycol coolant, with blower type fan, sized to maintain safe engine temperature in ambient temperature of 105 degrees F (40 degrees C). Radiator airflow restriction 0.5 inches of water (1.25 Pa) maximum.

J. Engine Accessories: Fuel filter, lube oil filter, intake air filter, lube oil cooler, engine-driven water pump. Furnish water temperature gauge and lube oil pressure gauge on engine-generator control panel.

K. Mounting: Heavy-duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails. Furnish unit with suitable spring-type vibration isolators. Provide mounting bolts sized for 2016 California Building Code seismic requirements, site class D.

2.2 GENERATOR

A. Product Description: NEMA MG1, single-phase, re-connectable, brushless synchronous generator with brushless exciter.

B. Rating: As indicated on Drawings.

C. Insulation Class: H.

D. Temperature Rise: 125 degrees C standby.

E. The generator shall be rated for delivering output KVA at rated frequency and power factor, at any voltage not more than 5% above or below rated voltage.

F. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to the single phase or three-phase fault at approximately 300% of rated current for not more than 10 seconds.

G. The generator set shall meet all requirements for NFPA 110 Level 1 systems. Level 1 prototype tests required by this standard shall have been performed on a complete and functional unit; component level type tests will not substitute for this requirement.

H. The engine generator unit shall be listed to meet UL 2200 or submit to an independent third party certification process to verify compliance as installed.

2.3 VOLTAGE REGULATION

A. Furnish generator-mounted volts per hertz exciter-regulator to match engine and generator characteristics, with voltage regulation plus or minus 1 percent from no load to full load. Furnish manual controls to adjust voltage droop, voltage level (plus or minus 5 percent) and voltage gain.

2.4 GOVERNOR

A. Product Description: Electronic Isochronous governor to maintain engine speed within 0.5 percent, steady state, and 5 percent, no load to full load, with recovery to steady state within 2 seconds following sudden load changes. Equip governor with means for manual operation and adjustment.

2.5 ENGINE GENERATOR SET CONTROL

A. Product Description: Microprocessor-based digital control system, designed to provide governing, voltage regulation, metering, protective relaying, automatic starting, monitoring, and control functions for the generator unit.

B. Control System shall be designed to allow local monitoring and control of the generator unit and remote monitoring and control as described in these specifications.

C. Control system shall be mounted on the generator unit. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration condition encountered. The controls shall be UL508 labeled, CSA282-M1989 certified, and meet IEC8528 part 4. The control, including all control, monitoring and protective functions, shall meet or exceed the requirements of Mil-Std 461C part 9, and IEC Std. 801.2, 801.3 and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions. The entire control shall be tested and meet the requirements of IEEE 587 for voltage surge resistance. Manufacturers utilizing components that have not been tested as a system, as installed, (as demonstrated by a statement of performance on standard published literature) shall conduct RFI/EMI testing on the equipment in the manufacturer's facility prior to shipping the equipment to the project job site. Voltage surge testing shall be performed on an identical prototype unit.

D. Control voltage shall be 12 or 24 volts DC. Control system shall withstand DC surge voltage produced by the battery-charging alternator operating at full load when the battery bank is disconnected. Generator set governing, voltage regulation, protection, and control equipment shall be capable of proper operation within the typical battery voltage levels.

E. All switches, lamps and meters shall be oil-tight and dust-tight, and the enclosure door shall be gasketed.

F. All switches shall be provided with fully illuminated backlit labels, and all metering shall be individually lighted to allow for easy reading of functions in a completely dark room.

G. All adjustments to the control system shall be made from the front of the generator set control panel, with the aid of a digital readout display integral to the equipment. No rotary pots shall be acceptable for any function of the control system provided for the generator set.

H. Control equipment shall contain a system of diagnostic LEDs to assist in analyzing proper system function.

I. The entire generator set control system as supplied shall be capable of being directly monitored and controlled by a personal computer connected to the control for monitoring, diagnosis, service, and adjustment of the system via an RS232 port on the control.

J. The generator set mounted control shall include the following features and functions:
   1. Three- (3) position selector switch or independent pushbuttons labeled RUN/OFF/AUTO. In the RUN position the generator shall automatically start, and accelerate to rated speed and voltage. In the OFF position the generator shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
   2. Red "mushroom-head" push-button EMERGENCY STOP switch. Depressing the emergency stop switch shall cause the generator set to immediately shut down and be locked out from automatic restarting. Reset of the control shall require reset of the emergency stop switch and the control system.

3. Pushbutton RESET switch. The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.
4. Push-button PANEL LAMP switch. Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power. The panel lamps shall automatically be switched off several minutes after the switch is depressed or after the switch is depressed a second time. Lamps shall be LED type.
5. Push-button LAMP TEST switch. Depressing the lamp test switch shall cause all the alarm and status lamps on the panel to be lighted, and cause the digital display panel to sequentially display all the alarm and status messages in the control system.

K. Emergency Generator Control Panel shall be NEMA 250, Type 1 generator-mounted control panel enclosure with engine and generator controls and indicators. Furnish provision for padlock and the following equipment features:
   1. Frequency Meter: 45-65 Hz range, digital display preferred (or 3.5-inch dial).
   2. AC Output Voltmeter: digital display preferred (or 3.5-inch dial), 2 percent accuracy, with phase selector switch.
   3. AC Output Ammeter: digital display preferred (or 3.5-inch dial), 2 percent accuracy, with phase selector switch.
   4. Output voltage adjustment.
   5. Push-to-test indicator lamps, one each for low oil pressure, high water temperature, over speed, and over crank.
   6. Engine Start/Stop selector switch or pushbuttons.
   7. Engine running time meter.
   8. Oil pressure gauge.
   9. Water temperature gauge.
   10. Auxiliary Relay: Three Pole Double Throw (3-PDT) operates when engine runs with contact terminals pre-wired to terminal strip.
   11. Additional visual indicators and alarms in accordance with by NFPA 110.
   12. Remote Alarm Contacts: Factory-wired SPDT contacts to terminal strip for extending each alarm function to a Control Panel or PLC for remote indication, in accordance with NFPA 110.
   13. High Battery voltage alarm.
   14. Low Battery voltage alarm.
   15. System ready.
   16. Anticipatory high water temperature.
   17. Anticipatory low oil pressure.
   18. Low coolant temperature.
   19. Switch in Off Position alarm.
   20. Over crank alarm.
   21. Emergency Stop alarm.
   22. High Water temperature alarm.
   23. Over speed alarm.
   24. Low Oil Pressure alarm.
   25. Line power available.
   26. Generator power available.
   27. Lamp test and horn silence switch.

L. Alarms: Provide wiring and conduit between ATS and engine-generator alarm points for a complete operating system. Provide display windows with 3/8-inch engraved

black letters on white background for each annunciated alarm. Provide at least one spare blank window for future use.

1. Engine Run
2. Engine Trouble
3. Engine Over speed shutdown
4. All other critical shut down function as recommended by the EG unit manufacturer
5. Spares

2.6 GENERATOR SET REMOTE ANNUNCIATOR PANEL

A. The generator set shall be connected to a manufacturer recommended or supplied remote annunciator panel with the following features at a minimum:
   1. Control:
      a. Manual Start / Stop
   2. Monitoring:
      a. Running / Ready
      b. General Failure
      c. High Temp
   3. Alarm:
      a. High Temp
      b. General Failure

B. Power Source: 120-VAC.

2.7 GENERATOR SET AND ENGINE CONTROL FUNCTIONS

A. The control system provided shall include cycle cranking system, which allows for user selected crank time, rest time, and number of cycles. Initial setting shall be 3 cranking periods of 15 seconds each, with 15 second rest period between cranking periods.

B. The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled and the engine protection parameters for engine oil pressure and engine temperature shall be reduced to proper levels to reflect the lower engine operating speed.

C. The control system shall include the engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification.

D. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit the exhaust smoke while the unit is starting. The control system shall automatically adjust governor gain and stability settings to compensate for engine performance variation related to engine temperature.

E. The control system shall include time delay start (adjustable 0-100 seconds) and time delay stop (adjustable 0-30 minutes) functions. Indicators shall be provided to reflect that the time delays are in operation, and the time remaining for completion of the time delay period.

F. The starting control logic shall check for engine rotation at each signal for the engine starter to run. If the engine rotation is not present when the starter is operating, a "fail to crank" alarm and shutdown shall be indicated on the generator set control panel.

G. The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature that is capable of discriminating between failed sender or wiring components, and an actual engine failure conditions.

H. Generator set start contacts shall be rated 10 amps at 32 VDC.

I. A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is outside manufacturer specified tolerances. During engine starting, the low voltage limit shall be disabled, and the system shall conduct a battery capacity test. A 'weak battery" alarm shall be initiated if the starting/control battery does not pass this test.

2.8 ACCESSORIES

A. Exhaust Silencer: Critical-type silencer, with muffler companion flanges and flexible stainless steel exhaust fitting, sized in accordance with engine manufacturer's instructions. Maximum noise level allowed is 70 dBA at 23 feet.

B. Metal Roof Thimble: Where unit is installed indoors, provide ventilated metal thimble for all high temperature (greater than 100 degrees C) wall, ceiling and roof penetrations.

C. Batteries: Heavy-duty, deep cycle gel pack/absorption glass-mat (AGM) type storage batteries, 12 or 24 volts, sized as recommended by the engine-generator manufacturer. Match battery voltage to starting system. Furnish cables and clamps.

D. Battery Tray: Treated for electrolyte resistance; constructed to contain spillage.

E. Battery Charger: Solid state to operate with type of batteries furnished. Current limiting type designed to float at 2.17 volts for each cell and equalize at 2.33 volts for each cell. Furnish overload protection, full wave rectifier, DC voltmeter and ammeter, and fused input. Furnish enclosure to meet NEMA 250, Type 1 requirements, or furnish as an internal component of the ATS. Provide 20-amp 120-volt power circuit, including conduit and wire, from nearest available panelboard.

F. Line Circuit Breaker: NEMA AB 1, molded case circuit breaker on generator output with integral thermal and instantaneous magnetic trip in each pole. Furnish battery voltage operated shunt trip, connected to open circuit breaker on engine failure. Unit mount in enclosure to meet NEMA 250, Type 1 requirements.

2.9 SOURCE QUALITY CONTROL

A. Provide shop inspection and testing of completed assembly.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install engraved plastic nameplates in accordance with these Specifications.

B. Ground and bond generator and other electrical system components in accordance with these Specifications.

C. Provide Emergency Shutdown procedure and post in a conspicuous location near the engine. Procedure shall indicate location(s) of fuel shutoff valve(s).

3.2 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, Section 7.22 as follows:
   1. Visual and Mechanical Inspection
   2. Compare equipment nameplate data with drawings and specifications.
   3. Inspect physical and mechanical condition.
   4. Inspect correct anchorage and grounding.

B. Electrical and Mechanical Tests
   1. Perform an insulation-resistance test on generator winding with respect to ground in accordance with ANSI/IEEE Standard 43.
   2. Perform phase-rotation test to determine compatibility with load requirements.
   3. Functionally test engine shutdown for low oil pressure, over-temperature, over-speed, and other features as applicable.
   4. Conduct performance test in accordance with ANSI/NFPA Standard 110, Section 5-13 (Installation Acceptance).
   5. Verify correct functioning of governor and regulator.
   6. Inspect and test fuel piping according to NFPA 58 "Testing" Paragraph.
   7. Repair leaks and defects with new materials, and retest system until satisfactory results are obtained.
   8. Test and adjust controls and safeties
   9. Test Values
      a. Performance tests shall conform to manufacturer's published data and ANSI/NFPA Standard 110.

3.3 MANUFACTURER'S FIELD SERVICES

A. Inform Owner of the date and time (a minimum of 14 days in advance) and allow the Owner to witness all field testing and commissioning.

B. Engage the services of a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections, and to assist in testing. Report results in writing.

C. Testing:
   1. Perform field quality control testing under the supervision of the manufacturer's factory-authorized service representative.
   2. Installer shall provide fuel and lubricating oil for all testing as noted above.

3. Installer shall provide a full tank of LPG fuel at the completion and acceptance of testing.

D. Tests: Include the following:
   1. Tests recommended by manufacturer.
   2. Adjust generator output voltage and engine speed to meet specified ratings.
   3. International Electrical Testing Association Tests: Perform each visual and mechanical inspection, and electrical and mechanical test stated in NETA ATS for engine-generator sets, except omit vibration baseline test. Certify compliance with test parameters for tests performed.
   4. NFPA 110 Acceptance Tests: Perform Single-step full-load pickup test.
   5. Exhaust-System Backpressure Test: Use a manometer with a scale exceeding 40 inches water gauge (120 kPa). Connect to exhaust line close to engine exhaust manifold. Verify that backpressure at full-rated load is within manufacturer's written allowable limits for the engine.
   6. Exhaust Emissions Test: Comply with applicable government test criteria.

E. Coordinate tests for engine-generator with tests for automatic transfer switch, and run them concurrently. Run complete electrical test, including, but not limited to, automatic transfer switch and generator control panel to ensure proper automatic Start-Stop operation. Coordinate testing with Automatic Transfer Switch field service representative.

F. Retest: Correct deficiencies identified by tests and observations, and retest until specified requirements are met.

G. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests. Provide certified copies of field tests approved and signed by the authorized service representative.

3.4 DEMONSTRATION AND TRAINING

A. Provide four (4) hours of training and instruction for at least four persons, to be conducted at project site with manufacturer's certified field service representative. Instruction shall include handouts to all trainees, procedures for the proper operation, adjustments and maintenance of the engine-generator system.

B. Simulate operation of the engine-generator in manual mode, test mode and causing a power outage by interrupting normal source, and demonstrate that system operates to provide engine- power.

3.5 CLEANING

A. Clean engine and generator surfaces. Replace oil and fuel filters with new filters after unit testing and prior to acceptance of the project.

B. On completion of installation, inspect system components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

Clean components internally using methods and materials recommended by manufacturer.

END OF SECTION

SECTION 26 36 00

TRANSFER SWITCHES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes automatic transfer switches in individual enclosures.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCES - CODES AND STANDARDS

A. NEMA ICS 6 Enclosures.

B. NEMA ICS 10 AC Transfer Switch Equipment.

C. NFPA 110 Emergency Standby Power Systems.

D. NFPA 70 National Electrical Code.

E. NETA ATS (International Electrical Testing Association) – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

F. UL 1008 Automatic Transfer Switches.

1.4 SUBMITTALS

A. Product Data: Submit catalog sheets showing voltage, switch size, ratings and size of switching and overcurrent protective devices, operating logic, short- circuit ratings, dimensions, and enclosure details.

B. Test Reports: Provide five (5) copies of results of manufacturer’s certification of performance testing.

C. Manufacturer’s Field Report: Indicate inspections, findings, and recommendations.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit instructions and service manuals for normal operation and routine maintenance. List special tools, maintenance materials, and replacement parts.

B. Manufacturer’s Field Report: Indicate inspections, findings, performance and recommendations.

1.6 QUALIFICATIONS

A. Manufacturer: Company shall specialize in manufacturing the products specified in this section with minimum five (5) years' experience and with service facilities within 50 miles of project site.

B. Supplier: Authorized distributor of specified manufacturer with minimum five (5) experience.

1.7 MAINTENANCE SERVICE

A. Provide service and maintenance (parts and labor) for a period of two (2) year from Date of Substantial Completion.

1.8 WARRANTY

A. Furnish two (2) year manufacturer's warranty from date of substantial completion for defective parts and labor to install the part.

PART 2 PRODUCTS

2.1 AUTOMATIC TRANSFER SWITCH

A. Product Description: NEMA ICS 10, automatic transfer switch suitable for use in standby systems as described in NFPA 70 and shall conform to NFPA 110. Manual operator conforming to UL 1008 shall be provided and switch shall be designed for safe operations under full load conditions.

B. The transfer switch shall be double throw construction, positively electrically and mechanically interlocked to prevent simultaneous closing and mechanically held in both normal and emergency positions. Independent break before make action shall be used to positively prevent dangerous source to source connections. The transfer switch shall be approved for manual operation.

C. The transfer switch electrical actuator shall have an independent disconnect means to disable the electrical operation during manual switching.

D. Rating: Voltage and current rating shall be as indicated on drawings, continuous duty, three (3) poles with solid neutral. Neutral continuous current rating shall not be less than twice the rating of the phase contacts. Power switch contacts shall be rated at 600 VAC.

E. Interrupting Capacity: 100 percent of continuous rating.

F. Withstand Current Rating: 65,000 RMS symmetrical amperes when used with molded case circuit breaker. Contacts shall be non-welding when used with upstream feeder overcurrent device of available fault current specified.

G. Service Conditions: NEMA ICS 10
   1. Temperature: -30 to +50 degrees C
   2. Relative Humidity: up to 95 percent

3. Altitude: 50 feet (15 meters) above sea level

H. Product Features
   1. Indicating Lights: Mount on front panel of switchboard to indicate NORMAL SOURCE AVAILABLE / UTILITY, ALTERNATE SOURCE AVAILABLE / STANDBY, and EMERGENCY.
   2. Provide LED status lights for: utility on, engine warm-up, standby ready, transfer to standby, in phase monitor, time delay neutral, return to utility, engine cool down and engine minimum run.
   3. Test Switch: Mount on front panel of switchboard to simulate failure of normal source.
   4. Provide manual operating handle to allow for manual transfer. This handle must be mounted inside the lockable enclosure so accessible only by authorized personnel.
   5. Provide a maintenance disconnect switch to prevent load transfer and automatic engine start while performing maintenance. This switch will also be used for manual transfer switch operation.
   6. Return to Normal Switch Mount on front panel of switchboard to initiate manual transfer from alternate source to normal source.
   7. Auxiliary Contacts: Provide the following discrete output signals, rated at no less than 10 amps at 120 volts, 60 Hz.
      a. Loss of utility power
      b. Preferred source active
      c. Alternate source active
      d. Any additional control signals as required to control a standby engine generator and as indicated on drawings.
   8. Preferred Source Monitor / Under voltage sensor: Monitor normal source voltage and frequency; initiate transfer when voltage drops below 70-95% (user adjustable) percent or frequency varies more than 10-20% (user adjustable) percent from rated nominal value.
   9. Alternate Source Monitor: Monitor alternate source voltage and frequency. Inhibit transfer when voltage is below 85 percent or frequency varies more than 3 percent from rated nominal value.
   10. In-Phase Monitor: Inhibit transfer until source and load are within 20 electrical degrees.
   11. Time Delay to Start Alternate Source Engine Generator: 0 to 10 seconds, adjustable and factory set at 1 second.
   12. Time Delay before Transfer to Alternate Power Source: 5 to 180 seconds, adjustable, and factory set at 5 seconds.
   13. Time Delay before Transfer to Normal Power: 1 to 30 minutes, adjustable; and factory set at 5 minutes. Time delay shall be automatically defeated in the event of alternate source failure, provide normal source is available.
   14. Engine Minimum run timer: 5 to 30 minutes, adjustable, of unloaded operation factory set at 10 minutes.
   15. Engine Exerciser: Provide a generator exerciser timer. Run times shall be user programmable. The exerciser shall be selectable between load transfer and engine run only and shall have a fail-safe feature that will retransfer the switch to preferred source during exercise period. Bypass exerciser control when normal source fails during exercising.
   16. Alternate System Exerciser: Transfer load to alternate source during engine exercising period.

I. Enclosure
   1. Indoor enclosure shall be NEMA 1, with front door to provide easy access to the internal panel door and devices.
   2. Provide adequate space for conduit entry from the top, termination of control cable, device wiring and raceway.
   3. Protective barrier shall be provides to prevent accidental contact with current carrying components (120-volt).
   4. All control equipment shall be mounted on the inside of the cabinet door in a metal lockable enclosure with transparent safety shield to protect all solid state circuit boards. Control boards shall have installed cover plates to avoid shock hazard while making control adjustments. The solid state voltage sensors and time delay modules shall be plug-in circuit boards with silver or gold contacts for ease of service.

J. Finish
   1. Manufacturer's standard coating on external surfaces. Coat internal surfaces with a minimum of one coat of corrosion-resistant paint, or plate with cadmium or zinc.

PART 3 EXECUTION

3.1 INSTALLATION

A. Switch shall be installed in accordance with approved manufacturer's instructions.

3.2 MANUFACTURER'S FIELD SERVICES

A. Engage the services of a qualified factory-authorized service representative to inspect field-assembled components and equipment installation, including commissioning, start-up demonstration and training, and to assist in Field Quality Control inspection and testing.
   1. Check out transfer switch connections and operations, and place in service.
   2. Adjust control and sensing devices to achieve specified sequence of operation.

B. Following completion of switch installation and after making proper adjustments and settings, site tests shall be performed to demonstrate that the switch function as specified.

3.3 FIELD QUALITY CONTROL

A. Field inspection and testing shall be performed under provisions of NETA ATS section 7.22 (3) – Automatic Transfer Switches, Emergency Systems, as follows:
   1. Visual and Mechanical Inspection
      a. Compare equipment nameplate data with drawings and specifications.
      b. Inspect physical and mechanical condition.
      c. Confirm correct application of manufacturer's recommended lubricants.
      d. Verify that manual transfer warnings are attached and visible.
      e. Verify tightness of all control connections.
      f. Inspect all bolted electrical connections for high resistance using one of the following methods:

1) Use of low-resistance ohmmeter in accordance with Section 7.22.3.2 (Electrical Tests).
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 10.12.

g. Perform manual transfer operation.
h. Verify positive mechanical interlocking between normal and alternate sources.

2. Electrical Tests
   a. Perform a contact-resistance test.
   b. Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable, in accordance with NETA ATS Section 7.22.3.1 (Visual and Mechanical Inspection).
   c. Perform insulation-resistance on each pole, phase-to-phase and phase-to-ground with switch closed and across each open pole for one minute. Perform tests in both source positions. Test voltage shall be in accordance with manufacturer's published data or NETA ATS Table 10.1.
   d. Calculate polarization index.
   e. Verify settings and operation of control devices.
   f. Calibrate and set all relays and timers in accordance with NETA ATS Section 7.9.
   g. Perform automatic transfer tests:
      1) Simulate loss of normal power.
      2) Return to normal power.
      3) Simulate loss of emergency power.
      4) Simulate all forms of single-phase conditions.
   h. Verify correct operation and timing of the following functions:
      1) Normal source voltage-sensing relays.
      2) Engine start sequence.
      3) Time delay upon transfer.
      4) Alternate source voltage-sensing relays.
      5) Automatic transfer operation.
      6) Interlocks and limit switch function.
      7) Time delay and retransfer upon normal power restoration.
      8) Engine cool down and shutdown feature.
3. Test Values
   a. Compare bolted connection resistance to values of similar connections.
   b. Bolt-torque levels should be in accordance with Table 10.12 unless otherwise specified by manufacturer.
   c. Minimum insulation-resistance shall be in accordance with manufacturer's published data or Table 10.1.
   d. Micro-ohm or milli-volt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from similar connections by more than 50 percent of the lowest value.

3.4 DEMONSTRATION AND TRAINING

A. Furnish four (4) hours of instruction for two (2) persons, to be conducted at project site with manufacturer's field service representative. Instruction shall include handouts to all trainees describing the procedures for the proper operation,

adjustment and maintenance of the automatic transfer switch. Use approved O&M manuals.

B. Demonstrate operation of transfer switch in normal and emergency modes.

C. Simulate power outage by interrupting the normal source, and demonstrate that system operates to provide emergency power. Coordinate testing and training to coincide with the engine-generator unit testing and training.

END OF SECTION

SECTION 26 51 00

LIGHTING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Interior lighting fixtures, lamps, ballasts, hangars, trim and diffusers.

B. Exterior lighting fixtures, lamps, ballasts, and poles.

C. Supports, suspension systems, and blocking.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCES

A. ANSI C78.379 - Electric Lamps - Classification of the Beam Patterns of Reflector Lamps.

B. ANSI C82.1 - Line Frequency Fluorescent Lamp Ballast.

C. ANSI C82.5 - Reference Ballasts - High-Intensity Discharge and Low Pressure Sodium Lamps

D. ANSI/NFPA 101 - Life Safety Code.

E. International Electrotechnical Commission (IEC)
   1. IEC 801-2 Electrostatic Discharge Testing Standard.
   2. IEC/EN 60669-2-1 Switches for household and similar fixed electrical installations - electronic switches.

F. Illuminating Engineering Society of North America (IESNA)
   1. LM-79 – Electrical and Photometric Measurements of Solid State Lighting Products.
   2. LM-80 – Measuring Lumen Maintenance of LED Light Sources.

G. National Electrical Manufacturer’s Association (NEMA) SSL-1 – Electronic Drivers for LED Devices, Arrays, or Systems.

H. Underwriters Laboratories, Inc. (UL) 8750 – Light Emitting Diode (LED) Light Sources for Use in Lighting Products

1.4 SUBMITTALS

A. Product Data
   1. Light fixtures.
   2. Lamps.

3. Ballasts.

1.5 EXTRA MATERIALS

A. LED Fixtures
   1. Provide 5 percent or two, whichever is greater, of each complete interior LED fixture type for Owner stock for future replacement. Provide only one extra fixture where fixture is listed for use in a hazardous classified environment.
   2. Provide one of each complete exterior LED wall or pole mount fixture for Owner stock for future replacement.

B. Other Fixtures
   1. Provide 10 percent or four, whichever is greater, of each type of tempered glass lens.
   2. Provide 5 percent or two, whichever is greater of each plastic and other security lens type.
   3. Provide 10 percent or one case, whichever is greater, replacement lamp for each lamp installed.
   4. Provide 5 percent or two, whichever is greater, of each ballast type.

1.6 WARRANTEE

A. Fixtures and ballasts shall have a minimum five year warrantee.

PART 2 PRODUCTS

2.1 LIGHT FIXTURES – GENERAL

A. Provide lighting fixtures, lamps, ballasts and accessories complete and ready for operation. Furnish the fixtures as indicated on the Drawings and as listed in the fixture schedule. Verify in all cases, the lengths and quantity of fixtures necessary to achieve the indicated results.

B. All lighting fixtures shall have published photometric tests conducted by Electrical Testing Laboratories. Make available the test results upon request. Testing shall include candlepower distribution curves, total fixture efficiency, brightness and shielding angles in longitudinal and transverse directions.

C. Provide lighting fixtures in the finishes and colors as noted on the Drawings.

D. Provide the UL and IBEW labels on all lighting fixtures.

E. Observe the requirements of the CBC Section 2606 regarding plastic lighting diffusers. Fixtures and auxiliary equipment mounted against combustible material shall be approved for such installation.

F. Make-up fixtures with Type AF or equal fixture wire. Provide an identified, approved landing lug for equipment ground wires.

2.2 LED LIGHT FIXTURES

A. General
1. LED light fixtures shall be in accordance with IES, NFPA, UL, as shown on the drawings, and as specified.
2. LED light fixtures shall be a factory assembled luminaire including all required driver and light engine modules integral to and within a single houseing. Lead lengths between driver and light engine shall not exceed 3 feet. Remote luminaire/driver installations are not acceptable.
3. LED light fixtures shall be Reduction of Hazardous Substances (RoHS) compliant.

B. LED Driver Modules
1. Description: Universal voltage switching-mode LED driver module with a rated lifetime of not less than 50,000 hours when operated at an ambient temperature of less than 60-degrees C.
2. LED drivers shall include native 0-10V dimming capabilities without additional control devices or field-installed circuitry. Integral short-circuit, open-circuit and overload fault protection to prevent driver failure.
3. LED drivers shall be capable of producing adequate output current to produce the specified light levels. Compatibility of driver and LED light engine must be tested and ensured by driver manufacturer.
4. Minimum efficiency: 85% at full load.
5. Minimum Operating Ambient Temperature: -20° C (-4° F).
6. Input Voltage: 120V to 277V (±10%) AC at 60Hz. Drivers that require DC input shall include an integral converter that accepts standard line voltage AC.
7. Power Factor: ≥ 0.95.
8. Total Harmonic Distortion: ≤ 20% and meet ANSI C82.11 maximum allowable THD requirements
9. Designed and tested to withstand electrostatic discharges up to 15,000 V without impairment per IEC 801-2.
10. Electrolytic capacitors to operate at least 20 degrees C below the capacitor's maximum temperature rating when the driver is under fully-loaded conditions and case temperature is 62 degrees C.
11. Maximum inrush current of 2 amperes for 120-Volt and 277-Volt drivers.
12. Withstand up to a 4,000 volt surge without impairment of performance as defined by ANSI C62.41 Category A.
13. Inaudible in a 27 dBA ambient.

C. LED Light Engine Modules
1. Minimum CRI: 80.
2. Color Temperature: 3500K, unless otherwise noted.
3. Minimum Rated Life: 50,000 hours as per LM79.

2.3 FLUORESCENT AND HID LIGHTING FIXTURES

A. Equip fluorescent fixtures with CBM-ETL labeled ballasts provided with internally mounted automatic reset thermal protectors and silver plated sockets.

B. Lenses, reflectors, and trim

1. Provide specialty lenses and frames such as Holophane type low glare lenses as indicated on the lighting fixture schedule. Verify that the fixture frames and trims are designed to function with the selected lens and the particular mounting conditions.
2. Provide substantial light sealing and separation between individual lamp rows in the louver assemblies of 3-lamp recessed parabolic fluorescent fixtures. This shall be accomplished by the provisioning of ballast compartment covers between cells even if no ballasts are contained therein.
3. Tempered Glass Lenses: Clear tempered glass, free from edge defects. Lenses must be held in place with a full compression plate, with no metal to glass contact.

C. Lamps
   1. Fluorescent lamps
      a. The contractor shall provide written or photographic documentation that the lamps specified below are used on the project (for LEED compliance requirements). Documents may include but are not limited to: Purchase receipts, photos of the product packaging onsite, or invoices.
      b. All fluorescent lamps shall be low mercury, Federal EPA TCLP compliant, extended life lamps.
      c. T-8 fluorescent lamps shall be extended performance, 3500 Kelvin, 86 CRI color rendering, long-life 36,000 hrs @ 3 hrs/start, GE Ecolux XL SPX lamps.
      d. T-5 fluorescent lamps shall be extended performance, 3500 Kelvin, 85 CRI color rendering, long-life 30,000 hrs @ 3 hrs/start, GE Starcoat Ecolux High output lamps
      e. Compact fluorescent lamps shall be low mercury, 3500 Kelvin, 82 CRI color rendering, 10,000 hrs @ 3 hrs/start, Philips “ALTO PL-T,” or Sylvania “DULUX ECOLOGIC.”
      f. Provide 4100 Kelvin, tri-phosphor, energy saving, slim-line or high output fluorescent lamps where lamps longer than four feet long are specified.
      g. Furnish all fluorescent lamps of the same type, throughout the Project, from the same manufacturer.
   2. High intensity discharge (HID) lamps
      a. All HID lamps shall be mercury and lead free, Federal EPA TCLP compliant, ECO lamps.
      b. Provide clear high pressure sodium lamps, Sylvania “LUMALUX Mercury Free /ECO.”
      c. Exterior metal halide lamps shall be clear, unless otherwise noted.
      d. Interior metal halide lamps shall be coated, unless otherwise noted.
      e. Furnish all HID lamps of a particular type throughout the Project from the same manufacturer.
   3. Incandescent lamps
      a. Provide 130 volt rated, long service life lamps.
      b. Lamps shall be A-21, frosted type, in wattage as indicated.

D. Electronic Ballasts
   1. Manufacturers
      a. Valmont.
      b. Advance.
      c. Universal.
   2. Provide fully electronic or hybrid style ballasts.

3. Power factor shall be greater than .85.
4. Ballast factor shall be greater than .87.
5. Total harmonic distortion (THD) shall not exceed: 20% for a four foot fluorescent ballast or 32% for an eight foot fluorescent ballast.
6. Provide UL listed ballasts that meet applicable California Energy Commission requirements.
7. Ballasts must be of the rapid start type; instant start is not acceptable.
8. Acceptable manufacturer: Magnetek, Motorola, or Approved Equal.

E. Dimming Ballasts
1. Manufacturers
   a. Valmont.
   b. Advance.
   c. Universal.
2. Description: ANSI C82.1, high power factor type electronic dimming ballast, ETL approved, UL labeled P.
3. Protected with two internal automatic resetting thermal switch devices for coil and capacitor.
4. Sound Level: ‘A’ for 430-MA or less lamps ‘B’ for 800-ma lamps and ‘C’ for 1,500-MA lamps. Stamp rating on ballast.
5. Provide low temperature ballasts where installed in non-conditioned spaces. Ballasts must operate to 0 degrees F.
6. Provide ballast suitable for lamps specified.
7. Voltage: Match luminaire voltage.
8. Source Quality Control: Certify ballast design and construction by Certified Ballast Manufacturers, Inc.
9. Comply with California Title 24 energy requirements.
10. Electronic ballasts must be provided within lighting fixtures as follows:
    a. 1 Lamp Fixture: 1 lamp ballast.
    b. 2 Lamp Fixture: 2 lamp ballast.
    c. 3 Lamp Fixture: 3 lamp ballast or tandem wiring for 3 lamps.
    d. 4 Lamp Fixture: 4 lamp ballast or two 2 lamp ballast.

F. Rapid Start Fluorescent Ballasts
1. Energy saving type, class P, CBM certified,
2. Ballasts shall have an "A" sound rating.
3. Acceptable manufacturers: Universal, Advance, Valmont, or Approved Equal.
4. Provide zero degree ballasts where used in exterior fixtures.

G. HID Ballasts
1. Description: Metal halide or high pressure sodium lamp ballast that satisfy specifications within ANSI C82.5
2. Lead peaked constant wattage auto transformer, quiet-type encased and potted.
3. Provide ballast suitable for lamp specified.
4. Voltage: Match luminaire voltage.
5. UL approved high power factor.
6. Exterior Fixtures: Equipped with ballasts designed for low temperature starting.

PART 3 EXECUTION

3.1 GENERAL

A. Install fixtures in straight, true lines and without visible gaps between fixtures and building surfaces and between fixtures in continuous rows. For linear wall mounted fixtures, ensure that the wall surface is finished flat, straight, and free of imperfections prior to mounting the fixtures. Replace or repair lighting fixture installations that are out of plumb or that have obvious gaps or misalignment.

B. Provide fixtures with the appropriate trim frames, flanges, canopies, and finish accessories to accommodate the ceiling conditions. Prior to ordering fixtures, and throughout the Project, verify the exact ceiling types, finishes, and thicknesses and coordinate the fixture installation therewith.

C. Refer to the Drawings, particularly the architectural elevations and reflected ceiling plans, in determining the exact mounting location and height of lighting fixtures. For wall mounted or suspended fixtures that do not have the mounting heights clearly indicated, contact the Owner for clarification prior to ordering pendants and installing the fixtures.

D. Following installation of HID and fluorescent lighting fixtures, and prior to completion of the Project, perform a burn in test of the lights. The burn in test shall consist of operating the fixtures continuously for a minimum of forty-eight (48) hours. Replace lamps that are inoperative or that show signs of flicker or color wander. If building power is not available for the burn in test, then provide a portable generator, fuel, and temporary connections for the stipulated period.

E. Provide final touchup painting to repair fixture finishes which are nicked or marred during installation. Obtain the paint from the fixture manufacturer.

3.2 AUDIBILITY

A. Fixtures shall be free from any undesirable hum, vibration, or noise. Provide lighting equipment suitable for the intended ambient sound levels. Where necessary to meet this criteria, provide additional means of sound deadening, whether or not specifically indicated. Fixtures that are found to be unsatisfactory in the opinion of the Owner shall be removed and replaced at the Contractor’s expense.

3.3 SUPPORTS AND BLOCKING

A. Provide hangers, suspension cables, and blocking for lighting fixtures that will provide support independent of suspended ceilings, ceiling or wall surfaces, and electrical outlet boxes. Exception: Fixtures less than 12 inches in all dimensions and weighing less than six pounds may be permitted to be supported from the electrical outlet box if the box itself is independently supported by blocking or hangars.

B. Refer to the Drawings for specific blocking details and seismic mounting details for lighting fixtures.

3.4 EXTERIOR POLE MOUNTED FIXTURES AND BOLLARDS

A. Provide pole base footings in accordance with the Drawings. Footings shall be reinforced concrete with anchor bolts sized and located in accordance with the manufacturer's recommendations for the geographic locality. Provide reinforced concrete in accordance with the requirements as stipulated elsewhere in these Specifications. Forms for pole bases shall be placed using resin-lined Sonotube concrete forms or Approved Equal to give a smooth finished appearance. Patch and sack cracks and voids in the bases to match the surrounding surface.

B. Verify the exact location of underground facilities in the vicinity of pole bases prior to boring holes and bring potential conflicts to the attention of Owner. Use an anchor bolt template as provided by the manufacturer for the placement of anchor bolts and substantially brace the forms to ensure that the base remains straight and plumb. Refer to the Drawings for fixture orientation and alignment, and utilize a transit site or snap line to verify same.

C. Exposed surfaces of concrete bases or footing shall be finished smooth without cracks, voids, or jagged edges. Chamfer and float the base after pouring concrete to achieve a finished appearance. In order to allow leveling of the pole, install the pole base-plate one inch above the top of the concrete footing. Level the pole plumb and pack the space under the base-plate with Embeco dry pack grout.

D. For fixtures with adjustable aiming or reflectors, arrange to perform a final adjustment of aiming at night under the direction of Owner.

3.5 OBSTRUCTIONS

A. Verify throughout the Project that mounting locations and suspension systems remain free of obstructions. Suspended or pendant mounted fixtures must be free to swing 45 degrees in all directions without hitting obstructions or other fixtures. Provide seismic rated swivel ball hangars for pendant mounted lighting fixtures to achieve the proper swing.

END OF SECTION

SECTION 31 05 13

SOILS FOR EARTHWORK

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Subsoil materials.
   2. Topsoil materials.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCES

A. American Association of State Highway and Transportation Officials:
   1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM International:
   1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
   3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).
   4. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Submit test data for controlled fill and select fill.

1.5 QUALITY ASSURANCE

A. Furnish each subsoil and topsoil material from single source throughout the Work.

B. Perform Work in accordance with Caltrans Standard Plans.

PART 2 PRODUCTS

2.1 SUBSOIL MATERIALS

A. Select Fill:

1. On-site excavated and re-used material or Imported graded limestone or coral sand and gravel.
2. Free of lumps and rocks larger than 4 inches, and debris.
3. A maximum of 25% fines passing the No. 200 mesh sieve.
4. Conforming to ASTM D2487 Group Symbol GM or GC.
5. Contractor may use crushed concrete passing a 1” screen.

2.2 TOPSOIL MATERIALS

A. Topsoil:
   1. Topsoil material scraped from excavation areas and passing a 1” screen with characteristics similar to other materials listed in this section.
   2. Sandy loam.
   3. Reasonably free of roots, rocks larger than 1 inch, subsoil, debris, large weeds, and foreign matter.
   4. Acidity range (pH) of 5.5 to 7.5.
   5. Containing minimum of 4 percent and maximum of 25 percent inorganic matter.

2.3 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Testing and Inspection Services for Testing and analysis of soil material.

B. Testing and Analysis of Subsoil Material: Perform in accordance with ASTM D698. ASTM C136.

C. When tests indicate materials do not meet specified requirements, change material and retest.

D. Furnish materials of each type from same source throughout the Work.

E. Testing frequency shall be one test for every 500 cubic yards of each type of imported soil.

PART 3 EXECUTION

3.1 EXCAVATION

A. Excavate subsoil from areas designated. Strip topsoil to full depth of topsoil in designated areas.

B. Stockpile excavated material meeting requirements for subsoil materials.

C. Remove excess excavated materials not intended for reuse, from site.

D. Remove excavated materials not meeting requirements for subsoil materials from site.

3.2 STOCKPILING

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

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

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

3.3 STOCKPILE CLEANUP

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

B. Remove all debris from the site and leave the site in a neat and orderly condition.

C. The Contractor shall handle and dispose of unsuitable and excess material legally, at refuse facility outside the Project site.

D. All salvaged material remains the property of the Owner and shall be stockpiled by the Contractor where directed by the Engineer.

END OF SECTION

SECTION 31 05 16

AGGREGATES FOR EARTHWORK

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Coarse aggregate materials.
   2. Fine aggregate materials.
   3. Aggregate drain rock.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCES

A. American Association of State Highway and Transportation Officials:
   1. AASHTO M147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses.
   2. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 10-lb Rammer and a 18-in. Drop.
   3. AASHTO T210 – Standard Method of Test for Aggregate Durability Index.

B. ASTM International:
   1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3).
   3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3).
   4. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
   5. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Submit name of imported fill material suppliers and Test Data.

1.5 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.

B. Perform Work in accordance with Caltrans Standard Plans.

PART 2 PRODUCTS

2.1 COARSE AGGREGATE MATERIALS

A. Class 2 Aggregate Base per Caltrans Standard Specifications 26-1.02B.

B. Coarse Aggregate Subbase: Crushed Gravel: Angular crushed; free of shale, clay, friable material and debris; Los Angeles abrasion 50% max; Durability index, AASHTO T210 of 35 minimum; Liquid limit 25% max; graded within the following limits:

Sieve Size	Percent Passing
2 ½ inches	100 (1)
2 inches	97-100 (1)
1 inch	65-79 (6)
1/2 inch	45-59 (7)
No. 4	28-42 (6)
No. 40	9-17 (4)
No. 200	4-8 (3)

( ) The value in the parentheses is the allowable deviation (±) from the target values.

C. Coarse Aggregate Base: Crushed Gravel: Angular crushed; free of shale, clay, friable material and debris; Los Angeles abrasion 50% max; Durability index, AASHTO T210 of 35 minimum; Liquid limit 25% max; graded within the following limits:

Sieve Size	Percent Passing
2 inches	100 (1)
1 inch	80-100 (6)
3/4 inch	64-94 (6)
3/8 inch	40-69 (6)
No. 4	31-54 (6)
No. 200	4-7 (3)

( ) The value in the parentheses is the allowable deviation (±) from the target values.

D. Class 2 Aggregate Base per Caltrans Standard Specifications 26-1.02B.

E. Aggregate Drain Rock: Natural stone; washed, free of clay, shale, organic matter; to the following limits:
   1. Minimum Size: 1/4 inch.
   2. Maximum Size: 1 1/2 inch.

2.2 FINE AGGREGATE MATERIALS

A. Fine Aggregate (Sand): Natural or bank sand; washed; free of silt, clay, loam, friable or soluble materials, and organic matter; graded in accordance within the following limits:

Sieve Size	Percent Passing
3/8 inch	100
No. 4	50
No. 14	6
No. 50	2
No. 200	1

2.3 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Testing and inspection services.

B. Coarse Aggregate Material - Testing and Analysis: Perform in accordance with ASTM D698. ASTM D4318. ASTM C136.

C. Fine Aggregate Material - Testing and Analysis: Perform in accordance with ASTM D698. ASTM D4318. ASTM C136.

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

PART 3 EXECUTION

3.1 EXCAVATION

A. Excavate aggregate materials from on-site locations indicated.

B. Stockpile excavated material meeting requirements for coarse aggregate materials.

C. Remove excess excavated materials not intended for reuse from site.

D. Remove excavated materials not meeting requirements for coarse aggregate materials from site.

3.2 STOCKPILING

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

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

C. Separate different aggregate materials with dividers or stockpile individually to prevent mixing.

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

3.3 STOCKPILE CLEANUP

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

END OF SECTION

SECTION 31 09 13

GEOTECHNICAL INSTRUMENTATION AND MONITORING

PART 1 GENERAL

1.1 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.2 REQUIREMENTS

A. This section specifies the requirements for installing geotechnical instrumentation, consisting of utility monitoring points, settlement monitoring points, survey control points and tell-tale crack monitors to monitor ground and structural movements during shaft excavation as specified in Section 33 05 07.21 and during tunnel construction as specified in Section 33 05 07.22.

B. The Work includes furnishing, maintaining, monitoring, reading, recording, and removing all instrumentation associated with the Work, specified herein, and shown on the Approved Plans.

C. The instrumentation is supplemented through the use of high quality pre-construction condition photographs and similar post-construction condition photographs as part of a Building and Structures Assessment Plan as specified herein.

D. All Work under this section is considered part and incidental to shaft excavation and tunneling which is included and to be paid for under their specific bid items. No separate payment shall be made for Instrumentation and Monitoring.

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Comply with the following industry standards effective at time of bid:

1. ASTM C150 – Type II Portland cement
2. ASTM C778 – Standard Specification for Standard Sand
3. NSF/ANSI Standard 060, Drinking Water Treatment Chemicals – Health Effects
4. Standard Specifications for Public Works Construction (SSPWC), Section 201-1.

B. State Regulatory Codes: to be current at all times:

1. California Code of Regulations (CCR), Title 8, Tunnel Safety Orders
2. CCR, Title 8, Construction Safety Orders, Section 1509 “Injury and Illness Prevention Program
3. Caltrans (CT) Manual for Encroachment Permits on California State Highways
4. CT Trenching and Shoring Manual

1.4 DEFINITIONS:

A. See Section 33 05 07.22.

B. BUILDING AND STRUCTURES ASSESSMENT PLAN: Systematic multimedia documentation that includes pictures, measurements, and descriptions for the current condition of buildings and/or other improvements and allows for the reconstruction of improvements were they to be damaged.

C. RESPONSE VALUE: Predetermined value at which when attained Contractor stops the Work and provides written notice and written plan discussing operational changes that are being made so as to not attain the Shutdown Value. Operational changes shall include a discussion at what conditions the Contractor will replace the tunnel equipment operator. Operations shall not resume until operational changes are implemented.

D. SETTLEMENT MONITORING POINTS (SMPS): Vertical displacement monitoring points constructed into the ground to monitor the vertical changes in elevation over the Project duration.

E. SHUTDOWN VALUE: Predetermined level at which when attained Contractor stops Work until submittal and Owner's acceptance of a written plan detailing corrective actions and restoration.

F. SURVEY CONTROL POINT: Temporary location established outside the zone of influence of any construction activities and used as a fixed reference or control point to monitor by optical survey methods the occurrence and amount of vertical and horizontal displacements at instrument locations.

G. TELL-TALE CRACK MONITORS: Instruments that measure the amount of movement occurring along cracks using two overlapping plates which move apart as the crack moves.

H. THRESHOLD VALUE: Predetermined level at where Contractor provides immediate written notice of condition.

I. UTILITY MONITORING POINTS (UMPs): Vertical displacement monitoring points attached to a utility and used to determine elevation changes of utilities over the Project duration.

1.5 PROJECT SITE CONDITIONS

A. See Section 33 05 07.22.

1.6 PERFORMANCE REQUIREMENTS

A. Locate all utilities in accordance with Section 01 20 00 before commencing drilling.

B. Install all instruments within 100 feet of shafts and tunnels before shaft and tunnel excavation commences.

C. Obtain written permission from the property owner and tenant for entry on to or entry into private property in order to complete the Building and Structures Assessment Plan. Obtain permits as required for instrumentation installation.

D. Drill, grout and dispose of resultant spoils.

E. Prepare bore log of as-built instrument.

F. Prepare ground and surfaces for instrument installation and testing.

G. Provide access, such as temporary or mobile platforms, and assistance to the Owner during instrumentation installation on or in the temporary works as directed by the Owner.

H. Protect instrumentation from damage during construction, and maintain instruments and components. Repair or replace instruments and components damaged during performance of Work, to the satisfaction of the Owner. Immediately provide written notice to Owner of any damage or maintenance problems.

I. Monitor instrumentation; provide data to Owner as specified herein.

J. Perform visual observation of the ground surface during construction operations and note observations and note changes. Document using pictures and measurements.

1.7 QUALITY ASSURANCE

A. Qualifications:

1. Geotechnical Instrumentation Specialist: Individual shall be a professional engineer registered in the State of California with experience in the installation and maintenance of geotechnical instrumentation similar to that specified herein on at least two prior projects similar in scope and size to this Project. Instrumentation specialist shall prepare and stamp instrumentation shop drawings and supervise and direct instrument installation, instrument readings, and interpretations.
2. Surveyor: Individual shall be a land surveyor licensed in the State of California for at least five years.
3. Technicians: Individuals shall be qualified with a minimum of two (2) years of experience in the installation and reading of geotechnical instrumentation similar to those specified herein.
4. Drillers: Personnel employed for drilling instrumentation boreholes shall have at least four (4) years of direct field experience in drilling boreholes.

B. Product Data: Includes manufacturer’s product description, installation requirements, shop drawings, operation, maintenance procedures, and samples where applicable,

as well as description of methods and materials for installing and protecting the instruments, including post installation acceptance tests.

C. Sources of information: All sources shall be widely available within the industry, specific to the purpose, and acceptable to the Owner. Reference shall be specific and include page number.

D. Building and Structures Assessment Plan: Plan documenting the multimedia documentation of pre-construction and post-construction conditions including measurements and photographs documenting the current state of buildings, utilities, and other improvements located within the active zone of the proposed shafts, tunnels, and where written permission has been granted. The purpose of the visual observation is to note any potential ground movement and structure damage that is not recorded by the geotechnical instrumentation.
   1. Permission shall grant equal access to Owner. Permission shall specifically state allowed work, i.e. photographs only or photographs and instrumentation with a detail bill of materials and locations.
   2. Pre-construction and post-construction photographs shall be high-resolution, demonstrate the vertical nature of the feature, and include a scale.
   3. Take photographs from the public right-of-way or on properties where access permission has been granted.
   4. Post-construction photos shall be of the same orientation and lighting as the corresponding pre-construction photographs.

E. Survey Control Point Installation Procedure: Includes the following:
   1. Method for cleaning the inside of casing.
   2. Grout mix design, including commercial names, proportions of admixtures and water, mixing sequence, mixing methods and duration, pumping methods and tremie pipe type, size and quantity.
   3. Drill casing or auger type and size.
   4. Depth increments for backfilling boreholes with sand and granular bentonite.
   5. Method for overcoming buoyancy of instrumentation components during grouting.

F. Settlement Surveying and Monitoring Plan: The plan shall identify the location of all instruments; survey control points; surface monitoring points; and survey schedules, procedures, and reporting formats.

G. Drill logs: Boreholes are to be logged under the supervision of a geologist or engineer with a minimum of three (3) years of experience. Logs shall be on an accepted format and include the depth, angle and orientation of hole, station and offset (if any) from the trenchless installation, trenchless installation description, geologic log, and notes of any inflows of water or other material, if encountered.

1.8 INSTALLATION:

A. Provide notice to the Owner not less than one (1) work day for all other instrument installations. Label all instruments with the same identifying instrument number as shown on the Approved Plans or in a manner acceptable to the Owner.

B. Installation Tolerances: Position all instruments within 12 inches of the horizontal location as specified herein. Position instrumentation to within 6 inches of the bottom elevation or deeper as specified herein. Position settlement monitoring points and instrument casings to the more restrictive of two degrees of vertical for the entire depth of each instrument or as required by the manufacturer.

C. When actual field conditions prevent installation of instruments at the location and elevations specified herein, obtain prior acceptance from the Owner for new instrument location and elevation. The proposed location is to provide similar information.

D. Shop Drawings: Show installed locations, the instrument identification number, the instrument type, the installation date and time, established elevations, initial elevations, offset and stationing, initial coordinates and boring log, and the anchor to tip elevation and instrument length, when applicable. Shop drawings include as-built shop drawings showing each instrument including installation records, depths, lengths, elevations, and dimensions of all key elements.

E. Perform a baseline reading for each instrument which shall include at least two readings from each instrument before commencing underground construction. The two readings are to be completed on two different work days each requiring a separate set-up. The readings are to provide statistically valid reproducible results allowing for temperature adjustments to both atmosphere and facility. If results are not valid, perform additional daily readings or re-install instrument until readings are reproducible.

F. Submit results within two (2) work days following readings and not less than three (3) work days preceding the commencement of excavation.

G. Surveys for monitoring geotechnical instrumentation shall be referenced to the same control points and benchmarks established for setting out the work. Control points shall be tied to benchmarks and other monuments outside of the zone of influence of the underground excavations.

H. Building and Structures Assessment Report: Provide pre-construction and post-construction assessment reports for buildings and structures located within a distance of 100 feet from the proposed pipe centerline and shaft perimeters.

I. Tell-Tale Crack Monitors Report: Provide pre-construction and post-construction assessment report for each point.

1.9 SUBMITTALS

A. Submittals shall be made in accordance with Section 01 33 00 and as specified herein.

B. Submittals shall be coordinated with all cross referenced sections and assembled and submitted as a single, complete, and comprehensive submittal.

C. Where calculations are required to be submitted, they shall be signed and sealed by a Professional Civil Engineer registered in the State of California. Calculations shall clearly identify all parameters used, state all assumptions made in the calculation, and identify all sources of information.

D. All shop drawings shall be legible with dimensions accurately shown and clearly marked in English.

E. Provide written notifications as specified herein or within one work day.

F. Preconstruction submittals:
   1. Name and qualifications for the following:
      a. Geotechnical Instrumentation Specialist.
      b. Technicians.
      c. Surveyors.
      d. Drillers.
   2. Sample drilling logs for instrumentation drilling.
   3. Schedule for installation of survey control points as specified herein or at least two (2) weeks prior to installation.
   4. Site specific shop drawings indicating the layout and designation of all control points and monitoring points as specified herein.
   5. Survey control point installation procedure.
   6. The Settlement Survey and Monitoring Plan should describe the proposed methods for monitoring each instrument type.
   7. All instrument manufacturer's product data at least two (2) weeks prior to installation.
   8. All permits required for instrument installation.
   9. Contingency plan in the event ground movement reaches the prescribed Response Values as specified herein.
   10. All instrument baseline readings.
   11. Building and Structures Assessment Plan including photographs.
   12. Construction submittals:
      a. Drilling logs for instrumentation installations within five (5) work days of drilling.
      b. Shop drawings and as-built drawings within five (5) work days following installation of each instrument.
      c. All instrument readings in a cumulative record on the same work day as the readings are taken or as soon as data is known if excessive ground movement is suspected.
      d. All interpretations within two (2) work days following readings.
   13. Post-Construction submittals:
      a. Final Building and Structures Assessment Report including comparative photographs.
      b. Signed and sealed cumulative records and interpretations within 4 weeks following instrument removal.
      c. Record of legal destruction of instruments within 4 weeks of instrument removal.

PART 2 PRODUCTS

2.1 MATERIALS

A. Sand: Compatible with manufacturer's written recommendations and ASTM C778.

B. Cement: Shall be Type II Portland cement and water in accordance with ASTM C150 and compatible with instrument manufacturer's written recommendations.

C. Water: Potable including source.

D. Drilling fluid: High yield sodium bentonite.

E. Water furnished from a potable water source.

F. Test all water for pH and treat with soda ash, or accepted equal, to adjust the pH of the water as required in the accepted mix design(s).

G. Bentonite, polymers, and additives, other than soda ash, shall be NSF/ANSI Standard 060 compliant.

H. Cement-Bentonite Grout: 22 lbs. cement; 12 lbs. bentonite; 1.5 gallons water.

I. Bentonite Slurry Grout: 50 lbs. sodium bentonite sealing and plugging agent; 7 lbs. sodium bentonite drilling mud; 32 gallons of water.

2.2 EQUIPMENT AND ANCILLARY CONSTRUCTION MATERIALS

A. Provide as shown on the Approved Plans, specified herein, and acceptable to the Owner.

B. Utility Monitoring Points (UMPs): Provide sensor with accuracy of at least ±0.01 foot.

C. Settlement Monitoring Points (SMPs): Provide sensor with accuracy of at least ±0.01 foot.

D. Tell-Tale Crack Monitors:

1. Provide sensors with maximum resolution of 1 mm.

PART 3 EXECUTION

3.1 GENERAL

A. Perform all Work in accordance with accepted submittals and manufacturer's written recommendations.

B. Comply with all applicable permits.

C. Protect all instruments, components, systems, and utilities from damage.

D. If any instrument is to be located on private property then the Contractor shall provide a right of entry and waiver in a form acceptable to the Owner from said property owner. Upon installation Include picture before instrument placement and instrument in-place. At end of project include similar pictures of instrument in-place, upon removal of instrument, and following any and all restoration work. Ensure lighting is similar in all cases.

E. Provide the Owner with access to the instrument locations. Installation of the instrumentation by the Contractor does not preclude the Owner, through an independent Contractor, from installing instrumentation in, on, near, or adjacent to the Work.

F. Maintain a copy of the Contract Documents in a location acceptable to the Owner and accessible to the geotechnical instrumentation specialist and the Owner.

G. Treat and dispose of all water in accordance with the requirements specified in Section 31 23 19.

H. Ensure each instrument is functional for its intended purpose and installed in manner that protects the instrument from damage and the general public from injury.

I. Place all instruments a minimum of ten (10) work days prior to start of excavation unless otherwise specifically stated otherwise.

J. Locate and avoid drilling into or damaging conduits and other underground facilities.

K. Perform and record baseline readings.

L. Remove and replace any damaged instrument or component that affects the fit, form, or function of the instrument.

M. Markings for each instrument identifying instrumentation name, location, and numbering shall be refreshed weekly or more frequently to ensure legible visibility of its location and unique identifier marking.

3.2 SURVEY

A. Adhere to the following requirements concerning survey oversight:
   1. Perform initial survey and record the horizontal coordinates and elevations within an accuracy of 0.005 feet (1/16 inch) for each survey point location and all subsequent surveys. Reference survey points so that they are accurately re-established if lost or destroyed.
   2. Perform interim surveys and commence readings at the commencement of shaft and tunnel excavation at the frequency specified herein.
   3. Perform a final survey, with two readings similar to the initial survey, of all control points and instruments upon completion of construction operations. Submit final readings as specified herein.

3.3 DRILLING, GROUTING, PREPARATION, ACCESS AND PROTECTION

A. Drill holes of appropriate size and depth in masonry, concrete and asphalt and cased holes in fills and ground for installation of instruments.

B. Clean holes to remove debris. Holes which the Owner considers unsatisfactory because of misalignment or other irregularities shall be re-drilled as directed by the Owner.

C. Withdraw the casing or auger without rotation so as to prevent ground collapse into the excavated hole.

D. Provide access and temporary facilities, such as power and sufficient general area lighting necessary for installing instruments.

E. Mix grout using equipment capable of thoroughly mixing grout material so that grout is of uniform consistency with no unsuspended solids. Place grout using a tremie method, where applicable, with side discharge ports on tremie pipe.

3.4 UTILITY MONITORING POINTS (UMPS)

A. Provide one (1) UMP for each utility crossed by the trenchless methods.

B. Remove pavement over utility by coring or cutting. Minimize area of pavement removal.

C. Excavate to top of utility using vacuum truck, hand auger, or other suitable method. Do not damage utility during excavation.

D. Construct temporary casing, trench box, or similar protective equipment as required to provide safe support and access for installation of point.

E. Construct bar and pipe riser to protect the UMPs. Maintain centralized alignment throughout installation. Do not allow the bar to contact the inside of the riser pipe.

3.5 SETTLEMENT MONITORING POINTS (SMPS)

A. SMPs shall be located as in the accepted submittals.

B. Grout the casing housing so it is in intimate contact with the ground and as shown in the Contract Drawings.

C. Provide up to 6 additional surface monitoring points at locations to be determined in the field by the Owner.

3.6 TELL-TALE CRACK MONITORS

A. Provide up to three (3) tell-tale crack monitors per property with a building adjacent to the tunneling and shaft alignments and up to two (2) per vacant property, property without a building.

B. Provide up to 4 additional tell-tale crack monitors at locations to be determined in the field by the Owner.

3.7 MONITORING

A. Frequency: As a minimum, follow the following schedule to determine frequency and duration of the monitoring:

Instrument Type	Monitoring Frequency within Active Zone(1)	Monitoring Frequency outside Active Zone(1)
Utility Monitoring Point (UMP)	Prior to start of work, every two hours continuously throughout project, and upon completion	Weekly/Monthly(2)
Settlement Monitoring Point (SMP)	Prior to start of work, every two hours continuously throughout project, and upon completion	Weekly/Monthly(2)
Tell-Tale Crack Monitors	Prior to start of work, every two hours continuously throughout project, and upon completion	Weekly/Monthly(2)

NOTES:

(1) The active zone for tunneling is measured parallel to the tunnel alignment and is 100 feet in front and behind the tunnel face. The active zone for shaft excavation is 100 feet from the open shaft and covers the duration from the start of shaft construction and for four weeks following shaft restoration.

(2) Weekly until movement substantially stops and monthly thereafter. Movement substantially stops when four consecutive, regularly scheduled measurements remain unchanged.

(3) Monitor and report weekly for four weeks following shaft restoration.

B. Perform additional monitoring as necessary to control construction and to ensure the safety of the Work.

C. Provide a report with the following:
1. Data sheets containing a cumulative history of readings; including weather conditions, temperature, and proximity of the excavation to the instrument location itself at the time of each reading.
2. A plot of measured values versus time, including a time history of construction activity likely to influence such readings.

D. Interpretation: Data or interpretation shall not be published or disclosed to other parties without advance written permission of the Owner. Provide instrument readings and interpretations of monitoring data to the Owner within the times specified herein.

3.8 RESPONSE VALUES

A. Instrument Response Values:

Instrument	Instrument Response Level by Requirement Caltrans
Settlement Monitoring Point (SMP)	±0.008 inch*(H), H or V (H= excavation depth in feet)
Tell-Tale Monitors	±2.0 inch

B. When a given Response Value is reached, the Contractor shall provide verbal notice within one hour upon occurrence, confirming written notice within 1 work day, and respond in accordance with the following:

Contractor Response Level Values		
Threshold Value	**Response Value**	**Shutdown Value**
50%	80%	100%

1. Threshold Value: Provide written notice within 24 hours of occurrence and meet with the Owner within 24 hours of providing notice to discuss means and method to determine what changes, if any, shall be made to better control ground movement. Instrument readings shall be made on a daily basis until five consecutive work days of readings remain unchanged; at which point the readings will revert to the reading frequency specified herein.
2. Response Value: Provide written notice and meet with the Owner within 24 hours to discuss means and methods to determine what changes shall be made to better control ground movement. Actively control ground movement in accordance with the accepted plan to prevent reaching the Shutdown Value. Instrument readings shall be made on a daily basis until five consecutive work days of readings remain unchanged; at which point the readings will revert to the reading frequency specified herein.
3. Shutdown Value: Stop all Work immediately and provide immediate written notice. Meet with the Owner to develop a plan of action before any Work resumes.

C. All measured deflection values are relative to the baseline value identified at the start of construction. Baselines shall not be reset after each bore and shall remain the same for the duration of this Contract.

D. The required responses specified herein shall apply to any visualization of ground movement between monitoring points including sinkholes, rat holes, and other visual forms of ground movement.

3.9 REMOVAL AND SITE RESTORATION

A. Verify with Owner that instrumentation is no longer required.

B. Remove the instrument prior to substantial completion of the Work, unless otherwise indicated.

C. Remove and/or abandon the instrumentation in accordance with the permit.

D. Backfill surface excavations with unshrinkable fill, when within apron, roadways or sidewalks, and with selected fill when outside of such areas up to the underside of surface restoration. Steel casings, if any shall be removed to a minimum depth of five (5) feet below ground surface.

E. Surfaces affected by installation of instruments shall be restored to their original condition prior to completion of Work.

END OF SECTION

SECTION 31 10 00

SITE CLEARING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Removing surface debris.
   2. Removing vegetation.
   3. Removing abandoned utilities.
   4. Excavating topsoil.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Within five (5) working days of Award of Contract, Contractor shall submit a site-specific Disposal Plan for site work, outlining work areas, methods, start work dates, equipment and crew types to perform the work as well as hazardous material handling and disposal plans.

C. Submittal shall include a list of all materials generated during construction activities that will require off-haul. Working with the Engineer, the Contractor shall develop a list of off-site refuse disposal facilities, including contact information and list of items accepted for disposal at identified facility consistent with the Disposal Plan.

D. Written proof the proposed disposal/recycling locations are permitted to receive said materials

1.4 QUALITY ASSURANCE

A. Conform to applicable Humboldt County Department of Environmental health regulations for environmental requirements, disposal of debris, and use of herbicides.

B. Perform Work in accordance with Caltrans Standard Plans.

C. All vegetation areas proposed for removal are to be marked by the Contractor and approved by the Engineer.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

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

3.2 PREPARATION

A. Notify affected utility companies not less than three working days before performing Work.

B. Request underground utilities to be located and marked within and surrounding construction areas.

3.3 PROTECTION

A. Locate, identify, and protect utilities indicated to remain, from damage.

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

C. Protect survey control points from damage or displacement.

3.4 CLEARING

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

3.5 REMOVAL

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

B. Remove paving and concrete shown for demolition.

C. Remove abandoned utilities. Indicated removal termination point for underground utilities on Record Documents.

D. Continuously clean-up and remove waste materials from site. Do not allow materials to accumulate on site.

E. Do not burn or bury materials on site. Leave site in clean condition.

3.6 TOPSOIL EXCAVATION

A. Excavate topsoil from areas to be further excavated, relandscaped, or regraded, without mixing with foreign materials for use in finish grading.

B. Do not excavate wet topsoil.

C. Stockpile in area designated on site to depth not exceeding 8 feet and protect from erosion. Stockpile material on impervious material, until disposal.

D. Remove topsoil from site.

E. The Contractor shall handle and dispose of unsuitable and excess material legally, at refuse facility outside the Project site.

END OF SECTION

SECTION 31 23 16

EXCAVATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Excavating for building foundations.
   2. Excavating for paving and parking areas.
   3. Excavating for utilities.
   4. Excavating for slabs-on-grade.
   5. Excavating for site structures.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCES

A. Local utility standards when working within 24 inches of utility lines.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with Caltrans Standard Plans.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 PREPARATION

A. Notify affected utility companies and owner not less than three working days before performing Work.
   1. Request underground utilities to be located and marked within and surrounding construction areas. Conduct additional utility locating including ground penetrating radar, potholing and other means.

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

C. Protect utilities indicated to remain from damage.

D. Protect plant life, and other features remaining as portion of final landscaping.

E. Protect bench marks, survey control points and existing structures from excavating equipment and vehicular traffic.

3.2 EXCAVATION

A. Excavate subsoil to accommodate utilities, structures, channels, swales, and other improvements.

B. Compact backfills in accordance with Section 31 23 23 and Section 31 23 17.

C. Slope banks with machine to angle of repose or less until shored.

D. Do not interfere with 45 degree bearing splay of foundations.

E. Grade top perimeter of excavation to prevent surface water from draining into excavation.

F. Trim excavation. Remove loose matter.

G. Remove lumped subsoil, boulders, and rock as specified in Section 31 23 23.

H. Notify Engineer of unexpected subsurface conditions.

I. Correct areas over excavated with structural fill Type specified in Section 31 23 23.

J. Remove excess and unsuitable material from site.

K. Stockpile excavated material in area designated on site in accordance with Section 31 05 13.

L. Repair or replace items indicated to remain damaged by excavation.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.

B. Request visual inspection of bearing surfaces by Geotechnical Engineer before installing subsequent work.

3.4 PROTECTION

A. Prevent displacement or loose soil from falling into excavation; maintain soil stability.

B. Protect structures, utilities and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth operations.

END OF SECTION

SECTION 31 23 17

TRENCHING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Excavating trenches for utilities from 5 feet outside building to utility service.
   2. Compacted fill from top of utility bedding to subgrade elevations.
   3. Backfilling and compaction.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCES

A. American Association of State Highway and Transportation Officials:
   1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 10-lb Rammer and a 18-in. Drop.

B. ASTM International:
   1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3).
   2. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
   3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3).
   4. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
   5. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.4 DEFINITIONS

A. Utility: Any buried pipe, duct, conduit, or cable.

1.5 SUBMITTALS - Not Used

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with Caltrans Standard Plans.

1.7 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.8 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify Work associated with lower elevation utilities is complete before placing higher elevation utilities.

PART 2 PRODUCTS

2.1 FILL MATERIALS

A. Select Fill: Select Fill as specified in Section 31 05 13.

B. Structural Fill: Coarse Aggregate Base as specified in Section 31 05 16.

C. Granular Fill: Coarse Aggregate Subbase as specified in Section 31 05 16.

PART 3 EXECUTION

3.1 LINES AND GRADES

A. Lay pipes to lines and grades indicated on Drawings.
   1. Engineer reserves right to make changes in lines, grades, and depths of utilities when changes are required for Project conditions.

B. Use laser-beam instrument with qualified operator to establish lines and grades.

3.2 PREPARATION

A. Notify affected utility companies not less than three working days before performing Work.
   1. Request underground utilities to be located and marked within and surrounding construction areas.

B. Identify required lines, levels, contours, and datum locations.

C. Protect plant life, lawns, and other features remaining as portion of final landscaping.

D. Protect bench marks, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

E. Maintain and protect above and below grade utilities indicated to remain.

F. Establish temporary traffic control when trenching is performed in public right-of-way. Relocate controls as required during progress of Work.

3.3 TRENCHING

A. Excavate subsoil required for utilities to utility service.

B. Remove lumped subsoil, boulders, and rock.

C. Perform excavation within 24 inches of existing utility service in accordance with utility's requirements.

D. Do not advance open trench more than 200 feet ahead of installed pipe. Access to all open trenches to be controlled by contractor. Open trenches shall be covered with plates when not directly monitored.

E. Cut trenches sufficiently wide to enable installation and allow inspection. Remove water or materials that interfere with Work.

F. Excavate trenches to depth indicated on Drawings. Provide uniform and continuous bearing and support for bedding material and pipe.

G. Do not interfere with 45 degree bearing splay of foundations.

H. When Project conditions permit, slope side walls of excavation starting 2 feet above top of pipe. When side walls cannot be sloped, provide sheeting and shoring to protect excavation as specified in this section. Provide shoring as required by OSHA.

I. When subsurface materials at bottom of trench are loose or soft, excavate to greater depth as directed by Engineer until suitable material is encountered.

J. Cut out soft areas of subgrade not capable of compaction in place. Backfill with course aggregate and compact to density equal to or greater than requirements for subsequent backfill material.

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

L. Correct areas over excavated areas with compacted backfill as specified for authorized excavation or replace with fill concrete as directed by Engineer.

M. Remove excess subsoil not intended for reuse, from site.

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

3.4 SHEETING AND SHORING

A. Sheet, shore, and brace excavations to prevent danger to persons, structures and adjacent properties and to prevent caving, erosion, and loss of surrounding subsoil.

B. Support trenches more than 5 feet deep excavated through unstable, loose, or soft material. Provide sheeting, shoring, bracing, or other protection to maintain stability of excavation.

C. Repair damage caused by failure of the sheeting, shoring, or bracing and for settlement of filled excavations or adjacent soil.

3.5 BACKFILLING

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

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

C. Place fill material in continuous layers and compact.

D. Place material in continuous layers as follows:
   1. Select Fill: Select Fill, maximum 8 inches loose depth.
   2. Structural Fill: Coarse Aggregate Base, maximum 6 inches loose depth.
   3. Granular Fill: Coarse Aggregate Subbase, maximum 6 inches loose depth.

E. Employ placement method that does not disturb or damage, utilities in trench.

F. Maintain optimum moisture content of fill materials to attain required compaction density.

G. Do not leave more than 50 feet of trench open at end of working day. Any trenches left open at the end of the working day are to be covered by plates.

H. Protect open trench to prevent danger to the public.

3.6 TOLERANCES

A. Section 01 40 00 - Quality Requirements: Tolerances.

B. Top Surface of Backfilling Under Paved Areas: Plus or minus ½ inch (0.04 feet) from required elevations.

C. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.

3.7 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.

B. Perform laboratory material tests in accordance with ASTM D698.

C. Perform in place compaction tests in accordance with the following:
   1. Density Tests: ASTM D1556, or ASTM D6938.
   2. Moisture Tests: ASTM D6938.

D. When tests indicate Work does not meet specified requirements, remove Work, replace, compact, and retest.

E. Frequency of Tests: Minimum of one test in each 1-foot of backfill, for every 200 feet of trench.

3.8 PROTECTION OF FINISHED WORK

A. Section 01 70 00 - Execution and Closeout Requirements: Protecting finished work.

B. Reshape and re-compact fills subjected to vehicular traffic during construction.

END OF SECTION

SECTION 31 23 19

DEWATERING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Design, construction, operation and maintenance of effective dewatering operations.
   2. Dewatering pumping control.
   3. Disposal of extracted groundwater.
   4. Removal and relocation of equipment and clean-up of sites.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 QUALITY ASSURANCE

A. Qualifications. Furnish the services of an experienced, qualified, and equipped Dewatering Subcontractor to design and operate the dewatering required for the Work. In lieu of the above, the General Contractor may do the dewatering in accordance with a system approved by the Owner and designed by a Civil Engineer who is registered in the State of California and who has experience in this type of work.

B. Data Available for Examination. Reports of subsurface are available to the Contractor for examination. This data will be made available for information only. Refer to Section 00 31 00 – Available Project Information.

C. Monitoring. The Contractor shall qualitatively monitor for odor or visual discrepancies indicative of hydrocarbon contamination in groundwater during dewatering operations. The Contractor shall notify the Owner immediately if potential contamination is encountered.

1.4 SUBMITTALS

A. Dewatering Plan: Submit for record purposes only and not for review or approval, shop drawings and data showing the intended plan for dewatering operations. Dewatering systems shall be designed and maintained by the Contractor and shall be coordinated with the design of shoring specified in Section 31 23 30. The plan should contain at a minimum the sizes of pumps, tanks, filtration devices, and the points of disposal. The plan should also include alternate (contingent) systems, and the Contractor should be prepared to alter the initial dewatering or shoring systems to meet the specified requirements. Submit the referenced intended plan not less than 15 days prior to start of dewatering operations.

B. Product Data: Submit data for each of the following:

1. Dewatering Pumps: Indicate sizes, capacities, priming methods, and engine or motor characteristics.
2. Pumping equipment for control of discharge.
3. Size of tank(s) used for storage.
4. Specifications and size and type of filters and any other materials used for filtration.
5. Traffic Control Plan: Provide traffic control plans around tanks, hoses and other dewatering equipment. Refer to Section 01 55 50 – Temporary Traffic Control System

PART 2 PRODUCTS

2.1 COMPONENTS OF THE DEWATERING SYSTEM

A. Provide units of standard manufacture and in good working order. Remove from the job site unserviceable parts and equipment. Major equipment for which repair parts are unavailable from local suppliers shall be considered obsolete and not acceptable.

PART 3 EXECUTION

3.1 PREPARATION

A. Coordination. Lay out and install dewatering installations beyond the limits of the permanent works. Avoid interference with access or other necessary activities.

B. Barricades, Shelters, and Safety. Provide protection for vital parts of the employed dewatering system from accidental damage, and erect signs and barricades to isolate hazardous areas.

3.2 PERFORMANCE

A. Dewatering. Perform dewatering operations as required so all underground and below grade Work is performed or installed in dry excavations. Maintain dewatering systems in continuous operation until the involved work is completed, including the placing and compaction of backfill materials in the dry.

B. Protection of Existing Facilities. Provide standby equipment of sufficient size and capacity to ensure continuous operation of the dewatering systems. Where any sloped excavation infringes on or potentially endangers any existing facilities or structures, provide shoring, sheeting, and bracing according to shop drawings and calculations signed and stamped by a Structural or Civil Engineer registered in the State of California. File a copy of such plans and calculations with the Owner for record purposes. Repair and make good all damage or settlement to the foundation or other portion of any new or any existing facilities or structures caused by permanent or temporary failure, operation of the dewatering systems, or by failure to maintain the existing groundwater level outside the dewatered areas. Such repair work shall be performed at no additional expense to the Owner.

C. Drainage. Contractor shall provide and maintain ample means to promptly and effectively remove water from all areas of work, to prevent the entry of harmful quantities of water into the excavations and to dispose of the water removed. Avoid environmental damage and nuisance.

D. Disposal of Extracted Ground Water. Dispose of groundwater extracted by the dewatering system employed at the construction site as described as follows:
   a. Reuse the water on-site for dust control, compaction, or irrigation, as appropriate.
   b. Retain the water on-site in a grassy or porous area to allow infiltration/evaporation.
   c. Discharge (by permit) to a sanitary sewer or storm drain (this option may require a temporary method to filter sediment-laden water prior to discharge). If discharge to a storm drain (i.e., surface waters) is the only feasible option, the Project will comply with Water Board requirements for construction dewatering. Measures may include characterizing the discharge and receiving waters and developing a Best Management Practices Plan including filtering methods and monitoring and reporting requirements.

E. Contractor shall submit a dewatering plan.

F. Removal. Remove equipment when no longer required for dewatering or water controlling operations. Maintain operation of monitoring systems until their removal is approved. Remove all temporary works and dewatering facilities in a manner satisfactory to the Owner and the permits for the Project.

3.3 DEWATERING PUMPING CONTROL

A. For dewatering pumping outside normal working hours, engines shall be equipped and/or shielded in a manner to keep noise to a minimum. Testing is required to show compliance with local ordinances. The Contractor shall conduct all work to minimize the impact of construction noise on nearby business and residential neighborhoods. Measures to reduce construction noise are listed in the Specification Section 01 57 00 in addition to those measures listed below.

B. To minimize noise levels, the Contractor shall attempt to obtain electrical power from PG&E in lieu of providing power by portable generator. If use of utility power is not practicable, generator power may be provided by sound-attenuated electrical generators.

C. Diesel generators shall not be utilized unless they are provided with sound barriers or enclosures, as necessary, to comply with local ordinances.

D. Open pumping from sumps shall not result in boils, softening of the ground, or loss of fines. Sumps, subdrains, drain blankets, wells and well points shall be installed with suitable filters or screens so that fines are not removed from the formation.

E. Groundwater control operations shall be prosecuted and maintained 24 hours a day, 7 days a week. Qualified personnel shall be on-site at all times to monitor system operations and to perform maintenance as necessary to keep the system in operation.

F. Provide a generator and all equipment necessary to provide a backup electrical power source in the event of a power service interruption.

G. Maintain temporary drainage facilities of adequate size, with standby pumps and adequate back-up power for emergency use, to collect and dispose of water which enters the pipeline trench or structure excavation.

3.4 CLEANUP

A. Upon completion of the work in this Section, remove rubbish and debris and leave the entire area affected by the work in a neat, clean and acceptable condition.

END OF SECTION

SECTION 31 23 30

SHORING AND TRENCH SAFETY

PART 1 GENERAL

1.1 SUMMARY OF SECTION

A. Principle items specified herein are:
   1. Shoring required for general safety, worker protection and protection of adjacent property from the hazards of caving ground.
   2. Trench excavations
   3. Structural excavations

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCED CODES AND SPECIFICATIONS

A. The following standards apply:
   1. Cal/OSHA, State of California Administrative Code, Title 8; Industrial Relations, Chapter 4, Subchapter 4, Construction Safety Orders.
   2. Occupational Safety and Health Administration (OSHA) Regulations, 29 CPR Part 1926 Subpart P - Excavations.

1.4 CONTRACTOR'S RESPONSIBILITIES FOR SAFETY

A. The Contractor shall be solely and completely responsible for conditions of the job site, including safety of all persons (including employees) and property during performance of the Work. This requirement shall apply continuously and not be limited to normal working hours.

B. The duty of the Engineer to conduct construction review of the Contractor's performance is not intended to include a review or approval of the adequacy of the Contractor's safety supervisor, the safety program, or any safety measures taken in, on, or near the construction site.

C. The Engineer will review the submittal of the Contractor's proposed shoring system to verify the general scope of the Work, to determine that qualified professional engineering services are used and to determine that appropriate construction techniques are proposed for use. This review shall not in any way be construed to relieve the Contractor from sole responsibility for the design and safety of such shoring.

D. The Contractor shall appoint a supervisory employee who shall be responsible for determining which of the engineered shoring systems (if alternates are provided) shall be used depending on local soil type, water table, etc.

1.5 PERMIT

A. For trenches or excavations five (5) - feet or more in depth, obtain from the State Division of Industrial Safety a permit for such excavation; submit a copy of the permit to the Engineer, prior to initiating any Work requiring said permit.

1.6 SAFETY ORDERS

A. The Contractor shall have at the Work site, copies or suitable extracts of the Construction Safety Orders of Cal-OSHA.

B. All Work shall comply with the provisions of these and all other applicable laws, ordinances and regulations.

1.7 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – “Submittal Procedures”:
   1. Trench Safety Plan:
      a. For trenches or excavations five feet or more in depth, the Contractor shall submit to the Engineer a detailed plan design of shoring, bracing, sloping, or other provisions to be made for worker protection from the hazards of caving ground. The design shall be coordinated with the dewatering plan (Section
      b. 31 23 19). Such plans shall be submitted at least 10 working days before the Contractor intends to begin trenching or excavation work. Submittal shall be for trench work and work at vaults, and other cuts 5 feet or more in depth. NOTE: Water table and moisture content will vary with rainfall and cause varying soil strength.
      c. Groundwater will be present in trench backfill of existing utilities. Contractor shall design shoring and dewatering systems to mitigate against washout of materials from existing utility trenches. Reconstruction of the structural section of the road will be completed at the Contractor’s expense.
      d. The trench safety plans shall be prepared, stamped and signed by a civil or structural engineer registered in California. Stamped and sealed copies of calculations necessary to obtain approval of the systems shall be submitted also. These plans shall be posted on the job site.
      e. Nothing herein shall be deemed to allow the use of a shoring, sloping, or protective system less effective than that required by the Construction Safety Orders of the Division of Industrial Safety.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01. REMOVAL OF SHORING

B. Removal of shoring shall not damage pipes or structures, cause settlement or heave the ground surface, or produce vibrations that could damage adjacent pipe or structures.

C. Minimum compaction requirements must be met after shoring is removed.

PART 4 TESTING

No field testing is required.

END OF SECTION

SECTION 31 25 13

EROSION CONTROLS

PART 1 GENERAL

1.1 GENERAL

A. The work of this section consists of furnishing and installing temporary erosion and sediment control measures necessary to prevent, control and abate water, mud, and erosion damage to public and private property as a result of the construction project.

B. Implementing measures to prevent storm water pollution during construction activities, in accordance with federal, state, and local regulations.

C. Minimize the extent of all ground disturbing activities and avoid work in any drainage channels if at all feasible.

D. Heavy equipment shall be placed outside of drainage channels except when absolutely necessary to perform the work.

E. Upon completion of construction activities, natural drainage shall be restored and re-contoured as nearly as practicable to pre-project conditions, and shall match adjacent natural channel contours.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 SUBMITTALS

A. Mill Certificate or Affidavit. A mill certificate or affidavit shall be provided attesting that the fabric and factory seams meet chemical, physical, and manufacturing requirements specified below.

1.4 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 basic designation only.

B. American Society for Testing and Materials (ASTM)
   1. ASTM D4439-04 - Standard Terminology for Geosynthetics.
   2. ASTM D4491-99a(2009) - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
   3. ASTM D4533- 04(2009) - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
   4. ASTM D4632-08 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
   5. ASTM D4751-04 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.

6. ASTM D4873-02(2009) - Standard Guide for Identification, Storage, and Handling of Geosynthetic Roles and Samples.

1.5 EROSION AND SEDIMENT CONTROLS

A. The controls and measures required by the Contractor are described but not limited to the items below.
   1. Structural Practices: Structural practices shall be implemented to divert flows from exposed soils, temporarily store flows, or otherwise limit runoff and the discharge of pollutants from exposed areas of the site. Structural practices shall be implemented in a timely manner during the construction process to minimize erosion and sediment runoff. Structural practices shall include the following devices.
      a. Silt Fences. The Contractor shall provide silt fences as a temporary structural practice to minimize erosion and sediment runoff. Silt fences shall be properly placed and installed to effectively retain sediment immediately after completing each phase of work where erosion would occur in the form of sheet and rill erosion (e.g. clearing and grubbing, trench excavation, backfilling, and grading). Silt fences shall be installed in the locations as directed by the Engineer. Final removal of silt fence barriers shall be upon approval by the Engineer.
      b. Straw Wattles (Fiber Rolls): Contractor shall provide fiber roles as temporary structural practice to minimize erosion and sediment runoff. Fiber roles shall be properly placed and installed to effectively retain sediment immediately after completing each phase of work (e.g., clearing and grubbing, trench excavation, backfill, and grading) in each independent runoff area (e.g., after clearing and grubbing in an area between a ridge and drain, fiber roles shall be placed as work progresses; fiber roles shall be removed/replaced/relocated as needed for work to progress in the drainage area). Final removal of fiber role barriers shall be upon approval by the Engineer. Fiber Roles shall be installed as directed by the Engineer and as shown in the Project Drawings.
      c. Seed and Mulch: per plans and specifications.

PART 2 PRODUCTS

2.1 SILT FENCES

A. Ultraviolet stabilized woven polypropylene face. The filter fabric shall meet the following requirements:

Physical Property	Test Procedure	Required Value
Grab Tensile	ASTM D 4632	160 lbs. min.
Elongation (%)	ASTM D 1682	25 % max.
Mullen Burst Strength, psi, min.	ASTM D 3876	350
Equivalent Opening Size, max.	US Standard Sieve	30-70
Ultraviolet Radiation Resistance, %	ASTM D 4355	70

Strength Retention		
Weight oz./sq. yd.	ASTM D 3776	4

B. Mill Certificate or Affidavit. A mill certificate or affidavit shall be provided attesting that the fabric and factory seams meet chemical, physical, and manufacturing requirements specified above.

C. The Contractor may use either wooden stakes or steel posts for silt fence construction

2.2 FIBER ROLES (SEDIMENT LOGS OR WATTLES)

A. Composed of bio-degradable materials.

B. The Contractor shall use wooden stakes for fiber role installation. Wooden stakes utilized for fiber role installation, shall have a minimum cross section of 1 inch by 2 inches, or as suggested by the fiber role manufacturer.

PART 3 EXECUTION

3.1 SPECIAL CONSTRUCTION REQUIREMENTS

A. It is the responsibility of the Contractor to minimize erosion and prevent the transport of sediment to the adjacent stream and sensitive areas.

B. At a minimum, the Contractor shall employ best management practices (BMPs) as described in the Project Plans.

C. If discrepancies occur between these specifications, plans, material referenced herein or manufacturer's recommendations, then the most protective shall apply.

D. It is the responsibility of the Contractor to fix any erosion, sediment, pollution, & waste control deficiencies identified by the Engineer.

E. Other selected disturbed earth areas shall be treated using appropriate erosion control measures per plans and specifications.

F. Additional erosion/sediment BMPs beyond what is shown on the plans may be required to comply with project permits and it shall be the responsibility of the contractor to implement additional BMPs as needed and as directed by the construction manager at no additional expense to the City.

G. Changes to the Plans may be made to respond to field conditions. Changes shall be noted on the plan when made.

H. At the conclusion of construction of certain task elements, the contractor will be required to implement additional post-construction erosion control measures where specified in the plans or where directed by the Engineer in order to protect natural

resources. These measures include, but are not limited to, installing seed, weed-free straw mulch and tackifier, weed-free straw wattles or fiber roles, and erosion control blanket consistent with the Project Plans.

I. Contractor shall comply with the project permits as required to ensure that water quality in Strongs Creek and tributaries is not degraded during construction activities and until the disturbed areas are stabilized and erosion potential is minimized. The Plans detail erosion and sediment BMPs that will be implemented to prevent entry of storm water runoff into the excavation site, entrainment of excavated contaminated materials leaving the site, and entry of polluted storm water runoff into waters during transportation and storage of excavated materials. BMPs that the Contractor shall implement include:
    1. Preservation of existing vegetation shall occur to the maximum extent practicable.
    2. Appropriate energy dissipation devises will be utilized to reduce or prevent erosion at discharge end of dewatering activity.
    3. Silt fences and or turbidity curtains shall be deployed as necessary during installation of selected coffer dams.
    4. Sediment sources shall be controlled using materials and methods specified in the Plans.
    5. Erosion control may include seeding, mulching, erosion control blankets, plastic coverings, and geotextiles that shall be implemented after completion of construction activities.
    6. Stockpiled material will be covered or watered to eliminate excessive dust, as necessary.
    7. Fiber roles or similar products will be utilized in appropriate locations to reduce sediment runoff from disturbed soils, as necessary.
    8. Excess water shall be pumped into the surrounding upland areas approved by the Engineer.
    9. Silt fences or water diversion structures shall be used to contain sediment. If sediment is not being contained adequately, as determined by visual observation, the activity shall cease.
    10. Construction materials, debris, and waste will not be placed or stored where it can enter into or be washed by rainfall into waters of the U.S./State.
    11. Appropriate vehicle storage, fueling, maintenance and cleaning areas shall be designated and maintained to prevent discharge of pollutants. Upland areas will be used for equipment refueling. If equipment must be washed, washing shall occur where wash water cannot flow into wetlands or waters of the U.S./States.
    12. Operators of heavy equipment, vehicles, and construction work will be instructed to avoid sensitive habitat/resource areas. To ensure construction occurs in the designated areas and does not impact environmentally sensitive areas, the boundaries of the work area shall be fenced or marked with flagging by the Contractor.
    13. Equipment when not in use shall be stored outside of wetlands and outside areas with drainage paths to wetlands and water ways.
    14. All construction equipment will be maintained to prevent leaks of fuels, lubricants or other fluids into the drainage channels and drainage paths. Service and refueling procedures will not be conducted where there is potential for fuel spills to seep or wash into water ways.
    15. Stationary equipment such as motors, pumps, generators, compressors, and welders, located within a dry portion of the drainage channels or adjacent to the

drainage channels shall be positioned over drip pans. The Contractor shall have spill containment materials located at the site, with operators trained in spill control procedures.

16. Extreme caution will be used when handling and/or storing chemicals and hazardous wastes (e.g., fuel and hydraulic fluid) near waterways, and any and all applicable laws and regulations will be followed. Appropriate materials shall be on site to prevent and manage spills. Contractor shall comply with the Emergency Spill Plan and Emergency Spill Response Plan and other relevant permit conditions.
17. Covered and secured storage areas for potentially toxic materials shall be provided. All hazardous material containers should be placed in secondary containment.
18. All construction vehicles or equipment shall be checked and maintained daily to prevent leaks of fuels and/or lubricants.
19. No debris, soil, silt, sand, bark, slash, sawdust, rubbish, oil or petroleum products, other organic material or earthen material from any construction related activity shall be allowed to enter into any waterways.
20. Soil and material stockpiles shall be properly protected to minimize sediment and pollutant transport from the construction site.
21. If, at any time, an unauthorized discharge of debris to surface water occurs, or any water quality problem arises, the associated project activities shall cease immediately until adequate BMPs are implemented, including stopping work. The regional water board will be notified by the Engineer promptly and in no case more than 24 hours after the unauthorized discharge or water quality problem arises.
22. The plans may not cover all the situations that arise during construction due to unanticipated field conditions. Variations may be made to the plan in the field subject to the approval of or at the direction of the Engineer.
23. Prior to final acceptance, all areas of the site will be vegetated or permanently stabilized and all temporary sediment control measures shall be removed.

3.2 INSTALLATION OF SILT FENCES

A. Silt fences shall extend a minimum of 16 inches above the ground surface and shall not exceed 34 inches above the ground surface. Filter fabric shall be from a continuous roll cut to the length of the barrier to avoid the use of joints. When joints are unavoidable, filter fabric shall be spliced together at a support post, with a minimum 6 inch overlap, and securely sealed. A trench shall be excavated approximately 4 inches wide and 4 inches deep on the upslope side of the location of the silt fence. The 4-inch by 4-inch trench shall be backfilled and the soil compacted over the filter fabric. Silt fences shall be removed upon approval by the Engineer.

B. Maximum spacing for post supports shall be 6 feet on center. Posts shall be buried 12 inches minimum and shall not exceed 36-inches above the ground surface.

3.3 INSTALLATION OF FIBER ROLES (SEDIMENT LOGS OR WATTLES)

A. Fine grade the subgrade by hand, dressing where necessary to remove local deviations and to remove larger stones or debris that will inhibit intimate contact of the fiber roll with the subgrade. Prior to roll installation, contour a concave key trench 2 to 4 inches deep along the proposed installation route. Soil excavated in trenching

should be placed on the uphill or flow side of the roll to prevent water from undercutting the roll.

B. Place fiber roles into the key trench and stake on both sides of the roll within 6 feet of each end. Spacing for stakes shall be 3 to 5 feet. Stakes are typically driven in on alternating sides of the roll. Stakes shall be buried 12 inches minimum.

C. When more than one fiber roll is placed in a row, the rows should be abutted securely to one another to provide a tight joint, not overlapped. Fiber roles shall be placed in a single row, lengthwise on the contour.

3.4 MAINTENANCE

A. The Contractor shall maintain the temporary and permanent vegetation, erosion and sediment control measures, and other protective measures in good and effective operating condition by performing routine inspections to determine condition and effectiveness, by restoration of destroyed vegetative cover, and by repair of erosion and sediment control measures and other protective measures. The following procedures shall be followed to maintain the protective measures.
   1. Silt Fence Maintenance. Silt fences shall be inspected in accordance with paragraph INSPECTIONS. Any required repairs shall be made promptly. Close attention shall be paid to the repair of damaged silt fence resulting from end runs and undercutting. Should the fabric on a silt fence decompose or become ineffective, and the barrier is still necessary, the fabric shall be replaced promptly. Sediment deposits shall be removed when deposits reach one-third of the height of the barrier. When a silt fence is no longer required, it shall be removed. The immediate area occupied by the fence and any sediment deposits shall be shaped to an acceptable grade. The areas disturbed by this shaping shall be re-vegetated.
   2. Fiber Role Maintenance. Fiber roll barriers shall be inspected in accordance with paragraph INSPECTIONS. Close attention shall be paid to the repair of damaged roles, end runs and undercutting beneath roles. Necessary repairs to barriers or replacement of roles shall be accomplished promptly. Sediment deposits shall be removed when deposits reach one-half of the height of the barrier. Roll rows used to retain sediment shall be turned uphill at each end of each row. When a fiber roll barrier is no longer required, it shall be removed. The immediate area occupied by the roll and any sediment deposits shall be shaped to an acceptable grade. The areas disturbed by this shaping shall be re-vegetated.

3.5 INSPECTIONS AND ACCEPTANCE

A. General. The Contractor shall inspect disturbed areas of the construction site, areas used for storage of materials that are exposed to precipitation that have not been finally stabilized, stabilization practices, structural practices, other controls, and areas where vehicles exit the site, at least once every seven (7) calendar days, within two (2) calendar days of forecasted rains, and within 24 hours of the end of any storm that produces 0.5 inches or more rainfall at the site.

B. Inspection Details. Disturbed areas and areas used for material storage that are exposed to precipitation shall be inspected for evidence of, or the potential for, pollutants entering the drainage system. Discharge locations or points shall be

inspected to ascertain whether erosion control measures are effective in preventing significant impacts to receiving waters. Locations where vehicles exit the site shall be inspected for evidence of offsite sediment tracking.

END OF SECTION

SECTION 32 11 23

AGGREGATE BASE COURSES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Aggregate subbase.
   2. Aggregate base course.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCES

A. ASTM International:
   1. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
   2. ASTM D2940 - Standard Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports.
   3. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Materials Source: Submit name of imported materials suppliers and Test Data.

1.5 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.

B. Perform Work in accordance with Caltrans Standard Plans.

PART 2 PRODUCTS

2.1 AGGREGATE MATERIALS

A. Aggregates for Earthwork: As specified in Section 31 05 16.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify compacted substrate is dry and ready to support paving and imposed loads.
   1. Proof roll substrate with fully loaded 10 cu yd. dump truck in minimum two perpendicular passes to identify soft spots.
   2. Remove soft substrate and replace with compacted fill as specified in Section 31 23 23.

C. Verify substrate has been inspected, gradients and elevations are correct.

3.2 PREPARATION

A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.

B. Do not place fill on soft or muddy surfaces.

3.3 AGGREGATE PLACEMENT

A. Spread aggregate over prepared substrate to total compacted thickness of minimum 6 inches as indicated on Drawings.

B. Roller compact aggregate to 95 percent maximum density per ASTM D698.

C. Level and contour surfaces to elevations, profiles, and gradients indicated.

D. Add small quantities of fine aggregate to coarse aggregate when required to assist compaction.

E. Maintain optimum moisture content of fill materials to attain specified compaction density.

F. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.4 TOLERANCES

A. Section 01 40 00 - Quality Requirements: Tolerances.

B. Maximum Variation from Elevation: 1/4 inch measured with 10 foot straight edge.

3.5 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.

B. Perform in place compaction tests in accordance with the following:
   1. Density Tests: ASTM D1556 or ASTM D6938.

2. Moisture Tests: ASTM D6938.

C. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

D. Frequency of Tests: One test for every 1000 square feet of each layer compacted aggregate.

3.6 COMPACTION

A. Compact materials to 95 percent of maximum density.

END OF SECTION

SECTION 32 12 16

HOT MIX ASPHALT PAVEMENT AND OVERLAYS

PART 1 GENERAL

1.1 DESCRIPTION

A. This section covers all material, equipment and labor required to construct hot mix asphalt pavement, including, but not limited to, placement of hot mix asphalt paving, tack coat, and temporary pavement.

B. Note: Aggregate base placed for street reconstruction is not covered in this section. Refer to Section 39-1.09B, “Subgrade” of the Caltrans Standard Specifications, and Section 31 23 16 - “Excavation” of these specifications for aggregate base roadbed specifications and additional requirements.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 QUALITY ASSURANCE

A. All materials shall conform to the applicable sections of the Caltrans Standard Specifications unless otherwise specified in these Specifications or on the Plans. In addition, all materials testing performed to provide quality assurance shall be performed in accordance with Section 01 40 00 Quality Requirements of these specifications.

1.4 SUBMITTALS

A. Submittals shall include, but not be limited to, the following items:
   1. Job mix formula per Caltrans Standard Specifications Section 39-1.03C for all hot mix asphalt material being used on the project.
   2. Load slips for all material delivery trucks shall be delivered to the job site with the truck. The Contractor shall retain all load slips, and shall make them available to the Engineer upon request.

PART 2 PRODUCTS

2.1 TEMPORARY HOT MIX ASPHALT PAVEMENT

A. Temporary pavement shall be hot mix asphalt conforming to the provisions of Section 39, “Hot Mix Asphalt” of the Caltrans Standard Specifications, plant mixed method. ”Cold mix" asphalt concrete containing SC-800 liquid asphalt may be used for temporary pavement.

2.2 TYPE “A” HOT MIX ASPHALT

A. Type “A” hot mix asphalt shall conform to the requirements for Type “A” hot mix asphalt with 1/2-inch HMA Type grading as specified in Section 39, “Hot Mix Asphalt” of the Caltrans Standard Specifications.

B. Asphalt binder for Type “A” hot mix asphalt shall be PG 64-16, as specified in Section 92, “Asphalts” of the Caltrans Standard Specifications. The amount of asphalt binder shall be determined by California Test 367 and provide a mix in conformance with Section 39-1.03B and approved by the Engineer.

2.3 OPEN GRADED FRICTION COURSE

A. Open graded friction course (OGFC), when specified, shall conform to the provisions of Section 39, “Hot Mix Asphalt” of the Caltrans Standard Specifications. Aggregate for OGFC shall conform to Section 39-1.02E OGFC table per the size shown on the plans.

B. Asphalt binder used for Open Graded hot mix asphalt pavement shall be PG 64-16 as specified in Section 92: “Asphalts” of the Caltrans Standard Specifications. The optimum amount of asphalt binder shall be determined by California Test 368 and approved by the Engineer.

2.4 PRIME COAT

A. Prime coat on aggregate base course will not be required.

2.5 TACK COAT

A. Paint binder (tack coat) shall be applied in one application at a rate of from 0.02-gallon to 0.10-gallon per square yard of surface covered. Tack coat shall conform with, and applied in conformance with Section 94, “Asphaltic Emulsions” of the Caltrans Standard Specifications. Tack Coat shall be type SS1 or RS1, and shall be applied to all vertical surfaces of existing pavement, curbs, gutters and construction joints.

2.6 SEAL COAT

A. No seal coat will be required.

2.7 PAVEMENT REINFORCING FABRIC

A. Pavement reinforcing fabric, if required, shall conform to Section 88-1.02J, “Paving Fabric” of the Caltrans Standard Specifications.

2.8 AGGREGATE BASE and SUBBASE

A. Aggregate base shall be Class 2 aggregate base and shall conform to the provisions in Section 26 “Aggregate Bases” of the Caltrans Standard Specifications and in addition the aggregate shall have at least 50% crushed coarse particles with at least one fractured face using Caltrans Test Method 205.

B. Aggregate for Class 2 aggregate base shall be free from organic matter and other deleterious substances and shall be of such nature that it can be compacted readily under watering and rolling to form a firm, stable base.

PART 3 EXECUTION

3.1 PAVEMENT REMOVAL

A. Pavement Grinding

1. Pavement grinding, when required, shall be performed in accordance with the requirements of Section 42-3, "Grinding," of the Caltrans Standard Specifications, as specified in these Special Provisions, and as directed by the Engineer.

2. The Contractor shall exercise care to avoid damaging existing concrete curbs and drainage facilities during all grinding operations. Damage to existing improvements shall be repaired at the Engineer's direction, and at the sole expense of the Contractor.

3. Prior to conducting grinding operations, the Contractor shall remove all weeds and dirt in the gutters and in cracks in the existing pavement surface to the satisfaction of the Engineer. The Contractor will not be permitted to use herbicides, and the method of weed removal shall be subject to the approval of the Engineer.

4. The Contractor shall completely remove all existing raised reflective markers from the street areas being ground.

5. The street shall be swept throughout the course of the grinding operations and shall be left thoroughly clean and clear of all grindings at the end of each working day. The Contractor shall exercise care to avoid spilling grindings into drainage inlets and cross-corner or cross-street` culverts, and shall promptly clean out any grindings that do spill into inlets or culverts.

6. Prior to initiation of grinding operations, the Contractor shall lower all traffic boxes and manhole lids and frames within the limits of the work.

7. Abrupt edges shall not be left in place when traffic is allowed back into the grinding area. Where abrupt edges exist (mid-block or on cross streets or alleys), or where directed by the Engineer, the Contractor shall build a transition ramp no shorter than 25 feet long that spans the entire length or width of the abrupt edge, lifting traffic out of the ground area and onto the surrounding pavement.

8. All A.C. grindings shall be disposed of by the Contractor.

B. Pavement Sawcutting

1. General
   a. Pavement sawcutting shall be performed with a wheel roller, pneumatic pavement cutter, or other sawcutting equipment approved by the Engineer. Depending upon the nature of the work, the sawcutting may be divided into two parts - initial sawcutting and final sawcutting

2. Initial Sawcutting
   a. All initial pavement sawcutting shall be to the full width required for the excavation, and to the full depth of the pavement, regardless of depth. All pavement material inside the sawcut limits shall be completely removed.

   b. Initial pavement sawcuts shall be straight and shall provide clean, solid, vertical faces free from loose or cracked material. All damaged or disturbed adjoining pavement shall be sawcut and removed.

3. Final Sawcutting
   a. Final sawcutting shall only be required where “T”-section trenches are shown on the Plans.

   b. All final sawcutting shall be made 6 inches wider on all sides than the width of the excavation, to the full depth of the pavement, regardless of depth, and after excavations have been backfilled. All pavement material inside the sawcut limits shall be completely removed. Final sawcutting shall be performed on all cross-street and cross-corner culverts, curbs, gutters, sidewalks, driveways, as shown on the Plans, and as directed by the Engineer.

   c. Final pavement sawcuts shall be straight and shall provide clean, solid, vertical faces free from loose or cracked material. All damaged or disturbed adjoining pavement shall be sawcut and removed. When possible, sawcuts shall be either parallel or perpendicular to the roadway centerline.

   d. The number of jogs in the sawcut lines shall be held to minimum and shall be subject to approval by the Engineer. The Contractor may be required to remove additional undisturbed pavement if, in the opinion of the Engineer, the lines are too erratic or contain too many jogs.

3.2 TEMPORARY PAVEMENT CONSTRUCTION

A. In all paved areas disturbed by the work, the Contractor shall install a minimum of 2 inches of temporary pavement before traffic is allowed back onto the area. The temporary surface shall be maintained by the Contractor at all hours of the day including non-working hours. The grade of temporary pavement shall be maintained to within one-half inch of the grade of adjacent roadway pavement until final pavement is installed, and shall be compacted such that the surface of the temporary pavement is flat. Temporary pavement shall be provided even if the existing pavement is to be removed later in street reconstruction.

B. Installation of temporary pavement by the Contractor prior to the obtaining of final compaction tests by the Engineer will in no way relieve the Contractor of obtaining final compaction before the required final paving is started. Temporary paving shall be removed in its entirety prior to placement of final pavement.

3.3 PERMANENT PAVEMENT CONSTRUCTION

A. The production, hauling, placing, compacting, and finishing of hot mix asphalt shall conform to Section 39, "Hot Mix Asphalt" of the Caltrans Standard Specifications.

1. Subgrade Preparation
   a. Subgrade shall be prepared in accordance with Section 39-1.09, "Subgrade, Tack Coat, and Geosynthetic Pavement Interlayer" of the Caltrans Standard Specifications and Section 31 23 17 Trenching of these specifications.

2. Roadway Base Placement
   a. Roadway base shall be placed and compacted in accordance with Section 26, "Aggregate Bases" of the Caltrans Standard Specifications and Section 32 11 23 Aggregate Base Courses of these specifications.

3. Tack Coat
   a. Prior to placing tack coat on existing pavement surfaces, the existing surface shall be swept clean of all dirt and dust.

   b. Tack coat (paint binder) shall be applied to all surfaces against which new hot mix asphalt pavement is to be placed in accordance with Section 39-1.09, "Subgrade, Tack Coat, and Geosynthetic Pavement Interlayer" of the Caltrans Standard Specifications. When being applied for paving fabric installation, tack coat shall extend 3 inches beyond the width of the paving fabric on all sides.

4. Pavement Reinforcing Fabric
   a. Pavement reinforcing fabric, when specified, shall be installed immediately after the tack coat is applied, in accordance with Section 39-1.09, "Subgrade, Tack Coat, and Geosynthetic Pavement Layer" of the Caltrans Standard Specifications. The fabric shall be aligned and placed with no wrinkles that lap. Adjacent borders of the fabric shall be lapped 2 to 4 inches.

   b. Seating of the fabric with rolling equipment after placement will be permitted. Turning of material trucks and the paving machine shall be kept to a minimum to avoid pulling the fabric away from the tack coat.

5. Hot Mix Asphalt Placement
   a. All hot mix asphalt shall be installed in accordance with Section 39, "Hot Mix Asphalt" of the Caltrans Standard Specifications. Unless lower temperatures are approved by the Engineer, all mixtures (except OGFC) shall be spread, and the first coverage of initial and breakdown compaction performed, when the temperature is not less than 250°F (120°C), and all breakdown compaction shall be completed before the temperature of the mixture drops below 200°F (95°C). Type "A" hot mix asphalt shall be placed only when the atmospheric temperature is above 50°F (10°C). Failure to meet temperature restrictions is grounds for rejection of the work by the Engineer.

   b. OGFC shall be spread at a temperature of not less than 200°F (95°C) and not more than 250°F(120°C), measured in the hopper of the paving machine. OGFC shall be placed only when the atmospheric temperature is above 50°F (10°C). Failure to meet temperature restrictions is grounds for rejection of the work by the Engineer.

   c. When spreading hot mix asphalt, the maximum screed width of any one pass shall be as directed by the Engineer. Compaction shall conform to Section 39-3, "Method Construction Process" of the Caltrans Standard Specifications.

   d. The completed surface shall be thoroughly compacted, smooth, and free from ruts, humps, depressions, or irregularities. Any ridges, indentations or other objectionable marks left in the surface of the hot mix asphalt by rollers, rakes, or other equipment shall be eliminated immediately.

6. Surface Tolerance
   a. The finished surface of all permanent hot mix asphalt and OGFC shall conform to Section 39-1.12, "Smoothness" of the Caltrans Standard Specifications.

END OF SECTION

SECTION 32 91 13

SOIL PREPARATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Preparation of subsoil.
   2. Soil testing.
   3. Placing topsoil.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

PART 2 PRODUCTS

2.1 SOIL MATERIALS

A. Topsoil: As specified in Section 31 05 13.

2.2 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Testing, inspection and analysis requirements.

B. Analyze to ascertain percentage of nitrogen, phosphorus, soluble salt content, organic matter content, and pH value.

C. Provide recommendation for fertilizer and lime application rates for specified seed mix as result of testing.

D. Testing is not required when recent tests and certificates are available for imported topsoil. Submit these test results to testing laboratory. Indicate, by test results, information necessary to determine suitability.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify prepared soil base is ready to receive the Work of this section.

3.2 PREPARATION OF SUBSOIL

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

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

C. Remove all cobbles and stones larger than 1” and other debris prior to placing top soil.

D. Scarify subsoil to depth of 3 inches where topsoil is to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted sub-soil.

3.3 PLACING TOPSOIL

A. Spread topsoil to minimum depth indicated on the plans. Rake until smooth.

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

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

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

END OF SECTION

SECTION 32 92 19

SEEDING

PART 1 GENERAL

1.1 GENERAL

A. The Work consists of sowing seed, mulch, and inoculant, and anchoring mulch in designated areas that have been disturbed by project activities, in naturalized habitats as shown on project plans and specified herein.

B. Contractor shall provide all material, labor and equipment necessary to perform the work.

C. Contractor shall coordinate with a local native plant nursery to secure and obtain local seed.

D. Contractor shall actively seed and mulch areas where earthwork and/or grading and ground disturbance has impacted naturalized areas, and reseed any disturbed areas or areas where active seeding did not germinate within the Six Month Seed Establishment Warranty Period. The revegetation areas identified in this Specification are Naturalized Seed Mix

E. The Contractor is not responsible for seed maintenance beyond the Six Month Seed Establishment and Maintenance Period unless the minimum percent survivability has not been achieved (see Six Month Seed Establishment and Maintenance Period section).

F. After active seeding commences, Contractor shall guarantee work for a minimum duration of six months with minimum 70% survivability or greater of seed species used in the seeding application (Refer to Section 3.8 Six Month Seed Establishment and Maintenance Period).

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCES

A. Nomenclature: "The Jepson Manual: Vascular Plants of California Second Edition," 2012 edition; University of California Press, Berkeley, CA.

B. Plant material standards: "American Standard for Nursery Stock," 2004 edition; American Association of Nurserymen.

C. The Contractor shall comply with all provisions from the California Invasive Plant Council (Cal IPC) regarding control of invasive plants listed in the California Invasive Plant Council's (Cal- IPC) that are rated high or moderate by the Cal-IPC list or

Humboldt weed Management Area list (HWMA). Information is available online at: http://www.cal-ipc.org/ip/inventory/weedlist.php

1.4 SUBMITTALS

A. Inspection certificates for plant diseases and infestations.

B. Certified Weed Free Mulch: Manufacturer's receipt that describes the provenance and constituents of mulch and certifies that it meets the specification described in this Section.

C. A letter, signed certification or appropriate lot tag, from propagule provider stating scientific name, common name, and origin of plant material to confirm that it meets the requirements described in this 022700-1 Revegetation Specifications.

D. Plant Establishment and Maintenance period shall be six months (Specified in Section 3.8).
   1. Plant maintenance service schedule and chart shall be submitted for review and approval by the Engineer.

1.5 QUALITY ASSURANCE

A. Contractor or Subcontractor shall have a minimum of five (5) years verifiable experience in revegetation, including maintenance.
   1. Contractor will provide staff able to perform work at the highest standards of horticultural excellence. Key staff shall have current knowledge of best management practices (BMP's) regarding: safety, hazardous materials spill response, plant health, pruning/thinning, and irrigation maintenance. The District reserves the right to demand the replacement of Contractor's staff who does not meet the District's standards for safety, professionalism, or horticultural knowledge.

B. Seed shall be graded and tagged in accordance with the American Standard for Nursery Stock as sponsored by American Association of Nurserymen, Incorporated (ANSI 260.1). Tags shall remain on plants until inspected and accepted by Engineer. Notify Engineer when seed is on-site to allow for an inspection to verify species, and quantities.

C. Certified Weed Free Mulch: Manufacturer's receipt that describes the provenance and constituents of mulch and certifies that it meets the specification described in this Section. Receipt shall certify that mulch does not contain noxious weeds or originate from a Sudden Oak Death host seed species derived from a quarantined county.

D. Special Status Species and Sensitive Habitats: Contractor shall be familiar with all environmental conditions described in the related sections as identified in Part 1.2 of this Specification.

1.6 TIMING AND COORDINATION

A. The Contractor shall inform the Engineer ten (10) working days prior to implementation of this Specification Section.

B. Order and Timing of Work: The following approximate order of Work and timeframes are assumed for the Work.
   1. Layout of seeding areas.
   2. Delivery of seed stock and revegetation materials.
   3. Active seeding of areas defined in Section 1.1 and as shown on the Drawings.

C. For each revegetation area, the Contractor shall request observation for commencement of the Six (6) Month Plant Establishment and Maintenance Period after Work of this Section has been implemented.
   1. At each revegetation area, the Six Month Seed Establishment and Maintenance Period shall begin upon written notice of acceptance by the Engineer and continue for a minimum of six months.

D. The Contractor shall provide all equipment, labor, and materials required to perform the required maintenance as described in this specification during the Six Month Seed Establishment and Maintenance Period.

E. The Contractor shall schedule on-site inspections as needed to ensure the proper maintenance of the seeded materials.

F. Prior to conducting all maintenance work, the Contractor shall contact the Engineer to inform them of the location, type of work to be done, and the equipment to be used. The Engineer may or may not approve the proposed maintenance work.
   1. Progress inspections: Periodic progress inspections may be made by the Engineer.

G. Completion of the Six (6) Month Seed Establishment and Maintenance Period shall be confirmed in writing by the Engineer.

PART 2 PRODUCTS

2.1 PRODUCTS

A. Seed: All seed shall be supplied by the Contractor and shall be purchased from a local supplier and shall be comprised of local coastal Humboldt County seed stock when available. Seed shall be delivered to the site tagged and labeled in accordance with the California Agricultural Code and shall be acceptable to the County Agricultural commissioner. Bag tag figures shall be evidence of purity and germination. Time since date of seed test shall not exceed 9 months.
   1. Seed shall be of a quality that weed seed shall not exceed 0.5 percent of the aggregate of pure live seed (percent germination x percent purity) and other material.
   2. Seed shall be minimum seventy (70) pure live seed (PLS = percent purity x percent germination), or less if allowed per the Planting Plan (and/or less if justifiable reasoning for not meeting this requirement).
   3. Legume seed shall be inoculated with inoculate specific to its needs within two hours prior to seeding. Inoculants shall not be used later than the date indicated on the container or as otherwise specified. All inoculated seed shall be labeled to show weight of seed, date of inoculation, and the weight and source of inoculated materials.

4. Seed shall be furnished in mixture as specified in this section. Seeds shall be purchased from a local supplier and shall be comprised of local Humboldt County Bay coastal dune ecoregion seed stock, ideally from within 15 miles radius of the project site. Substitutions based on availability of local seeds shall be approved by the Engineer.
5. Seed Quantities: Seed will be applied at 50 lbs/acre. Seed quantities (lbs.) per species for active seeding (including 10% supplemental seed quantity) are listed below:

Species Quantity (lbs/acre)	Vegetation Species Name	Common Name
0.5	Achilea millefolium	yarrow
0.5	Anaphalis margaritacea	pearly everlasting
0.3	Deschampsia caespitosa	hairgrass
0.3	Festuca rubra	red fescue
0.4	Danthonia californica	California oatgrass
0.3	Festuca californica	California fescue

6. Contractor shall assume minimum 10% supplemental seeding for areas that are exhibiting lack of germination and coverage and for those areas damaged by construction (post seeding application), to ensure matching ratios of seed composition shown on Drawings, in this Specification and/or as recommended by the Engineer. All supplemental seeds shall be in accordance with this Specification, Section 1.4 Submittals.

B. Fiber: Hydroseed mix fiber material shall be wood cellulose fiber containing no growth or germination-inhibiting factors. Natural wood cellulose fiber shall have the property of dispersing readily in water and shall have no toxic effect when combined with seed or other material. The homogenous slurry or mixture shall be capable of application with power spray equipment. A green colored dye which is non-injurious to plant growth shall be used. Wood cellulose fiber shall be packaged in new label containers marked by the manufacturer to show the air-dry weight content. The fibrous mulch in its air-dry state shall contain no more than 15% by weight of water.

C. Stabilizing Emulsion: Stabilizing emulsion shall be a concentrated liquid chemical that forms a plastic film upon drying and allows water and air to penetrate. The film shall be nonflammable and shall have an effective life of at least 1 year. Stabilizing emulsion shall be nontoxic to plant or animal life. In the cured state, the stabilizing emulsion shall not be re-emulsified. The material shall be registered with and licensed by the State of California, Department of Food and Agriculture, as an "Auxiliary Soil Chemical." Stabilizing emulsion shall be miscible with water at the time of mixing an application. Stabilizing emulsion shall not be applied during rainy weather or when soil temperatures are below 40 degrees Fahrenheit. Pedestrians or equipment shall not enter seeded areas after materials have been applied without approval by the District.

D. Mycorrhizal Inoculum: Endo (arbuscular) mycorrhizal inoculum shall be registered by the California Department of Food and Agriculture and consist of spores, mycelium and mycorrhizal root fragments in a solid carrier suitable for handling by hydro-seeding.
   1. The carrier shall be the material in which the inoculum was originally produced, and may include organic materials, vermiculite, perlite, calcined clay, or other

approved materials consistent with mechanical application and with good plant growth.

2. Each endomycorrhizal inoculum shall carry a supplier's guarantee of 80,000 propagules minimum per kilogram. The minimum propagule count shall be shown on each label provided. If more than one fungal species is claimed by the supplier, the label shall include a guarantee for each species of mycorrhizal fungus claimed.
3. Endomycorrhizal fungal species shall be suitable for the pH of the soil at the planting site. If the inoculum consists of a mixture of species, no more than 20% of the claimed propagule count shall consist of fungal species known to be unsuitable for the pH of the soil at the planting site.
4. A sample of approximately 28 grams (one ounce) of inoculum will be taken from each inoculum container by the Contractor. The number of propagules will be determined by laboratory testing. Propagules shall include live spores, mycelial fragments and viable mycorrhizal root fragments.
5. Endomycorrhizal inoculum shall be stored, transported and applied at temperatures of less than 32° C (90° F).

E. Mulch: Mulch shall be derived from certified weed free rice straw, approved imported weed free wood chips or approved wood chips generated onsite. Material shall be free of salt, foreign and deleterious materials.
   1. Materials for imported wood mulch shall not contain noxious weeds or originate from a Sudden Oak Death host seed species derived from a quarantined county. Imported wood mulch shall not be produced from tree trimmings that contain leaves, seeds, inflorescences, or small twigs.
   2. Rice Straw: Shall be 3 to 8 inches in length. The contractor shall furnish evidence that clearance has been obtained from the County Agricultural Commissioner, as required by law, before straw from outside the county in which it is to be used is delivered to the site of the work. Straw that has been used for animal/livestock bedding is prohibited.

F. Water: Water shall be clean, potable, and free of deleterious material.

PART 3 EXECUTION

3.1 NATURALIZED SEEDING AREAS

A. Seeding Methods: broadcast seeding may be employed in the naturalized area planting zone.
   1. Broadcast seeding with a Cyclone Type Seeder: Seed shall be broadcast using manually operated cyclone-type spreaders or by hand. After seedbed preparation has been completed, seeds shall be applied over disturbed areas by uniformly broadcast seeding the seed mix at the specified seeding rate. Broadcast seeding shall be applied as soon as final grading is completed and after September 15. Unless otherwise approved by the Engineer, seeding shall be completed by October 1 for the grassland enhancement areas and October 30 for the disturbed areas with erosion control mix, in the year site work is complete.
   2. Remedial Seeding: The Contractor shall be required to reseed areas that fail to grow by the end of the first growing season if eighty-five (85) percent vegetative

establishment is not achieved. Eighty-five (85) percent establishment is based on the density of the natural herbaceous cover in the surrounding area.

B. Mulching: Contractor shall spread mulch uniformly over the area. If a mulch blower is used, the strands shall not be shredded less than eight (8) inches in length to allow anchoring. Anchor mulch immediately after placing to minimize loss by wind and water. Use a mulch anchoring tool that is a series of straight notched disks specifically designed for the purpose, to crimp the mulch to a depth of two (2) to three (3) inches. To maintain proper seed depth, a regular farm disc shall not be used to crimp mulch. Mulch treatments shall be performed in conjunction with broadcast seeding in in the naturalized planting zone are as follows:
   1. Mulch with certified weed free straw by uniformly spreading mulch over the seeded area at the specified rate.
   2. Broadcast seeding, performed immediately after crimped straw installation, is allowed.
   3. The contractor shall clean up areas of straw which are blown from the site, and the areas shall be retreated at no additional expense.

C. Preliminary Inspection: Notify the Engineer 48 hours in advance of all seeding. Inspection and favorable review of the completed work shall begin the Six Month Six Month Seed Establishment and Maintenance Period.

D. Final Inspection and Acceptance: Final inspection shall be conducted upon completion of maintenance replacements, and corrective work. Five (5) working days' notice shall be given. If project improvements, corrective work, and maintenance have not been performed as specified and to the satisfaction of the Engineer, maintenance shall continue at the Contractor's expense until such time as work has been successfully completed.

E. Guarantee and Replacement:
   1. Replace all seeded areas not in vigorous condition as soon as directed by the Engineer. Repair any areas where grass does not become established during the Six Month Seed Establishment and Maintenance Period. Seed mixtures used for replacement must be of the same kind and quantity as specified in this Section 2.1 Products Section.
   2. Guarantee all seeding to be in good health and in thriving condition until the end of the Six Month Six Month Seed Establishment and Maintenance Period.

3.2 SEED APPLICATION

1. Prior to commencing revegetation seeding, Contractor shall protect native dunes, wetland, and the endangered wall flower as shown on the Drawings.
2. Naturalized Areas: Broadcast or hydroseeding seeding and mulching shall occur where disturbance has occurred in the naturalized areas as shown on the Drawings.

3.3 IRRIGATION

A. The Contractor shall water all plants after the initial installation.

B. Methods: Water may be provided by hand spraying water from a water truck or other portable water system. Water may be sourced from sources that are available (and

permitted) to the project District. No high-pressure or fire hoses may be used for irrigation.

C. Contractor shall inspect plants for signs of water stress and water accordingly during the Six Month Six Month Seed Establishment and Maintenance Period to maintain adequate moisture depth in soil to insure vigorous growth; hand water as required

3.4 FIELD QUALITY CONTROL

A. Preparation: Contractor shall only commence seeding work once a notice to proceed has been received from Districts Representative.

B. Contractor shall coordinate with Districts Representative to confirm the locations of each revegetation area prior to implementation.

C. Each revegetation area shall be flagged by Contractor at the direction of Districts Representative and constitute the limits of that seeding/planting area

D. Contractor shall use a clearly visible, unique, colored flag for each seeding area.

E. Contractor shall not commence Six Month Six Month Seed Establishment and Maintenance Period work until approval has been received from Engineer.

F. Contractor shall notify Engineer a minimum of 10 working days prior to the following inspections, unless otherwise noted herein:
   1. Inspections.
   2. Installation of supplemental revegetation.

G. Progress inspections: Periodic progress inspections may be made by Engineer.

3.5 INSPECTIONS

A. The Contractor shall conduct weekly (4 times per month for a total of 24 inspections) on-site inspections during the Six Month Six Month Seed Establishment and Maintenance Period. Inspection shall include, at a minimum, assessment of damaged, injured, or non-performing seeded or planted areas, need for supplemental revegetation, non-native and/or competitive weed removal, and need for additional mulch or irrigation. A weekly inspection report including data collected and assessment of the seed establishment as described herein shall be provided to the Engineer within five (5) working days of each inspection.
   1. Contractor shall inspect the site at least once every seven (7) calendar days, within two (2) calendar days of forecasted rains, and within 24 hours of the end of any storm that produces 0.5 inches or more rainfall at the site.

B. Remedial Revegetation: The Contractor shall be required to correct any deficiencies to Engineer's satisfaction by reseeding areas that fail to grow by the end of the Six Month Seed Establishment and Warranty Period if a minimum of seventy (70) percent vegetative establishment of the actively seeded/planted species is not achieved.

3.6 SUPPLEMENTAL SEEDING AND PLANTING

A. Replacement seeding shall occur in areas of bare soil greater than five square feet. Seeds must be of the same quality as specified in 2.1 A of this specification and installed per section 3.1 Naturalized Seeding Areas.

B. After seeding application, mulch mixture shall be lightly compacted into the soil surface to help insure good soil/seed contact.

C. Supplemental seeding shall be marked on the Record Drawings to be used during monitoring.

3.7 CLEAN-UP

A. Immediately remove all seeding materials from the site post implementation.

3.8 SIX MONTH SEED ESTABLISHMENT AND MAINTENANCE PERIOD

A. Seed Establishment Period: Contractor shall notify Engineer at least one week prior to completion of all revegetation and related work for the initial inspection. The approval shall signify that the live material has been satisfactorily installed and the "Six Month Seed Establishment and Warranty Period" may begin.
   1. If the inspection reveals deficiencies in the seeding or live material stock seeded areas, Engineer shall give the Contractor a list of deficiencies to be corrected by the Contractor.
   2. If the inspection reveals deficiencies in the seeding or seeded material stock before the end of Six Month Seed Establishment and Warranty Period, Engineer shall give the Contractor a list of deficiencies to be corrected by the Contractor.

B. Protect seeded areas against damage during Six Month Seed Establishment and Warranty Period until Final approval. If any revegetation area becomes damaged or injured, remedy or replace immediately as directed by Engineer at no additional cost to District.

C. Guarantee and Replacement:
   1. Guarantee all seeding to be in good health and in thriving condition until the end of the maintenance period or until active growth is evident for six (6) months from date of acceptance.
   2. Replace any seeded areas, which fail to establish normal healthy growth or are missing during the first six months. Additionally, replace seeding stock based on the success criteria within Six Month Seed Establishment and Warranty Period at no additional cost to District.

D. The Contractor shall be responsible for keeping areas free of weeds at all times during Six Month Seed Establishment and Warranty Period.

E. Replenish mulch (if applicable) and maintain adequate soil moisture at all times during Establishment and Warranty Period.

F. At the conclusion of the Six Month Seed Establishment and Warranty Period, the revegetation areas shall be compared to the "Six Month Seed Establishment and

Warranty Period Success Criteria" below. This success criterion must be met in order for sign-off of completion of the Establishment and Warranty Period and to relieve Contractor of maintenance requirements. Once the District signs off that the below success criteria have been met, it shall be the Districts responsibility to ensure the site is managed in order to meet subsequent annual success criteria.

1. All seeded Areas
    a. Minimum of 70% survivability of seeded grass species and/or native and naturalized grass species known from the project area with 100% mulch cover; No more than five percent relative cover of non-native invasive plants*. No large unvegetated bare spots or erosional areas greater than 5 square feet.

* Invasive species are defined as those listed by the California Invasive Species Council (Cal-IPC) and/or those plants defined in the Humboldt Weed Management Area Strategic Weed List.

G. Final Inspection and Acceptance: Final inspection will be conducted upon completion of maintenance replacements, and corrective work. Five (5) working days' notice shall be given. If project improvements, corrective work, and maintenance have not been performed as specified and to the satisfaction of DU Representative, maintenance shall continue at the Contractor's expense until such time as work has been successfully completed.

END OF SECTION

SECTION 33 05 07.21

SHAFT CONSTRUCTION

PART 1 GENERAL

1.1 REQUIREMENTS

A. This section specifies the requirements for excavating, sheeting, and shoring required to construct jacking, receiving, and rescue shafts for tunneling.

B. Assume sole responsibility for designing, locating, and sizing the shaft excavations to accommodate the construction method, all existing utilities, all permanent structures, and conform to right-of-way limitations.

C. Relocate, support, or bypass all utilities required in the performance of the Work.

D. Other excavations as specified in Section 33 05 07.22.

E. Furnish all designs, tools, equipment, materials and supplies, and perform all labor required to complete the Work as indicated on the Approved Plans and specified herein.

F. Shafts located within Caltrans (CT) ROW are subject to CT review, acceptance, and inspection. This includes associated work required to complete the work.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards effective at time of bid:
   1. ASTM A36 - Specification for Carbon Structural Steel
   2. ASTM A328 - Specification for Steel Sheet Piling
   3. ASTM A500 - Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
   4. ASTM A572 - Specification for High-Strength Low-Alloy Columbian-Vanadium Structural Steel
   5. ASTM A992 - Specification for Structural Steel Shapes
   6. ASTM C33 - Specification for Concrete Aggregates
   7. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
   8. ASTM C109 - Compressive Strength of Hydraulic Cement Mortars (Using 2- inch or [50-mm] Cube Specimens)
   9. ASTM C150 - Specification for Portland Cement
   10. ASTM C618 - Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
   11. AWS D1.1/D1.1M - Structural Welding Code - Steel

12. NFPA 241 – Standard for Safeguarding Construction, Alteration, and Demolition Operations
13. NSF/ANSI Standard 060 - Drinking Water Treatment Chemicals – Health Effects

B. State Regulatory Codes to be current at all times:
   1. California Code of Regulations (CCR), Title 8, Tunnel Safety Orders
   2. CCR, Title 8, Construction Safety Orders, Section 1509 “Injury and Illness Prevention Program
   3. Caltrans (CT) Manual for Encroachment Permits on California State Highways
   4. CT Trenching and Shoring Manual

1.4 DEFINITIONS

A. As defined in Section 33 05 07.22.

1.5 PROJECT SITE CONDITIONS

A. As stated in Section 33 05 07.22.

1.6 DESIGN REQUIREMENTS

A. Design shafts to conform to right-of-way limitations as shown on the Plans.

B. Design temporary shoring system to provide a minimum factor of safety of 2.0 against sliding and 1.5 against bottom heave. Design shaft sides and bottom sufficient to support Contractor’s construction equipment and means and methods.

C. Coordinate the shaft design and construction submittals with the Specifications referenced above. Include, and not limited to maximum allowable jacking forces, loads induced by ground pre-treatment, and traffic loads.

D. Demonstrate casing joint length, carrier pipe joint length, and PTM construction method are compatible with jacking shaft length.

E. Design excavation support systems compatible with the subsurface ground conditions identified in Section 33 05 07.22.

F. Design, provide, and operate a dewatering system in compliance with Section 31 23 19 so as to maintain groundwater at least 2 feet below the excavation.

G. Drill ground to minimize vibration and allow for shoring installation and shaft excavation.

H. Upon completion of shaft excavation install sump pump(s) to remove all incidental, construction, and storm water. Water shall be treated and disposed in conformance with Section 31 23 19 and as permitted.

1.7 PERFORMANCE REQUIREMENTS

A. Design and construct the shaft using materials that limit water inflow to less than 2 gallons per minute from all sources before and during tunneling operations except as specifically specified otherwise. Limit groundwater inflow before PTM commences.

B. Sump pumping shall not be used as a method of dewatering.

1.8 QUALITY ASSURANCE

A. Contractor's Engineer: Excavation support systems shall be designed by a Civil or Structural engineer registered in the State of California who has a minimum of five (5) years of experience in shaft designs including shafts of similar size and in similar ground conditions as measured by ground type, N values, and depth of groundwater.

B. Surveyor: Surveying shall be performed by a California licensed surveyor who has surveyed a minimum of five (5) tunnels in the last five (5) years and transferred line and grade within a shaft.

C. Initial Survey: Prior to beginning demolition or excavation, perform a survey in accordance with Section 31 09 13 that identifies and locates facilities within 50 feet of the shaft excavation.

D. Work Plan: Loads, materials and equipment to be used, the method and sequence and timing of installation, and site restoration plan.

E. Field Inspection Plan: for field verification of the shaft design that at a minimum, measures and records settlement, bottom heave, groundwater elevation, and shaft member deflections daily in accordance with accepted submittals.

F. Installation Logs: include the following as applicable:
   1. Shoring element number, location, length, plumbness, and bearing material.
   2. Concrete, grout, and steel properties.
   3. Dates for excavation completed and concrete placed.
   4. Diameter of top and bottom of shaft.
   5. Elevations of top of ground, top of shoring elements, and bottom of shoring elements.
   6. Results of all tests and observations.

G. Cutter Soil Mixing (CSM), jet grout, and other soil replacement methods: Construct in-the-field test panels to validate the design assumptions and to determine grout injection rates. Take and test the compressive strength of concrete cast into the panels.

1.9 SUBMITTALS

A. Submittals shall be made in accordance with Section 01 33 00 and as specified herein.

B. Shaft submittals shall be coordinated with submittals from all sections referenced above, assembled and submitted as a single, comprehensive submittal.

C. Where calculations are required to be submitted, they shall be signed and sealed by a Professional Civil Engineer registered in the State of California. Calculations shall clearly identify all parameters used, state all assumptions made in the calculation, and identify all sources of information.

D. All shop drawings shall be legible with dimensions accurately shown and clearly marked in English.

E. Qualifying submittals:

1. Qualifications of Contractor's Engineer and Surveyor.
2. Product Data:
    a. Materials specified in Part 2.
    b. Material Safety Data Sheets.
    c. Manufacturer's mixing and handling requirements, personal safety equipment, first aid measures, and methods for proper storage and disposal of waste materials, including containers.
3. Certifications:
    a. Products described herein including Certificates of Compliance from the manufacturer.
    b. Personnel trained in handling, mixing, injection, and disposal of materials.
4. Work Plans:
    a. Specific to the design.
    b. Specific to the selected materials.
5. Contingency Plans
    a. Ground conditions are different than those anticipated.
    b. Groundwater conditions are different than those anticipated.
    c. Shoring moves more than allowed in shaft design.
    d. Members are out of design tolerance, i.e. out of vertical.
6. Field Inspection Plans as direct by the design.

F. Pre-Construction submittals:
1. Calculations, including jacking force impacts and penetrations:
    a. Bottom heave.
    b. Lateral support.
    c. Provide design calculations used to size shoring members, determinable material specifications and joint and connection details. Include stability evaluations at each stage of excavation, backfill and shoring removal, and tunnel penetration. Indicate calculated deflections for allowable load limits.
2. Shop Drawings: signed and stamped, shall include:
    a. Existing Site Plan: for each shaft location indicating utilities, structures, and vegetation that are to be protected in place.
    b. Site Plan: for each shaft indicating the location, excavation dimensions, site grading, and site development details for the excavation and work areas, and the proposed limits of disturbance. Include details of types, amounts, and positioning of materials and equipment required at each location. Show overhead utilities and other overhead conflicts.
    c. Methods, procedures, and sequence for preloading and installing bracing.
    d. Foundation details for all permanent structures.
3. Shop drawings for crane positioning at each shaft location:

a. Drawings showing different crane positions to be used that demonstrate safe swing in and around existing aerial utilities.
b. Shoring construction and removal sequence in conjunction with backfill placement.

4. Sample daily log forms.
5. Concrete design mix and compressive strength test results.

G. Construction Submittals:
1. Shaft field inspection data on the same date as taken and interpretation by noon the following work day.
2. Daily Installation Logs.
3. Concrete test results from a certified laboratory.
4. Field test results for each concrete mix.
5. Field test results for each field test panel.

PART 2 PRODUCTS

2.1 MATERIALS

A. Provide all shoring materials in accordance with accepted submittals.

B. Structural Steel, as a minimum:
1. HP shapes: ASTM A 572, Gr. 50.
2. Channels, angles and plates: ASTM A 36
3. Wide flange: ASTM A 992.
4. Hollow steel section: ASTM A 500.
5. Sheet piles: ASTM A 328.

C. Corrugated Metal Pipe (CMP): Zinc Coated.

D. Concrete materials:
1. Portland Cement: ASTM C 150, Type I or II unless otherwise required in the design.
2. Fly Ash/Slag unless otherwise required in the design:
a. Fly Ash Admixture: ASTM C 618, Class C or F
b. Ground Granulated Blast Furnace Slag: ASTM C 33, uniformly graded, ¾ in maximum aggregate size.
3. Normal Weight Aggregate: ASTM C 33, uniformly graded, ¾ in maximum aggregate size.
4. Concrete strength per ASTM C39 or C109.

E. Water: Potable.

F. Bentonite: High yield sodium bentonite; NSF/ANSI Standard 060 compliant.

G. Admixtures: Shall be accepted by the Owner. If commercially available and acceptable to the product manufacturer all polymers, and additives, other than soda ash, shall be NSF/ANSI Standard 060 compliant.

H. Welding unless otherwise required in the design: AWS D1.1/D1.1M.

I. Corrugated Metal Pipe/Casing unless otherwise required in the design:
   1. ASTM A36.
   2. Zinc coating.
   3. Minimum of ¼ inch thick.

PART 3 EXECUTION

3.1 GENERAL

A. Perform all work in accordance with accepted submittals.

B. Provide Owner with access to the shaft.

C. Provide the Owner with access to review and copy associated records.

D. Upon Owner's request, allow for the collection of ground and spoils samples.

E. Maintain a copy of the Approved Plans and accepted submittals at a location acceptable to and accessible to Owner.

F. Before commencing with any excavation perform preconstruction activities in conformance with Section 31 23 16.

G. Install all instrumentation in accordance with Section 31 09 13.

H. Prior to commencing shaft excavation, comply with:
   1. CCR, Title 8, Tunnel Safety Orders;
   2. CT Manual for Encroachment Permits on California State Highways; and
   3. CT Trenching and Shoring Manual.

I. Dispose of all excess earthen materials in conformance with Section 31 05 13.

J. Treat and legally dispose of all water in accordance with Section 31 23 19.

3.2 SHAFT SIZE AND LOCATION

A. Proposed shaft locations are as shown on the Approved Plans.

B. Shaft sizes are as determined by the Contractor and accepted by Owner.

C. Proposed shafts at locations other than where shown on the Approved Plans shall comply with the following conditions:
   1. Alternate, rescue, or additional shaft locations shall be defined as alternate shaft locations proposed by the Contractor.
   2. Alternate shaft locations shall be acceptable to the Owner and not be:
      a. Located in cross streets,
      b. Block a sole entrance or exit to a property, or
      c. Relocated within Caltrans ROW without Caltrans' written approval.

D. Drill ground as needed to minimize impact and allow proper placement of shaft members.

E. Obtain and provide all approvals and permits for alternate shaft locations to the Owner.

F. Contractor's Surveyor shall stake locations of the shaft elements and guide frames as required by the Contractor's design.

3.3 EXCAVATION

A. Locate all utilities before commencing excavation.

B. All earthwork shall be in accordance with Section 31 05 13.

C. Fill and compact with backfill in accordance with Section 31 23 17 and 31 05 16.

3.4 SHAFT CONSTRUCTION: GENERAL

A. Protect existing structures, utilities, vegetation, and facilities before commencing shaft excavation.

B. Construct instrumentation as shown on the Plans and as specified in Section 31 09 13 before shaft excavation.

C. Drill ground as needed to minimize impact and allow proper placement of shaft members

D. If settlement or deflections of supports or shaft bottom indicate the support system requires modification, the Contractor's Engineer shall redesign and resubmit revised shop drawings and design calculations.

E. Construct jacking shafts with the shoring flush with the existing ground surface or extending not more than 4 feet above the existing ground surface.

F. Rescue Shaft Construction: Vertical shaft boring with a CMP liner is an acceptable construction method. Construct rescue shaft in front of the MTBM. Push the MTBM into the rescue shaft.

3.5 SHAFT CONSTRUCTION: INTERNAL BRACING SUPPORT SYSTEM

A. Construct the internal bracing support system using walers, struts, and/or shores as required by the design accepted in the Contractor's submittals.

B. Construct and maintain all bracing support members in intimate contact with other support members and with the ground.

C. Preload bracing members by jacking struts to no more than 50 percent of the design load as provided in the accepted submittals.

D. Preload bracing members in accordance with methods, procedures, and sequence as described on the shop drawings.

E. Use procedures that produce uniform loading of bracing members without eccentricities or over-stressing and distortion of members or system.

3.6 SHAFT CONSTRUCTION METHODS

The following are selected methods that meet the design and performance requirements specified herein. Choose one of the following methods or another method that meets the requirements specified herein.

A. Corrugated Metal Pipe (CMP) in Drilled Shaft.
   1. Drill the hole within the design tolerances submitted for vertical alignment, diameter, and depth. Make drilled hole sufficient size to allow placing of CMP and backfilling the annular space without damaging the CMP.
   2. Provide CMP true and round within design tolerances and of sufficient length to line entire hole. Construct CMP within design tolerances of plumb as stated in the accepted submittal.
   3. Backfill the annular space with grout of sufficient strength and flowability to provide intimate contact with the ground and CMP. Provide backfill grout in accordance with the accepted submittals.
   4. Design and construct the shaft bottom as an integral part of the entire shaft.
   5. Remove the first six feet of CMP below the ground surface during shaft backfill operations.

B. Interlocking Sheet Piles
   1. Design and construct the shaft bottom as an integral part of the entire shaft.
   2. Remove all steel subsurface ground support materials, except for those lying directly below the installed jacked pipe.
   3. Piles shall be guided and held in position by temporary gates with each pile properly interlocked with its neighbor.
   4. Where shaft extends into rock, extend sheet piles to depth required by predrilling into rock.

C. Beam and Plate and/or Slide Rail System
   1. Install beams or rails before starting excavation. Install beams or rails by pre-drilling method and sufficiently keyed into bottom of excavation. Beams and rails are referred to beams hereafter.
   2. Use concrete/grout to encase the beams in the pre-drilled holes. If casing is used, extract casing as concrete is poured while maintaining minimum 5 feet head of concrete within the casing. Monitor volume of concrete to ensure voids do not result during extraction of casing. Drilling, placement of concrete, and installing and removing casing is in accordance with Section 49 of the latest Caltrans Standard Specifications.
   3. Space beams at intervals indicated on the approved shop drawing.
   4. Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.
   5. Install tight plates or lagging within flanges of beams as excavation proceeds. All lagging is referred to as plates hereafter. Trim excavation as required to install plates. Fill voids behind plates with soil, and compact.
   6. Plates can be placed on the backside of beams in the first 4 feet of the excavation to facilitate removal of the excavation support system.
   7. Beams shall be installed to the minimum depths shown on approved shop drawings.

D. Cutter Soil Mixing (CSM)

1. Mix bentonite slurry with native ground using a mixing tool to construct CSM shaft walls.
2. Match cutter wheel tooling to anticipated ground conditions.
3. Excavate a guide trench for collection of surplus slurry.
4. The primary CSM segments will be installed at the spacing shown on the shop drawings. After a set of CSM segments has been installed and allowed to set for a minimum of one (1) day, then the adjacent secondary CSM segments will be installed so that sufficient overlap between the secondary and primary segments is obtained as shown on the shop drawings. Do not allow the concrete to fully set in the primary CSM segments before placing the secondary CSM segments.

E. Drilled Caissons and Secant Piles
   1. Drilled Caissons: Use reinforcement consisting of welded steel cages that are placed vertically in pre-drilled holes that are backfilled with structural concrete.
   2. Secant Piles: Use reinforcement consisting of structural steel beams that are placed vertically in predrilled holes that are backfilled with structural concrete.
   3. The primary secant piles or drilled caissons will be installed at the spacing shown on the shop drawings. After a set of primary piles or caissons has been installed and the concrete fill allowed to set for a minimum of one (1) day, then the adjacent secondary piles or caissons will be installed so that sufficient overlap between the secondary and primary piles or caissons is obtained as shown on the shop drawings. Secondary holes shall be reinforced. Do not allow the concrete to fully set in the primary holes before placing the secondary pile or caisson.
      a. Temporary Steel Casings: Provide casings for protection of workers and inspection personnel, for prevention of cave-ins or displacement of earth walls, and for retention of groundwater when applicable, and flowing ground.
      b. Defective Casings: Do not use buckled, distorted or otherwise damaged casings. Replace casings damaged or disturbed during construction, casings that are not mud-tight or otherwise not in accordance with Approved Plans or Specifications.
   4. Excavation
      a. Excavation and construction methods shall result in minimum disturbance of surrounding material and full lateral support of secant piles or caissons by surrounding material.
      b. Excavate secant piles or drilled caissons to dimensions. Use a guide frame on the surface to layout pile or caisson locations. Maintain sidewall stability during drilling. Excavate holes for closely spaced secant piles or caissons, and those occurring in fragile strata, only after adjacent holes are filled with concrete and allowed to set. Secant pile or caisson drilling equipment shall have the minimum torque capacity and downward force capacity for the site conditions.
   5. Placing Concrete
      a. Before placing concrete, the tip of each secant pile or drilled caisson shall be accepted in writing by the Owner. Each secant pile or drilled caisson shall be probed in the presence of the Owner, cleared of mud, water, loose material, and debris.
      b. Place concrete using a down pipe to direct flow of concrete. Except in the presence of water, the maximum height of concrete free fall is 4.0 feet provided the concrete does not hit the sides of the hole. Use a tremie pipe or pump, if the distance is greater than 4.0 feet or groundwater is present.

c. Place concrete to form a monolithic cylindrical pile or caisson having full lateral support from surrounding undisturbed materials.
d. Withdraw casing constantly after concrete has been deposited.
e. Concrete placement in each secant pile or caisson shall be one continuous operation. If placing operations must be stopped, leave surface approximately level. If concrete has hardened, clean surface and slush with a 1-to-1 cement sand grout before placing operation is resumed.
f. When water is present, place concrete through water by means of a watertight tremie pipe. When placing concrete under water, discharge end of tremie shall be submerged in fresh concrete and shaft of tremie maintained full of concrete to a point above water level. Increase cement content of concrete required to be placed in water by one sack per cubic yard of concrete.

3.7 QUALITY CONTROL, TESTS, AND INSPECTIONS

A. Provide quality control, testing, and inspection as required in the accepted submittals.

3.8 REMOVAL OF SUPPORT SYSTEM/SITE RESTORATION

A. After all equipment and excavated materials for the tunneling operations have been removed from the jacking shaft, prepare the bottom of the shaft in the same manner as a pipe foundation and remove all loose and disturbed materials below pipe grade to undisturbed ground and re-compact the material in accordance with Section 31 05 16 Aggregates for Earthwork and Section 31 23 17 Trenching.

B. Remove excavation support to a minimum of 4 feet below grade during shaft backfill operations. Perform removal in a manner that avoids ground settlement and damage to adjacent facilities.

C. Site restoration shall be completed at all shaft locations restoring site to its original pre-construction condition in its entirety.

END OF SECTION

SECTION 33 05 07.22

PILOT TUBE METHOD

PART 1 GENERAL

1.1 REQUIREMENTS

A. This section specifies minimum design and performance requirements for the trenchless construction of a steel casing pipe (casing) using the pilot tube method (PTM). The casing is to have a pressurized flow operated potable water pipeline inserted to design line and grade inside the steel casing.

B. No excavation deeper than four (4.0) feet shall be permitted within 100 feet of the jacking shaft, receiving shaft, and tunnel alignment until after tunneling operations have been successfully completed. Exceptions are:
   1. Potholing to locate utilities conflicting with the shafts or tunnel alignment
   2. Relocation of utilities conflicting with the shafts or tunnel
   3. Installation of instrumentation as specified in Section 31 09 13
   4. No excavations projecting away from the tunnel and behind the receiving shaft for 50 feet.

C. Furnish all designs, tools, equipment, materials and supplies, and perform all labor required to complete the Work as indicated on the Approved Plans and specified herein.

D. Select, furnish, and maintain the PTM and ancillary equipment in proper and safe working order.

E. Install casing to the line and grade as noted on the Approved Plans and within the tolerances noted herein.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Comply with the following industry standards effective at time of bid:
   1. NFPA 241 – Standard for Safeguarding Construction, Alteration, and Demolition Operations
   2. NSF/ANSI Standard 060 – Drinking Water Treatment Chemicals – Health Effects
   3. Standard Specifications for Public Works Construction (SSPWC).

B. State Regulatory Codes: to be current at all times:
   1. California Code of Regulations (CCR), Title 8, Tunnel Safety Orders
   2. CCR, Title 8, Construction Safety Orders, Section 1509 “Injury and Illness Prevention Program
   3. Caltrans (CT) Manual for Encroachment Permits on California State Highways
   4. CT Trenching and Shoring Manual

1.4 DEFINITIONS

A. ADVANCE RATE: Forward progress over a given period of time; includes penetration rate, makeup time, downtime, and idle time; typically measured in feet or meters per hour or shift.

B. ANNULAR SPACE: The theoretical volume between the gauge cut and the outside radius of the jacking pipe times the length of the installation, equal to annulus x length of tunnel.

C. ANNULAR THICKNESS: The radial distance between the excavated radius created by the gauge cutter and the outside radius of the jacking pipe. The radial distance is equal to the overcut (gauge cut) plus the shield cut.

D. ANNULUS: The theoretical area between the gauge cut and the pipe outside diameter (OD) equal to (π x (gauge cut OD2 - pipe OD2)/4). It is the combined area created by the overcut and the shield cut.

E. BACKFILL GROUTING: Grout injected into void space between the carrier pipe and casing after the drive is completed.

F. BOULDER: Per ASTM D653, a rock fragment, usually rounded by weathering or abrasion, with a dimension of 12 inches (305 mm) or more.

G. BURIED OBJECTS: Items in the ground that can affect PTM advancement and line and grade control. Buried objects that prevent continued advancement along the design path, which includes tolerances, are called obstructions.

H. CARRIER PIPE: For this project, a PVC or FPVC pipe for use in a pressurized potable water conveyance system.

I. CASING: For this project, a steel casing pipe jacked using PTM equipment in a multiple pass excavation and casing pipe installation system that supports a bore. The casing is not a carrier pipe.

J. CEMENTED SOILS: Soils in which the particles are held together by a naturally occurring or man-made chemical agent that changes the soils' physical and mechanical properties.

K. COBBLE: Per ASTM D653, a rock fragment, usually rounded or semi-rounded, with dimensions between 3 and 12 inches (75 and 305 mm).

L. COHESIONLESS SOILS (NON-COHESIVE SOILS): Earth materials containing less than 20 percent soil particles passing the No. #200 sieve. Any free-running soil, such as sand or gravel, whose strength depends on friction between particles.

M. COHESIVE SOILS: Earth materials containing 20 percent or more soil particles passing the No. #200 sieve.

N. CONTACT GROUTING: Grouting injected into the theoretical void space between the jacking pipe and the ground after the drive is completed.

O. CONTAMINATED PLUME: The underground trace of an environmental pollutant.

P. CONTRACT DOCUMENTS: Documents prepared for and accepted by the Owner for bidding and for awarding a project; they can include bid forms, general conditions, special conditions, technical specifications, Approved Plans, geotechnical data reports, permits, and if prepared the geotechnical baseline report.

Q. CONTROLS: Part of the PTM system that allows synchronized excavation, removal of spoils, and jacking of pipe to balance forward movement with excavation so that ground settlement and heave are managed.

R. CROSSING: Pipeline installation in which the primary purpose is to provide one or more passages beneath a waterway, road, or other surface obstruction.

S. CROWN: The highest point of the pipe or tunnel.

T. CUT AND COVER: See open-cut.

U. CUTABILITY: The capacity of rock to be spalled, ripped, chipped, and broken into smaller pieces to allow the advance of the PTM. Key properties affecting cutability include the frequency of discontinuities, unconfined compressive strength, tensile strength, hardness, and abrasiveness of the rock.

V. CUTTER chamber access: See face access.

W. CUTTER WHEEL: Any rotating tool or system of tools on a common support that excavates at the face of a bore.

X. CUTTINGS: See spoils.

Y. DELAY TIME: Lost time associated with the Owner’s issues.

Z. DEWATERING: The act of removing groundwater or lowering the groundwater elevation, using a system of wells and pumps. Sump pumping is not an acceptable form of dewatering.

AA. DIFFERENTIAL CUT: The spiral, screw like pattern created on the excavated surface as the gauge cutter is advanced while being rotated around the bored periphery of the cutter wheel.

BB. DIRECT-JACKED PIPE: Pipe installed in the ground and serves as the casing and carrier pipe.

CC. DOWNTIME: Time lost when the PTM is unable to operate; generally associated with equipment failure.

DD. DRILLING FLUID: Water that may contain additives, including bentonite, polymers, soda ash, surfactants, or other materials, to enhance stability and excavatability. If the drilling fluid contains additives, and is design to have specific properties, it is considered to be an engineered drilling fluid, whether specified by the engineer or selected by the Contractor. Some additives may increase the effectiveness of the

drilling fluid and reduce adhesion of the spoils (cuttings). One use of a drilling fluid is in a closed-loop system for transporting spoils and for counterbalancing earth and groundwater pressures during microtunneling.

EE. DRIVE: Designation of the pipe installed from a jacking shaft to a reception shaft.

FF. DRIVE SHAFT: See jacking shaft.

GG. EFFECTIVE STRESSES: In a saturated mass of soil or rock, the total stress P minus pore water pressure, Uw.

HH. EMERGENCY RECOVERY SHAFT: See rescue shaft.

II. ENGINEERED DRILLING FLUID: See drilling fluid.

JJ. ENTRANCE SEAL: See launch seal. AM. ENTRY RING: See launch seal.

KK. EXIT SEAL: Same as a launch seal except for the retrieval of the machine at the reception shaft. Used in high groundwater and unstable soils to prevent loss of ground.

LL. EXIT SHAFT: See reception shaft.

MM. EYE: The opening in the shaft wall through which the PTM is launched.

NN. FACE: The location where excavation is taking place.

OO. FACTOR OF SAFETY: The ratio of the structural capacity of a system to expected or actual loads on the system.

PP. FILTER CAKE: A thin layer of clay or polymer from the slurry at the face and perimeter of the formation being excavated. The filter cake is formed through filtrate loss.

QQ. FILTRATE: A liquid that has passed through a filter.

RR. FINES: Portion of a soil finer than a No. 200 (75 mm) US standard sieve.

SS. FRAC-OUT: See inadvertent return and hydrofracture.

TT. GAUGE CUT: The outermost projection of the excavation, measured as a diameter. The gauge cut is subject to cutter wear and to the differential cut.

UU. GAUGE CUTTER: The cutter that creates the gauge cut and is subject to wear.

VV. GEL STRENGTH: Per ASTM D653, the condition of a liquid that has begun to exhibit measurable shear strength.

WW. GEL TIME: The measured time interval between the point when the slurry mix is in a fluid state and the point when it begins to form a gel.

XX. NOT USED

YY. GRAVEL: Per ASTM D653, rounded or semi-rounded particles of rock that will pass a 3-inch (76.2-mm) sieve and be retained on a No. #4 (4.75-mm) US standard sieve.

ZZ. GROUND COVER: Distance between the ground surface and the crown of the pipe.

AAA. GROUNDWATER: All subsurface water, as distinct from water on the surface.

BBB. GROUTING: The process of filling voids or of modifying or /improving ground conditions. Grouting materials may be cementitious, chemical, or composed of other mixtures.

CCC. GUIDANCE SYSTEM: System that locates the actual position of the PTM relative to the laser or other device. The laser or other device should be referenced to the design line and grade.

DDD. GUIDED BORING METHOD: Another term for the pilot tube method, in which an auger boring power unit is used with a pilot tube's guidance and steering system.

EEE. HEAVE: Measurable upward movement of the ground or structure as the result of the excavation process.

FFF. HORIZONTAL AUGER BORING (HAB): A technique for forming a bore from a jacking or drive shaft to a receiving shaft by means of a rotating auger with cutting tools. The casing is jacked forward sequentially in a cyclic process while the auger is turned. Spoils are removed back to the drive shaft by helically wound auger flights rotating in the steel casing. The equipment may have limited guidance and steering capability.

GGG. HQ: A diamond core wire line tube drill bit size where the hole diameter is 96 mm and the core diameter is 63.5 mm.

HHH. HYDROFRACTURE: A special form of inadvertent return in which drilling fluid reaches the surface or waterway. Also called a frac-out.

III. IDLE TIME: Lost time when the PTM is not in operation; not including make-up time or downtime.

JJJ. INADVERTENT RETURN: The loss of drilling fluid, including slurry and lubrication, from the slurry or lubrication system. A special form of inadvertent return, where the fluid exceeds the strength and confining pressure of the ground and reaches the surface or waterway, is called a hydrofracture or frac-out.

KKK. INCLINOMETER: (1) A geotechnical instrument used to measure horizontal deflection transverse to an installed vertical pipe casing by passing a probe through a casing (via two sets of grooves in the casing). (2) An instrument used within the PTM to measure pitch and roll.

LLL. INJURY AND ILLNESS PREVENTION PROGRAM (IIPP): Health and safety plan in accordance with CCR, Title 8, Construction Safety Orders, Section 1509 "Injury and Illness Prevention Program."

MMM. INVERT: The lowest point of the pipe, tunnel, or shaft.

NNN. JACKING FORCE: The total force required to overcome the face pressure component and the frictional resistance component along the pipe so as to allow forward movement of the PTM and the trailing pipe string.

OOO. JACKING FRAME: A structural component that houses the hydraulic cylinders used to propel the PTM machine and pipeline. The jacking frame cradles the jacking pipes, and serves to distribute the thrust load to the pipeline and the reaction load to the shaft wall or thrust block or shaft invert.

PPP. JACKING LOADS: See jacking force.

QQQ. JACKING PIPES: Pipes designed to be installed using pipe jacking techniques.

RRR. JACKING SHAFT: Excavation from which trenchless technology equipment is launched for the installation of a pipeline. The jacking shaft may incorporate a thrust wall to spread reaction loads to the ground and an entry ring to control inflows of groundwater and soil at the portal.

SSS. JACKING SHIELD: A fabricated steel cylinder from within which the excavation is carried out either by hand or machine. An articulated steering section and steering jacks are incorporated into the shield to allow it to be adjusted so as to control line and grade. The term is associated with traditional tunneling.

TTT. K-RAIL: A modular concrete or plastic barrier used employed to separate lanes of traffic.

UUU. LASER: A device commonly incorporated into the guidance system and used to track alignment and grade during the tunneling or jacking operation.

VVV. LAUNCH SEAL: A mechanical seal, usually consisting of a rubber flange that is mounted to the wall of the jacking shaft. The flange seal is distended as the PTM and trailing pipe string pass through the seal into the ground. The seal is intended to prevent the flow of groundwater, soils, slurry, and lubrication into the shaft during tunneling operations.

WWW. LUBRICATION: The act of injecting an engineered drilling fluid, normally bentonite and/or polymers, designed to reduce the skin friction and jacking forces on the jacking pipe during installation. The drilling fluid fills the annular space.

XXX. MAKEUP -UP TIME: The time spent to add a pipe segment and make connections.

YYY. MARSH FUNNEL VISCOSITY: A measure of the flow rate of a fluid through a calibrated funnel. A Marsh funnel is typically used to measure drilling fluid and slurry viscosity, in seconds per quart (sec/qt) of fluid. The Marsh funnel viscosity of water is 26 seconds per quart.

ZZZ. MAXIMUM ALLOWABLE JACKING FORCE: The largest jacking force that can be applied to the jacked pipe, allowing for an appropriate factor of safety.

AAAA. MAXIMUM ANTICIPATED JACKING FORCE: The largest anticipated jacking force required to advance jacking pipe and machine along a drive.

BBBB. MIXED FACE: An interface within the excavated tunnel zone between two geological units that have a significant contrast in engineering properties (e.g., rock overlain by soft ground, or very soft, low-strength soil overlain or underlain by a very stiff, high-strength soil).

CCCC. MIXED GROUND: The excavated tunnel zone, without a defined interface, that contains soil and coarse fractions of gravels, cobbles, and boulders (i.e., silt with boulders). This term is not currently defined by ASTM or USCS.

DDDD. MIXED REACH: Refers to a significant change in ground type, characteristics, or behavior along the excavated tunnel between the jacking and receiving shafts. This term is not currently defined by ASTM or USCS.

EEEE. MUCK: Spoils or removal of same.

FFFF. N-VALUE: The number of blows per foot required to drive a standard penetration test (SPT) soil sampler into the ground during geotechnical exploration. The N-value is often used to estimate in situ consistency of clays and silts and relative density of sands.

GGGG. NONCOHESIVE SOILS: See cohesionless soils.

HHHH. NQ: A diamond core wire line tube drill bit size where the hole diameter is 75.7 mm and the core diameter is 47.6 mm.

IIII. OBSTRUCTION: Any buried object that lies completely or partially within the cross section of the PTM and that impedes continued forward progress along the design path and within allowable tolerances.

JJJJ. ONE-PASS: A procedure by which the carrier pipe is directly jacked into the ground without a casing.

KKKK. OPEN-CUT: A method by which access is gained to the required underground level for installation, maintenance, or inspection of a pipe, conduit, or cable. The excavation is then backfilled, and the surface is reinstated.

LLLL. OPEN-FACE: Term referring to one mode of operation of a traditional TBM.

MMMM. OVERCUT: The theoretical difference between the radial measurement of the gauge cut and the shield; equal to (gauge cut OD - PTM OD)/2. Actual overcut is reduced as the gauge cutter is worn and because of the differential cut.

NNNN. OVER EXCAVATION: A process of excavating more material than the theoretical volume of the tunnel based on diameter and advanced distance. Over excavation can lead to ground settlement and the formation of voids.

OOOO. PACKER: See compression ring.

PPPP. PENETRATION RATE: Instantaneous excavation distance per time while the PTM is operating, typically measured in inches per minute or millimeters per minute.

QQQQ. PERCHED WATER: An accumulation of groundwater that is above the regional groundwater table in an unsaturated zone.

RRRR. PIERCING TOOLS: See earth piercing.

SSSS. PIEZOMETER: A specialized monitoring well that provides discrete screens and underground seals to produce a measurement of the groundwater pressure at specific intervals below ground. The groundwater pressure may be measured using open standpipes or vibrating wire transducers.

TTTT. PILOT TUBE METHOD: A multistage method of accurately installing a product pipe to line and grade by use of a guided pilot tube followed by upsizing to install the product pipe. The pilot tube method does not fit within the definition of microtunneling.

UUUU. PIPE JACKING: A system of using hydraulic jacking from a drive shaft to directly install pipes behind a shield machine so that they form a continuous string in the ground.

VVVV. PIPE LUBRICANT: See lubrication.

WWWW. PIPE STRING: The succession of joined individual pipes being used to advance and support the excavation.

XXXX. PITCH: The upward or downward angle of the PTM, measured from a theoretical horizontal plane passing through the longitudinal axis of the PTM.

YYYY. PLASTIC VISCOSITY: A measure of the internal resistance to fluid flow, expressed as the tangential shear stress in excess of the yield stress divided by the resulting rate of shear.

ZZZZ. PLOWING: A condition where the PTM is being steered in one direction yet continues along an undesired direction.

AAAAA. PORE WATER PRESSURE: The pressure of the groundwater held within a soil or rock: in gaps (pores) between particles.

BBBBB. POTHOLING: Small, carefully dug, non-mechanized excavation, used to locate a utility or other subsurface feature.

CCCCC. PRODUCT PIPE: See carrier pipe.

DDDDD. PUSH RING ADAPTER: Mechanical component mounted on the thrust ring to prevent the thrust ring from coming into contact with and damaging the pipe collar.

EEEEE. RECEIVING SHAFT: See reception shaft.

FFFFF. RECEPTION SHAFT: Excavation into which the trenchless technology equipment is driven and recovered.

GGGGG. RESCUE SHAFT: An unplanned additional shaft required to remove obstacles/obstructions and/or retrieve or repair the trenchless technology equipment. The rescue shaft may need to function as a jacking shaft to complete the drive.

HHHHH. ROCK: Per ASTM D653 and ISRM, any naturally formed aggregate of mineral matter occurring in large masses or fragments.

IIIII. ROLL: The angle of rotation about the theoretical longitudinal centerline of the PTM, measured from the 12 o'clock position.

JJJJJ. SEPARATION (of objects): The distance between two objects measured at their closest approach.

KKKKK. SETTLEMENT: Measurable downward movement of the ground or of an overlying utility or other structure as the result of excavation or dewatering.

LLLLL. SETTLEMENT POINT OR MARKER: An instrument installed at ground surface or driven into the ground to monitor vertical ground deformations before, during, and after construction.

MMMMM. SHIELD CUT: The theoretical difference between the radial measurement of the shield and the jacking pipe and is equal to (shield OD - pipe OD)/2.

NNNNN. SPOILS: Earth, rock, and other materials excavated during the installation process. Also referred to as cuttings.

OOOOO. SUMP PUMP: A device placed at the base of a shaft or in a shield to collect and remove fluids incidental to the construction process and resulting from shaft leakage, and to prevent the excavation equipment from flooding.

PPPPP. SURFACE WATER: Any water encountered or collected at ground level.

QQQQQ. THRUST BLOCK: An engineered structure, located between the jacking frame and the shaft wall, which distributes the jacking force developed by the hydraulic jacking frame over a large surface area to the ground behind the back wall of the shaft.

RRRRR. THRUST RING: A fabricated ring that is mounted on the face of the jacking frame. It is intended to transfer the jacking force from the jacking frame to the thrust-bearing area of the pipe section being jacked.

SSSSS. TOOLING: Ground-engaging elements of the cutter wheel designed to excavate and penetrate the ground.

TTTTT. TRENCHING: See open-cut.

UUUUU. TRENCHLESS TECHNOLOGY: A family of construction techniques for installing or rehabilitating underground infrastructure with minimal disruption to surface traffic, businesses, and residents. Also includes technologies for inspection, leak location, and leak detection with minimal disruption and minimal excavation from the ground surface.

VVVVV. TUNNEL ENVELOPE: The vertical band within the ground where the tunnel is excavated. Includes one tunnel diameter above the crown and one tunnel diameter below the invert.

WWWWW. TWO-PASS: A procedure by which the carrier pipe is installed within a casing.

XXXXX. UNANTICIPATED RETURN: See inadvertent return.

YYYYY. UTILITY TUNNELING: A construction method for excavating an opening beneath the ground without continuous disturbance of the ground surface. The excavation is of sufficient diameter to permit personnel access, and allow excavation, transport of spoils, and erection of a ground support system.

ZZZZZ. WALER: Beam used within a braced excavation as support to control wall deflections.

AAAAAA. WATER JETTING: Process of using the internal cleansing mechanism of the cutter head, by which high-pressure water is sprayed from nozzles to help remove cohesive soils.

BBBBBB. YAW: The angle of the PTM to the left or right of a theoretical vertical plane passing through the PTM's longitudinal axis.

CCCCCC. ZONE OF INFLUENCE: Volume of ground that could possibly be affected impacted by settlement or heave from tunnel mining, shaft excavation, pile driving, or other construction activities.

1.5 DESIGN REQUIREMENTS

A. Contractor may change the excavated diameter to fit their means and methods as long as the selected diameter enables the installation of the carrier pipe in accordance with Section 33 05 07.24. If the change results in an increased excavated diameter, the increased diameter is not a cause for an differing site condition.

B. Provide the maximum anticipated installation loads imposed on the casing, and demonstrate that anticipated loads are incorporated into the manufacturer's design of the casing subject to the Owner's review. The minimum factor of safety shall not be less than 2.0.

C. Provide a PTM capable of advancing through the range of anticipated ground conditions along the alignment including any Contractor pre-treated ground. PTM shall be capable of advancing through rock with uniaxial compressive strength (UCS) at least twice the maximum anticipated rock UCS on the project.

D. Provide a jacking system capacity that exceeds the maximum anticipated jacking force by at least 50 percent.

E. Shaft wall and ground behind shaft wall shall be designed to support the maximum anticipated jacking force with a minimum factor of safety of 2.0. If a thrust block is

used then the thrust block shall be normal to the pipe alignment and shall be designed to support the maximum anticipated jacking force with a minimum factor of safety of 2.0.

F. Drainage facilities shall be sized to handle flows including construction water and anticipated inflows from the ground.

G. Provide a spoil conveyance system based on the Contractor's PTM selection and instantaneous advance rates.

H. If pre-treating the ground then pre-treat ground as specified in Section 31 32 13.

I. Contact Grouting is required for all drives with a casing ID greater than 30.0 inches. Provide minimum annular thickness of 0.75 inches and maximum annular thickness of 1.0 inches.

1.6 PERFORMANCE REQUIREMENTS

A. Provide a PTM system capable of performing in the ground conditions as presented herein.

B. Prevent PTM from deviating from acceptable line and grade.

C. Ground movement on the surface directly above the tunnel shall not exceed that specified in Section 31 09 13.

D. Install the casing within the following line and grade tolerances:
   1. Carrier pipe is installed to design line and grade with at least 1.0 inch of separation from the casing sidewall.
   2. Horizontal tolerance: Plus or minus 0.33 feet (4.0 inches) of theoretical centerline of the carrier pipe or increase the casing pipe size to accommodate the installation requirement.
   3. Vertical tolerance: Plus or minus 0.17 feet (2.0 inches) of the theoretical centerline of the carrier pipe or increase the casing pipe size to accommodate the installation requirement.

1.7 QUALITY ASSURANCE

A. Experience requirements outlined below shall be met at the time of bid and remain in force through completion of the Project. Work subcontracted out does not qualify as experience.
   1. The Contractor performing the tunneling work shall have at least ten (10) years of experience in tunneling using PTM and shall have successfully completed five (5) tunneling projects using PTM with OD between 12 inches and 36 inches in similar ground conditions, as measured by unconfined compressive strength (UCS), with drive lengths of at least 250 feet on each project.
   2. PTM Tunneling Superintendent shall have at least five (5) years of experience supervising tunneling using PTM and shall have successfully completed at least five (5) projects in similar ground conditions, as measured by UCS, as anticipated on this Project.

3. PTM Operator shall have at least three (3) years of experience and shall have successfully completed five (5) tunneling projects using PTM with OD between 1 foot and 3 feet in similar ground conditions, as measured by UCS, as anticipated on this Project.
4. Contractor's tunnel engineer shall be a Professional Engineer registered in the State of California. Experience shall include design calculations on five (5) PTM projects within the last five (5) years.
5. Surveyor shall be a Professional Land Surveyor registered in the State of California with experience in underground surveying. Experience shall include:
   a. Five (5) tunnel projects within the last five (5) years,
   b. Transfer of points and line from the surface to below ground,
   c. Closed loop tunnel survey for line and grade, and
   d. The use of geodetic surveying if the guidance system requires such.
6. Experience records shall list the five (5) most recent tunneling projects, including all PTM projects completed for the Owner, and all projects demonstrating the specified experience. The experience record shall include name of project; owner of the project; names of contacts including all contact information; PTM size; ground conditions as measured by UCS, longest drive planned and completed; and total footage planned and completed.
7. The Owner will be the sole judge in determining if the prospective tunneling Contractor, PTM project superintendent, PTM operator, and surveyor meet the aforementioned work and project experience requirements.
8. The PTM operator shall not be replaced without the prior written approval of the Owner.

B. Surveying:
   1. Establish control points sufficiently far from the tunnel alignment so as not to be affected by ground movement or damaged by any Work.
   2. Verify and record the line and grade of the PTM three times at equal intervals while installing the first 20 feet of casing and then again at each
   3. 50-foot advancement to ensure the alignment is within the specified tolerances.
   4. During construction, survey tunnel line and grade at 50 feet of installed casing and every 100 feet thereafter (i.e. 50, 150, 250).
   5. Provide a cumulative line and grade record during construction and locate previous survey points within 2.0 feet of the location previously surveyed.

C. Pipe Lay Schedule shall include:

   1. Each pipe is to be marked with consecutive numbers inside and outside as it is placed for jacking beginning with the number 1.
   2. All numbers are to be underlined.
   3. Markings shall be acceptable to the Owner.

1.8 SUBMITTALS

A. Submittals shall be made in accordance with Section 01 33 00 and as specified herein.

B. Submittals shall be coordinated with all relevant submittals, assembled and submitted as a single, complete, and comprehensive submittal.

C. Where calculations are required to be submitted, they shall be:
   1. Signed and sealed by a Professional Civil Engineer registered in the State of California;
   2. Clearly identify all parameters used;
   3. State all assumptions made in the calculations;
   4. Identify all sources of information;
      a. All sources of information shall be widely accepted industry standard and
      b. Acceptable to the Owner.

D. All shop drawings shall be legible with dimensions accurately shown and clearly marked in English.

E. Pre-Construction Submittals:
   1. Submit a schedule for all tunneling operations and associated works including proposed work shifts, scheduled shutdown times and planned maintenance schedule etc. Schedule shall be coordinated with overall schedule for the Contract.
   2. Submit qualifications and experience records for the following:
      a. Contractor performing the Work;
      b. PTM project superintendent;
      c. PTM operator;
      d. Contractor's Engineer; and
      e. Contractor's Surveyor.
   3. Preprinted PTM data sheets and specifications or a letter from the PTM manufacturer, in English, demonstrating that the selected machine is capable of progressing through the anticipated ground conditions, including, but not limited to the UCS.
   4. Shop drawings of PTM showing details of the following:
      a. Cutter head configuration;
      b. Thrust and steering system;
      c. Ancillary equipment arrangement
   5. PTM manufacturer's recommendations for equipment and methods to be used for entering the cutter head to undertake cutter head inspection, maintenance and cutter tool replacement.
   6. Layout of launch shaft site showing all major equipment including jacking frame, control console, spoil removal system, electrical equipment, pipe storage, pipe lifting crane etc.
   7. Description of main jacking system with details, including jacking capacity, maximum instantaneous jacking speed, and operational requirements.
   8. Method of intent on PTM operational parameters including, based upon ground condition encountered:
      a. Location of auger as to casing leading edge;
      b. Auger design (e.g. pitch, flight, diameter);
      c. Auger rotational speed;
      d. Jacking speed;
      e. Thrust as a function of distance.
   9. Calculations which clearly state the relationship between hydraulic jacking pressure and jacking force for the jacks.
   10. Calculation of Maximum Anticipated Jacking Force.
   11. Calculation of estimated bank volume per unit length of tunnel and excavated volume per unit length of tunnel.

12. Shaft design calculations and if used maximum jacking capacity of the thrust block, shaft wall, and ground behind shaft wall that will be supporting the jacking forces in compliance with Section 33 05 07.21.
13. Grade and alignment control system details including configuration, operating parameters and monitoring requirements:
    a. Provide written confirmation from manufacturer that proposed guidance system can achieve the required line and grade tolerances for the given drive lengths.
    b. Provide method to protect guidance system from physical disturbances.
    c. Provide method to mitigate guidance system distortion by heat and/or humidity.
14. PTM Operating Work Plan:
    a. Complete launch procedure commencing with any modification to the designed shaft shoring system and ending with the first pipe segment jacked into the ground.
    b. Method statement for providing a mechanical entry seal.
    c. Complete exit procedure commencing with any modification to the designed shaft shoring system and ending with the first pipe segment projecting 2 feet into the receiving shaft.
15. Pipe lubrication and grout system details including capacity, operating parameters and procedures:
    a. Description of lubrication and grout mixing equipment;
    b. Procedure for lubricating the pipe during jacking operations;
    c. Proposed lubrication design mix including proportions, water quality, and pH;
    d. Identify pressure gauge and volumetric gauge locations;
    e. Theoretical calculations predicting lubrication injection pressure and volume required so as to avoid an inadvertent return. Volume shall be expressed as per foot of casing.
16. Casing: as specified elsewhere.
    a. Calculation of Maximum Allowable Jacking Force. Include the hydraulic pressure that is required to develop the Maximum Allowable Jacking Force;
    b. Lubrication port size, location, and spacing;
    c. Manufacturer's written recommendations for repair of (1) casing and (2) sidewall failures based upon structural and non-structural failure requirements.
17. Procedure to accurately measure the volume of excavated material per pipe segment. Include a determination of the theoretical volume of excavated material per pipe segment and allowable tolerances on this volume.
18. Procedure to accurately measure the groundwater inflow into the tunnel.
19. Provide sample of daily progress report, operator's manual log, lubrication log, and line and grade log.
20. Provide a sample of the automated record, in English, with information available for recording, variations in data acquisition frequency, and available formats for Owner to select automated recording fields. If an automated data acquisition system is not available, state "not used".
21. The records of the start-up inspection of all mechanical and hydraulic equipment shall be submitted to the Owner within one (1) work day of the completed inspection. Include:
    a. Free-wheeling rotational auger torque with first casing segment attached;
    b. Thrust to dead push/retract PTM with first casing segment attached;
    c. Line and grade.

22. Shaft and pipe ventilation system details including fan size and operating parameters.
23. Shop drawings for crane positioning:
    a. Drawings showing different crane positions to be used that demonstrate safe swing around existing aerial utilities at each shaft location.
24. Electrical system, lighting system, and onsite power generation details.
25. Water sources, handling and disposal details.
26. Contingency Plans addressing the following:
    a. Cutter head becomes stalled.
    b. Water inflows exceed:
        1) 50% of allowable limits;
        2) 80% of allowable limits;
        3) 100% of allowable limits.
    c. Guidance plan with guidance system operational parameters observed, measured, and recorded to determine if the guidance system has moved or if heat/humidity distortion is affecting the guidance.
    d. Line and grade control plan with operational parameters observed, measured, and recorded to determine if the PTM is off line and/or grade. The plan shall include a return to the design line and/or grade over the remaining portion of the drive and at a rate of not more than 1.0 inch per 25 feet.
        1) 50% of allowable limits;
        2) 80% of allowable limits;
        3) 100% of allowable limits.
    e. Jacking plan with operational parameters observed, measured, and recorded to determine if the jacking force is increasing at a rate that would exceed the Maximum Allowable Jacking Force or the jacking force is increasing at a rate causing reasonable concern for completing the drive.
    f. Casing failure plan with inspection, repair, and removal plans. Repair methods shall be acceptable to the pipe manufacturer and the Owner.
    g. Thrust force causes deformation or deflection when exposed to jacking loads, shows signs of structural damage, or provides insufficient capacity to advance pipe.
    h. PTM cannot be advanced due to insufficient jacking capacity.

F. Construction Submittals:
    1. Notifications:
        a. All notifications are to be provided in writing and within one (1) work day unless otherwise specified herein.
        b. Immediately notify the Owner when water inflows exceed 50 percent of the maximum allowed. Include written description of the operational changes being made to avoid attaining the maximum allowed.
        c. Immediately notify the Owner when water inflows exceed 80 percent of the maximum allowed. Include written description of the operational changes being made to avoid attaining the maximum allowed.
        d. Immediately stop tunneling and notify the Owner when water inflows exceed 100 percent of the maximum allowed. Include written description of the operational changes being made and acceptable to the Owner before the resumption of tunneling.
        e. Immediately notify the Owner when the PTM is off line or grade by 50 percent of the maximum allowed. Include written description of the operational changes being made to avoid attaining the maximum allowed.

f. Immediately notify the Owner when the PTM is off line or grade by 80 percent of the maximum allowed. Include written description of the operational changes being made to avoid attaining the maximum allowed.
g. Immediately stop tunneling and notify the Owner when the PTM is off line or grade by 100 percent of the maximum allowed. Include written description of the operational changes being made and acceptable to the v before the resumption of tunneling.
h. Immediately notify the Owner upon encountering an object that impedes the forward movement and may prove to be an obstruction of the PTM.
i. Immediately provide written notification to the Owner upon implementation of any contingency plan.

2. Provide daily progress reports with the following information for each shift:
   a. Date.
   b. Project name.
   c. Start and finish times for each crew.
   d. Station of tunnel face at start and end of each shift.
   e. Number of each pipe segment installed and length of pipe.
   f. Setting and resetting of PTM's pitch.
   g. Setting, resetting, and verification of the laser's slope or guidance system.
   h. Resetting or adjusting the laser and the affect to line and grade.
   i. Location and estimated volume of groundwater inflows, including method of estimation.
   j. Downtime, if any, and cause for downtime.

3. Provide PTM operator's manual log with three recording points of measurements for each pipe segment up to and including 10 feet long. Provide the first recording point within one foot of the start, second recording point near the midpoint, and third recording point within one foot of the end. For each of the recording points, record the following measurements and provide unit of measure:
   a. Printed name of operator and signature.
   b. Time of measurement.
   c. Station of pipe at the time of measurement,
   d. Position of the PTM in relation to design line and grade.
   e. Inclination and roll of the cutter head.
   f. Maximum jacking force exerted by the main jacks.
   g. Advance rate.
   h. Cutter head rotation speed and torque.
   i. Any problems encountered since last recording point.
4. The automated data recording system, if available, shall record the same operating parameters as specified for manual recording, unless otherwise specified by the Owner.
5. Provide contemporaneous log of all line and grade checks including PTM instrument and guidance system resets and adjustments. Log shall include:
   a. Date, time, station of face, and person making adjustment.
   b. Measurements immediately before adjustment.
   c. Measurements immediately after adjustment.
   d. Survey data if adjustment is performed based upon survey data.
   e. Daily verification of design slope and person making verification.
   f. Date, time, station of face, and person resetting line and grade control.
6. Provide report of cutter head inspection including the following:

a. Date, time, station of pipe, and person conducting the inspection.
b. Number and position of cutters changed.
c. Reason for cutter change.
d. Existing condition of all remaining cutters.
e. Advance allowance before next inspection.

7. Provide all manual and automated records and logs by 9 AM the following work day. Provide hard copy and electronic copy of automated records in formats acceptable to the Owner.
8. Survey data:
   a. Survey of line and grade for PTM operations.
   b. Submit readings to the Owner on the same work day the readings are taken.
   c. Provide interpretation of survey results to the Owner on the following work day.
   d. Provide contemporaneous written log of all laser set-ups and adjustments.
   e. Provide copies of field forms used to establish all lines and grades. G. Post-Construction Submittals:
9. Provide as-built survey of constructed tunnel. Mark survey locations so results can be replicated. Provide results in both tabular format and AutoCAD format acceptable to the Owner. Scale to be acceptable to the Owner. Survey shall confirm that carrier pipe can be installed within design tolerances.

1.9 PROJECT CONDITIONS

A. See project geotechnical report “Manila Community Services District Water Tank Replacement Project” prepared by Crawford & Associates, Inc., dated December 2017.

1.10 PROTECTION OF EXISTING UTILITIES AND FACILITIES

A. Responsible for the care and protection of all existing utilities, facilities, and structures that may be encountered in or within 100 feet of the Work.

1.11 PERMITTING REQUIREMENTS

A. Before commencing with any tunneling Work comply with all requirements of the Tunnel Classification as issued by the State of California, Department of Industrial Relations, Division of Occupational Safety and Health, see Appendix E.

B. When working within or under Caltrans right-of-way or easement comply with the Caltrans (CT) Encroachment Permit on California State Highways, see Appendix F.

C. Contractor performing this work is required to hold a current C-34 or General Engineering Contracting License from the State of California.

PART 2 PRODUCTS

2.1 MATERIALS

A. Provide casing in accordance with Section 33 05 07.24 that is specifically manufactured for pipe jacking as specified herein.

B. Lubrication shall consist of:
   1. High yield sodium bentonite.
   2. Potable water.
   3. Test all water for pH and treat with soda ash to adjust the pH of the water as required in the accepted mix design(s).
   4. Bentonite, polymers, and additives, other than soda ash, shall be NSF/ANSI Standard 060 compliant

C. Hydraulic fluids used in the PTM shall be fire resistant, in accordance with NFPA 241.

2.2 EQUIPMENT

A. PTM and components:
   1. Provide a PTM capable of advancing through the anticipated ground conditions, including Contractor pre-treated ground.
   2. Provide a PTM that meets the requirements specified herein, including:
      a. Provide steering system.
      b. Enable guidance to a predetermined reference point.
      c. Provide protection to the electric and hydraulic motors and operating controls against water damage. Parts and components shall be water resistant.
      d. Provide robust and suitable tools on the excavation tooling in order to avoid the need for replacement during the drive.
      e. Provide the PTM and trailing gear with pumps capable of removing water and maintaining satisfactory working conditions for the PTM.
      f. Provide independent back-up sump pumping system that does not operate from the main PTM power supply for use in emergency situations.
   3. Provide sufficient overcut and cleaning of overcut to prevent binding of excavation system on fines and allow steering.

B. Pipe Jacking Equipment:
   1. Provide for control to ensure that the Maximum Allowable Jacking Force will not be exceeded at all times.
   2. Ensure measured hydraulic cylinder extension rates are synchronized with the measured instantaneous excavation rate of the PTM.
   3. Uniform distribution of jacking forces on the end of the casing by the use of thrust rings and packers.

C. Remote Control System:
   1. Allow for routine operation of the PTM system without the need for personnel to enter the tunnel.
   2. Display available to the operator, showing the position of the PTM in relation to a design reference together with other information such as roll, pitch, complete guidance system, valve positions, thrust force, cutter head torque, rate of advance, and installed length.
   3. Integrate the system of excavation and removal of spoil and its simultaneous replacement by pipe. As each pipe segment is jacked forward, the control system synchronizes all of the operational functions of the system.

D. Active Direction Control:
   1. Equip with a lighted target system for guidance.

2. Provide active steering information that is monitored and transmitted to the operator. As a minimum, this information shall include location of the target.
3. Provide a reference laser, or other submitted device that indicates visually in the jacking shaft that the directional control system has not been accidentally moved.

E. Provide spoil conveyor system capable of providing the required conveyance capacity.

F. Provide means for accurately measuring water inflow into the tunnel.

PART 3 EXECUTION

3.1 GENERAL

A. Perform all Work in accordance with accepted submittals.

B. Provide the Owner with access to the shaft, PTM equipment, tunnel if accessible, and operations control instrumentation at all times during tunneling operations.

C. Provide the Owner with access to review and copy associated records.

D. Upon Owner's request, allow for the collection of ground and spoils samples.

E. Do not commence any tunneling operation until all submittals, including submittals for all related Work specified elsewhere, are reviewed and accepted by the Owner.

F. Maintain a copy of the Contract Documents at the jacking shaft site or other location acceptable to the Owner and accessible to the PTM operator.

G. A start-up inspection and testing of all mechanical and hydraulic systems and power supply shall be conducted prior to the commencement of tunneling operations. The Owner shall be notified in writing at least three (3) work days prior to the start-up inspection. Key system and equipment performance data shall be measured and recorded during the inspection, including cutter head free-wheeling rotational torque for each stage of excavation and pilot drilling, jacking system, guidance systems, and PTM pitch settings.

H. Pipe jacking operations shall not commence until the concrete thrust block, tremie seal (if selected), and pre-treated ground zones, are in place and have attained the minimum required strength as stated in the accepted submittals.

I. Locate all utilities before commencing tunnel excavation.

J. Protect in-place or relocate existing utilities. Remove and replace in-kind any damaged utility.

3.2 WORK AREA PREPARATION AND MAINTENANCE

A. Organize surface equipment in such a manner as to enable proper operation at all times, to minimize impacts to property owners, and to maintain traffic control patterns as specified.

B. Provide suitable containment basin(s) made of plastic lining for any equipment operating with fuel, hydraulic, or lubrication oils.

C. Maintain and keep all equipment in proper working order. All oil, hydraulic, and fuel leaks shall be repaired immediately upon discovery. Any leaking equipment shall not be used until repaired. Any fluid shall be contained and cleaned up upon discovery. Provide written notification within 4 hours of discovery.

D. Contain all lubricant spills upon discovery and clean up and dispose of spills properly. Provide written notification within 4 hours of discovery.

E. Protect guidance system from accidental movements, i.e. bumping by personnel or equipment.

F. Provide and maintain temporary surface drainage facilities during construction.

3.3 EXCAVATION

A. Alignment Establishment:
   1. Perform surveying in accordance with Section 31 09 13 and as specified herein.
   2. Contractor's Surveyor shall check line and grade shown on the Approved Plans before commencing tunneling operations and immediately report any errors or discrepancies to the Owner.
   3. Use the line and grade shown on the Approved Plans to furnish and maintain reference control lines and grades for the potable water pipeline construction.

B. Pretreat the ground outside the shaft in order to prevent unfavorable ground behavior and groundwater inflow during launch and retrieval procedures as required and specified in Section 31 32 13.

C. Obstructions during tunneling:
   1. Remove, clear, or otherwise make it possible for the PTM to progress past or through an object in accordance with the submitted contingency plan.
   2. Contractor placed grout is at Contractor's risk.
   3. The proposal of alternative methods for removing, clearing, or otherwise making it possible for the PTM to progress past an object that does not allow for the direct observation and measurement of the object shall not be considered for additional payment.

D. Inspect casing and ensure casing is clean and free of undesirable materials, water, and defects that would impair installation of the carrier pipe as required in Section 33 05 07.23.

E. All excavated material from tunnel construction not used as backfill shall be disposed of in accordance with Sections 31 05 13, 31 05 16, and 31 23 16.

3.4 SITE RESTORATION

A. All surface improvements damaged or removed as a result of the Work and associated operations shall be reconstructed to the same dimensions and pavement

thickness, and with the same type materials used in the original Work unless otherwise shown on the Plans.

B. Restoration shall follow construction as the Work progresses and be completed no later than 10 days after the carrier pipe is installed. Any testing or further inspection necessary for final completion and inspection of the pipe shall not be cause for any delay of restoration Work required under this Contract. This provision for restoration shall include all property that was affected by the construction operations. Such final restoration that cannot be performed within the 10-day period due to adverse weather conditions may upon written request, including a proposed procedure and time schedule, be performed as accepted by the Owner. Any delayed restoration will be contingent upon providing suitable safe temporary facilities without inconvenience or nuisance in the interim.

C. Clean and test carrier pipe in accordance with Section 33 11 16 before placing the pipe in service.

END OF SECTION

SECTION 33 05 07.23

CARRIER PIPE INSTALLATION INTO CASING

PART 1 GENERAL

1.1 REQUIREMENTS

A. This section specifies minimum design and performance requirements for the installation of carrier pipe within casing constructed previously using Pilot Tube Method (PTM).

B. Furnish all designs, tools, equipment, materials, and supplies and perform all labor required to complete the Work as indicated on the Approved Plans and specified herein.

C. Successfully complete final acceptance testing of the installed potable water pipe as specified in Section 33 11 16 before commencing with backfilling and after completion of backfilling.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. State Regulatory Codes to be current at all times:
   1. California Code of Regulations (CCR), Title 8, Tunnel Safety Orders
   2. CCR, Title 8, Construction Safety Orders, Section 1509 “Injury and Illness Prevention Program
   3. Caltrans (CT) Manual for Encroachment Permits on California State Highways
   4. CT Trenching and Shoring Manual

1.4 DEFINITIONS

A. For additional definitions refer to Sections 33 05 07.22 and 31 32 13.

B. Blocking: For this project, dimensional redwood lumber used to support the carrier pipe and secure the pipeline to design line and grade. The top blocking is used to prevent the carrier pipe from floating within the casing during backfill operations.

C. Bulkhead: A watertight wall that separates the casing into sections. For this project, bricks cast in cement mortar and located at both ends of each casing.

D. Carrier Pipe Support: Pre-manufactured or fabricated means to allow alignment of the carrier pipe within the casing and to prevent the movement of the carrier pipe during backfill grouting. Carrier pipe supports include skids, spacers, blocking, etc.

E. Casing Spacers: Pre-manufactured carrier pipe supports attached to the carrier pipe, advanced with the carrier pipe and used to set the carrier pipe to design line and

grade within a casing. Spacers include legs that support the weight of the carrier pipe and risers that prevent buoyancy. Casing spacers slide along near the casing invert.

F. Cast Invert: A cementitious mix poured and screeded to allow the carrier pipe to be set to design line and grade.

G. Cellular Grout: A lightweight cementitious material that contains stable air or gas cells uniformly distributed throughout the mixture in amounts greater than 20 percent and is suitable for complete backfilling of the void space between carrier pipe(s) and casing pipe. Density, both wet and cured, are critical design features.

H. End Seal: System used to seal the open end of the casing with a protruding carrier pipe. Common systems include “boot” and “wrap” and “modular link seals.” The “boot” is a form fitting one-piece that is pulled –on and extends from the casing to the carrier pipe and held in place with stainless steel hose clamps .The “wrap” is a flat sheet which extends from the casing to the carrier pipe and held in place with stainless steel hose clamps. The “modular link seals” are a series of compressible modular links spanning the gap between the casing and carrier pipe. Also see bulkhead.

I. Rails: Parallel set of guides, similar to railroad tracks, used to set the carrier pipe to design line and grade within a casing. The carrier pipe is slid along the rails which are attached near the casing invert.

J. Skid: Dimensional redwood lumber attached parallel to the carrier pipe and are advanced with the carrier pipe. Both top and bottom skids provide for resetting the carrier pipe to line and grade and provide a minimum amount of backfill grouting to fill the void. Skids slide along near the casing invert. Skids are to be cut, dog-eared to allow the skid to ride over weld beads and other small imperfections.

1.5 DESIGN REQUIREMENTS

A. Carrier pipe configuration within casing shall be as shown on the Approved Plans.

B. The following carrier pipe supports shall be permitted for use: casing spacers. The use of blocking, centralizers, wood skids, rails, and saddles shall not be permitted.

C. Carrier pipe supports shall be designed to withstand the total weight of the carrier pipe plus the weight of water within the completely filled carrier pipe with a factor of safety of at least 3.0.

D. Calculate the maximum anticipated construction loads, buoyancy, and operational loads and ensure that anticipated loads are incorporated into the manufacturer’s design of the carrier pipe subject to the Owner’s review.

1.6 PERFORMANCE REQUIREMENTS

A. Carrier pipe shall be installed within the following tolerances:

B. Line tolerance: plus or minus two (±2.0) inches of design line.
   1. Grade tolerance: ±1.0 inches for each 100 feet of pipeline, or a total grade tolerance of 0.05 feet between appurtenances.

C. No high or low points shall occur along the installed carrier pipe other than as shown on the Contract Documents.

D. Carrier pipe shall be free draining along the pipe invert without depressions that hold water with depth greater than 0.5-inch.

E. The outer most projection of the carrier pipe shall be separated from the inner most projection of the steel casing pipe by at least two (2.0) inches.

F. The carrier pipe shall be capable of meeting the design flow.

G. Carrier pipe supports shall prevent the movement of the carrier pipe during backfilling.

H. The casing shall be free of standing water and groundwater inflows prior to placing carrier pipe.

1.7 QUALITY ASSURANCE

A. Requirements outlined below shall be met at the time of bid and remain in force through completion of the project. Subcontracted work does not qualify as experience.
   1. The Contractor installing the carrier pipe shall have at least ten (10) years of carrier pipe installation experience and shall have successfully completed:
      a. Five (5) projects involving installation of carrier pipe inside casing with carrier pipe diameter between 8 inches and 24 inches ID.
      b. Five (5) projects involving installation of carrier pipe inside casing with the same carrier pipe material as specified for this project.
      c. At least one (1) project involving installation of at least 250 continuous feet of carrier pipe installation inside casing.
   2. Project Superintendent shall have:
      a. A minimum of five (5) years of experience in the installation of carrier pipes inside casings.
      b. A minimum of five (5) projects, with each project consisting of at least 250 continuous feet of carrier pipe installation inside casing.
      c. Successfully completed two (2) projects involving the installation of carrier pipes inside casings with carrier pipe diameter between 8 inches and 24 inches ID.
      d. Three (3) projects involving installation of carrier pipe inside casing with the same carrier pipe material as specified for this project.
   3. Grout pump operator shall have:
      a. A minimum of five (5) years of experience in the installation of carrier pipes inside casings.
      b. A minimum of five (5) projects, with each project consisting of at least 250 continuous feet of carrier pipe installation inside casing.
      c. Successfully completed two (2) projects involving the installation of carrier pipes inside casings with carrier pipe diameter between 8 inches and 24 inches ID.
      d. Successfully completed two (2) projects involving installation of carrier pipe inside casing with the same carrier pipe material as specified for this project.

e. Successfully completed one (1) project involving installation of carrier pipe inside casing with length longer than the longest length required for this project.
f. Operated equipment similar to the one proposed for this project.

4. Surveyor shall be a Professional Land Surveyor registered in the State of California with experience in underground surveying. Experience shall include:
   a. Five (5) tunnel projects within the last five (5) years,
   b. Transfer of points and line from the surface to below ground,
   c. Closed loop tunnel survey for line and grade.
5. Experience records shall list the five (5) most recent carrier pipe installation projects, including all such projects completed for the Owner, and all projects demonstrating the specified experience. Each experience record shall include name of project; owner of the project; names of contacts including all contact information; carrier pipe material used; carrier pipe diameter; casing pipe internal diameter and longest laying length.
6. The Owner will be the sole judge in determining if the prospective Contractor, project superintendent and operator meet the aforementioned work and project experience requirements.

1.8 SUBMITTALS

A. Submittals shall be made in accordance with Section 01 33 00 and as specified herein.

B. Carrier pipe installation submittals shall be coordinated with all relevant submittals, assembled and submitted as a single, complete, and comprehensive submittal.

C. Where calculations are required to be submitted, they shall be signed and sealed by a Professional Civil Engineer registered in the State of California. Calculations shall clearly identify all parameters used, state all assumptions made in the calculation, and identify all sources of information.

D. All shop drawings shall be legible with dimensions accurately shown and clearly marked in English.

E. Pre-Construction Submittals:
   1. Detailed carrier pipe-laying schedule. Schedule shall be coordinated with overall schedule for the Project.
   2. Qualifications and experience records for the following:
      a. Contractor performing the Work;
      b. Project superintendent;
      c. Operator;
      d. Contractor’s surveyor.
   3. Work plan describing proposed procedures, materials and equipment to transport or jack carrier pipe into position.
   4. Manufacturer’s preprinted specifications and operating instructions for proposed pipe carrier system or jacking equipment.
   5. Written confirmation from the carrier pipe manufacturer that the pipe wall and joint configuration to be supplied are appropriate for and consistent with the Contractor’s proposed means and methods.
   6. Written handling instructions from the carrier pipe manufacturer.

7. Design calculations for carrier pipe supports. Clearly state their respective spacing assumed in the calculations. If carrier pipe support design calculations are signed and sealed by a Professional Engineer who is a staff member of the manufacturer, professional engineering registration in the State of California is not required.
8. Shop drawings showing details of all carrier pipe supports proposed for use.
9. Shop drawing showing acceptable end seal details.
10. End seal materials, written recommendations, and installation instructions.
11. Calculations of maximum anticipated construction loads and buoyancy that might be imposed on the carrier pipe.
12. As-built survey of casing pipe in both tabular format and AutoCAD format acceptable to the Owner. Scale shall be acceptable to the Owner. Survey shall confirm that carrier pipe can be installed within design tolerances.
13. Design profile of carrier pipe placement showing carrier pipe supports.
14. Description of the means and methods of maintaining alignment of the carrier pipe within design tolerances during carrier pipe installation.
15. Electrical system, lighting system, and onsite power generation details.
16. Shaft and pipe ventilation system details including fan size and operating parameters.
17. Potable water sources, handling and disposal.

F. Construction Submittals:
   1. Daily installation logs with the following information:
      a. Date.
      b. Project name.
      c. Start and finish times for each shift.
      d. Location of pipe by station.
      e. Printed name of operator and signature.
      f. Number of carrier pipe segments installed.
      g. Carrier pipe support ID and location.
      h. Any unusual conditions or events.
   2. Provide all logs by 9 AM the following work day.

G. Post-Construction Submittals:
   1. As-built survey of installed carrier pipe in both tabular format and AutoCAD format acceptable to the Owner. Scale to be acceptable to the Owner.

1.9 SAFETY

A. Train all non-contractor project staff in shaft and tunnel entry operations prior to entry.

PART 2 PRODUCTS

2.1 MATERIALS

A. Provide carrier pipe with the following properties:
   1. Nominal Pipe Size: 7.90-inch inside diameter
   2. Material:
      a. Fusible polyvinyl chloride (FPVC) C-900 with wall thickness DR18, in accordance with Section 33 05 31-19; or

b. Fusible HDPE (FHDPE) carrier pipe with wall thickness DR9, in accordance with Section 33 05 31-20.

2.2 EQUIPMENT

A. Not Used

2.3 END SEALS AND BULKHEADS

A. Bulkheads shall be field-fitted of brick and mortar.
   1. Bricks shall be:
      a. Solid, without holes
      b. Manufactured in accordance with ASTM C-902.
   2. Mortar shall be:
      a. Acceptable to carrier pipe manufacturer.
      b. In accordance with brick manufacturer's written recommendations.

B. End seals boots shall be custom manufactured without seams and secured at both ends with stainless steel bands.

C. Modular link seals designed to completely span and secure the carrier pipe are not permitted.

D. End seal wraps or zippered end seals are not permitted.

PART 3 EXECUTION

3.1 GENERAL

A. Perform all Work in accordance with accepted submittals.

B. Provide Owner with access to the Work.

C. Maintain a copy of the Contract Documents and accepted submittal at a location acceptable to the Owner and accessible to the Owner.

3.2 INSTALLATION OF CARRIER PIPE

A. Carrier pipe installation shall not commence until:
   1. Casing has been cleaned, and
   2. Casing is leak-free and free of standing water.

B. Perform as-built survey of the casing and demonstrate the ability to install carrier pipe within design tolerances prior to commencing carrier pipe installation.

C. Mount carrier pipe to carrier pipe supports to allow for proper alignment of the carrier pipe within design tolerances and to provide the required clearance between the casing and carrier pipes as specified herein.

D. Treat and dispose of all water in accordance with the requirements specified in Section 31 23 19.

E. Perform final acceptance testing of the completed drive upon completion in accordance with Section 33 05 31.19 or 33 05 31.20.

3.3 SITE RESTORATION

A. All surface improvements damaged or removed as a result of the Contractor's operations shall be reconstructed to the same dimensions, and with the same type materials used in the original Work.

B. Restoration shall follow construction as the Work progresses. Any testing or further inspection necessary for final completion and inspection of the pipe shall not be cause for any delay of restoration Work required under this Contract. This provision for restoration shall include all property that was affected by the construction operations.

C. Ensure new potable water pipe is free and clear of all foreign materials before placing in service.

END OF SECTION

SECTION 33 05 07.24

JACKED STEEL CASING

PART 1 GENERAL

1.1 REQUIREMENTS

A. This section provides specifications for steel casing pipe for tunneling using the Pilot Tube Method (PTM) in Section 33 05 07.22.

B. Furnish all designs, tools, equipment, materials, and supplies and perform all labor required to complete the Work as indicated on the Contract Drawings and specified herein.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Comply with the following industry standards effective at time of bid.

1. ASTM A 36/A 36M, Standard Specification for Carbon Structural Steel 3.
2. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
3. ASTM A 283/A 283M, Standard Specification for Low and Intermediate
4. Tensile Strength Carbon Steel Plates.
5. ASTM A515 - Standard Specification for Pressure Vessel Plates, Carbon
6. Steel, for Intermediate- and Higher-Temperature Service.
7. ASTM A 568/A 568M, Standard Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled, and Structural Quality Cold Roll.

B. State Regulatory Codes: to be current at all times:
1. California Code of Regulations (CCR), Title 8, Tunnel Safety Orders
2. CCR, Title 8, Construction Safety Orders, Section 1509 “Injury and Illness Prevention Program
3. Caltrans (CT) Manual for Encroachment Permits on California State Highways
4. CT Trenching and Shoring Manual

1.4 DEFINITIONS

A. See Section 33 05 07.22.

1.5 PROJECT SITE CONDITIONS

A. See Section 33 05 07.22.

1.6 PERFORMANCE REQUIREMENTS

A. Casing pipe shall be provided for the carrier piping where shown on the Plans.

B. A smaller outside diameter casing pipe may be used if all other criteria are met and with acceptance of the Owner and CT.

C. A larger outside diameter (OD) casing pipe may be used if all other criteria are met and with acceptance of the Owner and CT. Include all requirements imposed by a larger outside diameter casing which includes additional materials, additional utility relocations, impacts to existing structures, and waste disposal. The use of a larger casing OD is not an acceptable cause for a differing site condition.

1.7 QUALITY ASSURANCE

A. Product Data: Includes manufacturer's product description, handling instructions, installation requirements, shop drawings, operation, maintenance procedures, and samples where applicable, as well as description of methods and materials for installing and protecting the casing, including post installation acceptance tests.

B. Field welding materials shall be compatible with the casing material.

C. Field welder certifications are to be appropriate for welding task and current at time of welding.

1.8 SUBMITTALS

A. Submittals shall be made in accordance with Section 01 33 00 and as specified herein.

B. Submittals shall be coordinated with all cross referenced sections and assembled and submitted as a single, complete, and comprehensive submittal.

C. Where calculations are required to be submitted, they shall be signed and sealed by a Professional Civil Engineer registered in the State of California. Calculations shall clearly identify all parameters used, state all assumptions made in the calculation, and identify all sources of information.

D. All shop drawings shall be legible with dimensions accurately shown and clearly marked in English.

E. Pre-Construction Submittals:
   1. Calculations demonstrating that the casing pipe has been designed to support the maximum anticipated construction and operational loads, with special respect

to the maximum anticipated jacking loads. Increase the casing sidewall thickness, as necessary, to withstand the anticipated stresses with a minimum factor of safety of 2.0.
2. Submit manufacturer's mill specification sheet listing diameter, thickness, and class of steel used in making the casing, and the mill certification.
3. Submit shop drawing showing casing lay length and joint detail. If welded casing include rod or wire and steel casing compatibility certification.
4. Submit manufacturer's pipe handling instructions.
5. Casing field repair method.
6. If different casing diameter is used than that indicated on the Contract Drawings, submit written justification, including availability of shield and ancillary equipment for the alternate diameter, whichever is applicable. Provide a table showing revised separation distances of all utilities within 20 feet of the pipeline and shafts.
7. Welder qualifications and welding certifications as needed.
8. Welding work plan and materials.

PART 2 PRODUCTS

2.1 STEEL CASING PIPE

A. Provide casing with minimum outside diameter and plate thickness as shown on the Plans, unless the Contractor elects to change the excavated diameter to fit their means and methods, subject to acceptance by the Owner and CT.

B. The wall thickness of casing passing under the CT right-of-way shall not be less than 0.50 inches.

C. The casing segments shall not be longer than 10.01 feet for the installed length.

D. Provide casing that is specifically manufactured for tunneling using jacking methods with a smooth outer wall and is manufactured to the following dimensional criteria:
   1. Circumference < 0.5%
   2. Exterior Roundness < 0.5%
   3. End Squareness +/- 1.5 mm
   4. Straightness < 3 mm
   5. Pipe Length +/- 6 mm

E. Comply with ASTM A 36/A 36M, ASTM A 283/ A 283M, Grade D, ASTM A515 Grade 60 or ASTM A 568/A 568M Grade 33 or accepted equal Grade and wall thickness.

F. All casing segments shall be joined by continuous, full circumference, full penetration butt welds or Permalok™ joint.

G. Provide and protect lubrication system. System is to be acceptable to the Owner. Provide for injection of lubrication at the leading edge of the casing pipe.

END OF SECTION

SECTION 33 05 31.19

FUSIBLE PVC (FPVC) PIPE

PART 1 GENERAL

1.1 REQUIREMENT

A. The Contractor shall furnish all tools, equipment, materials, and supplies and shall perform all labor required to complete the Work as indicated in the Contract Documents.

B. The Contractor shall furnish, install, and test fusible polyvinylchloride (FPVC) pipe, fittings, and appurtenances of the dimensions and to the lines and grades shown on the Contract Documents.

C. This section covers the furnishing and installation of fusible polyvinylchloride pipe and fittings for potable water, as specified and shown in the Contract Documents.

D. Excavation and backfill, including the pipe bedding, shall conform to the provisions of Section 31 23 17 and Section 31 05 16.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. All Work specified herein shall conform to or exceed the applicable requirements of the referenced portions of the following publications to the extent that the provisions thereof are not in conflict with other provisions of these Specifications.

B. Comply with the current provisions of the following codes and standards current at the time of bid.
   1. AWWA C900-97 Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 inches through 12 inches. (100 mm through 300 mm), for Water Distribution
   2. AWWA C905-97 Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 inches through 48 inches (350 mm through 1200 mm), for Water Distribution and Transmission
   3. AWWA M23 AWWA Manual of Supply Practices PVC Pipe – Design and Installation, Second Edition
   4. ASTM D1784 Specifications for Rigid Polyvinyl Chloride (PVC) Compounds
   5. ASTM D1785 Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120
   6. ASTM D2152 Test Method for Degree of Fusion of Extruded Polyvinyl Chloride (PVC) Pipe and Molded Fittings by Acetone Immersion
   7. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure Rated Pipe (SDR Series)
   8. ASTM D3139 - Standard Specifications for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

C. Comply with the applicable reference specifications as directed in the General Conditions.

1.4 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 as specified herein.

B. Submittals shall be coordinated with all relevant submittals, assembled, and submitted as a single complete and comprehensive submittal.

C. Qualifying submittals:
1. Contractor's pipe designer PE.
2. Certification from pipe manufacturer that Contractor is qualified to join, lay and handle pipe.
3. FPVC fusion technician's experience and qualifications demonstrating conformance with Quality Assurance requirements specified herein.
4. Written certification from the FPVC pipe fusion equipment supplier that the fusion technician has received training in the proper use of the fusion equipment and the manufacturer's recommended fusion equipment.

D. Pre-construction submittals:
1. Pipe Size
2. Dimensionality
3. Pressure Class per applicable standard
4. Color
5. Recommended Minimum Bending Radius
6. Recommended Maximum Safe Pull Force
7. Manufacturer's written recommendations for transport, handling, storage, and repair of the FPVC pipe shall be included.
8. Recommendations for shipping, handling, lifting, fusing, surface testing, and final testing.
9. Recommendations for installation within a tunnel including maximum allowable scouring and gouging of the sidewall during installation.
10. Manufacturer's technical data showing complete information on material composition, physical properties, pressure rating and dimensions of the FPVC pipe. Manufacturer's recommendations for transport, handling, storage, and repair of the FPVC pipe shall be included.
11. Specifications of fusing machine and fusing procedures and restrictions, including machine cut sheet.
12. Fusion machine data logger with temperature, date and pressure recording elements.
13. Design calculations for each pipe size and pipe DR to be furnished.
14. Pipe manufacturers' joint assembly procedure including cool down time and data logger equipment.
15. Detailed Pipe Laying Schedule.
16. Shop drawings and cut sheets providing information on fittings, including dimensions, compliance with standards and pressure rating.
17. Information on pipe accessories, including but not limited to special adaptors for connections to ductile iron fittings

18. Certifications: Furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this section, as specified in the referenced standards and the following supplemental requirements:
    a. Hydrostatic test reports.
    b. Three-edge bearing strength test reports.
19.

E. Post-construction submittals
    1. Fusion Data (heater plate temperature, hydraulic cylinder interface pressures, time/duration, etc.) shall be submitted to the Owner within two workdays following the completion of any joint.
    2. FPVC pipe manufacturer shall furnish an affidavit of compliance that all delivered materials comply with the requirements of these specifications.
    3. As-built drawings including pipe joints and appurtenance installations.

1.5 CARE AND HANDLING

A. All pipe shall be bundled or packaged in such a manner as to provide adequate protection of the ends during transportation to the site. Any pipe damaged in shipment shall be replaced as directed by the Owner.

B. Pipe shall be loaded, off-loaded, and otherwise handled in accordance with AWWA M23, and all of the pipe supplier's written guidelines shall be followed.

C. Any scratch or gouge greater than 10% of the wall thickness will be considered significant and can be rejected unless determined acceptable by the Owner.

D. Pipe lengths should be stored and placed on level ground. Pipe should be stored at the job site in the unit packaging provided by the manufacturer. Caution should be exercised to avoid compression, damage, or deformation to the ends of the pipe. The interior of the pipe, as well as all end surfaces, should be kept free from dirt and foreign matter.

E. The Contractor shall not store pipe upon the roadway or parkway of residential streets for more than 5 days or upon commercial streets for more than 3 days.

F. Pipe shall be stored and stacked per the pipe supplier's guidelines.

1.6 QUALITY ASSURANCE

A. General
    1. Pipe is subject to UV damage. Pipe is to be protected from direct sunlight
    2. All piping shall be made from PVC compound conforming to cell classification 12454 per ASTM D1784.
    3. Fusion Technician shall be qualified by the pipe supplier to fuse fusible polyvinyl chloride pipe of the type(s) and size(s) being used. Qualification shall be current as of the actual date of fusion performance on the project.
    4. Fusible polyvinyl chloride pipe shall be used as manufactured under the trade names Fusible C-900®, Fusible C-905®, and FPVC®, for Underground Solutions, Inc., Poway, CA, (858) 679-9551 or Owner approved equal. Fusion

process shall be as patented by Underground Solutions, Inc., Poway, CA, Patent No. 6,982,051.

5. The pipe shall be warranted for one year per the pipe supplier's standard terms.
6. In addition to the pipe warranty, the fusion services shall be warranted for one year per the fusion service provider's standard terms.

B. Weld Quality Control Documentation: Contractor shall produce and submit field weld reports within two days of welding activity. Report shall provide the following information, at a minimum:
   1. Date, time, and ambient temperature
   2. Joint Number that correlates to Project pipeline stationing
   3. Employee Identification that is unique to Project approved FPVC Fusion Technician
   4. Equipment Identification and specifications including piston area
   5. Pipe Data including material, size, Dimension Ratio
   6. Interfacial Pressure in pounds per square inch (psi) including Heat, Soak, Fuse, and Cool
   7. Recommended Gauge Pressures in pounds per square inch (psi) including Heat, Soak, Fuse, and Cool
   8. Recorded Data including Drag pressure, weld temperature
   9. Graphs of pressure and temperature over time. Provide one graph for the first five minutes of weld procedure and a summary plot of the entire weld and cool down process.

C.

PART 2 PRODUCTS

2.1 FUSIBLE POLYVINYLCHLORIDE PIPE

A. See Section 33 05 07-23, Carrier Pipe Installation for pipe size.

B. Fusible polyvinyl chloride pipe for potable water shall conform to AWWA C900-97, AWWA C905-97, ASTM D2241 or ASTM D1785 as applicable. Testing shall be in accordance with the referenced AWWA standards for all pipe types.

C. Fusible polyvinyl chloride pipe for potable water shall conform to AWWA C900-97, AWWA C905-97, ASTM D2241 for standard dimensionality, as applicable. Testing shall be in accordance with the referenced AWWA standards.

D. Fusible polyvinyl chloride pipe shall be extruded with plain ends. The ends shall be square to the pipe and free of any bevel or chamfer. There shall be no bell or gasket of any kind incorporated into the pipe.

E. Fusible polyvinyl chloride pipe shall be manufactured in a standard 40' nominal length or custom lengths as specified.

F. Fusible polyvinyl chloride pipe shall be blue in color for identification as a potable water application.

G. Pipe generally shall be marked per AWWA C900, AWWA C905, ASTM D2241, or ASTM D1785 as applicable, and shall include as a minimum:
   1. Nominal pipe size
   2. PVC
   3. Dimension Ratio, Standard Dimension Ratio or Schedule
   4. AWWA pressure class or standard pressure rating for non-AWWA pipe
   5. AWWA standard designation number or pipe type for non-AWWA pipe
   6. NSF-61 mark verifying suitability for potable water service
   7. Extrusion production-record code
   8. Trademark or trade name
   9. Cell Classification 12454 and/or PVC material code 1120 shall be included

H. Pipe shall be homogeneous throughout and be free of visible cracks, holes, foreign material, blisters, or other visible deleterious faults.

I. The Contractor shall coordinate the requirements of this Specification with the requirements of Section 33 05 07.22, Pilot Tube Method.

2.2 FUSION JOINTS

A. Unless otherwise specified, fusible polyvinylchloride pipe lengths shall be assembled in the field with butt-fused joints. The fusion technician shall follow the pipe supplier's guidelines for this procedure. All fusion joints shall be completed as described in this Specification.

2.3 FUSIBLE POLYVINYL CHLORIDE SWEEPS OR BENDS

A. Fusible polyvinyl chloride sweeps or bends shall conform to the same sizing convention, diameter, dimensional tolerances and pressure class of the pipe being joined by the sweep of bend.

B. Fusible polyvinyl chloride sweeps or bends shall be manufactured from the same fusible polyvinyl chloride pipe being used for the installations, and shall have at least 2 feet of straight section on either end of the sweep or bend to allow for fusion of the sweep to the pipe installation. There shall be no gasketed connections utilized with a fusible polyvinyl chloride sweep.

C. Standard fusible polyvinyl chloride sweep or bend angles shall not be greater than 22.5 degrees, and shall be used in nominal diameters ranging from 4 inches through 16 inches.

2.4 CONNECTION TO NEW OR EXISTING WATER DISTRIBUTION PIPING

A. Fusible polyvinylchloride pipe shall be connected to new or existing domestic water piping and appurtenances to provide a leak-free connection.

B. Connections to existing or new domestic water piping shall be as indicated in the construction documents.

2.5 BEDDING AND ENCASEMENT MATERIALS

A. All bedding and encasement materials shall be as shown on the Plans and in Sections 31 05 16 and 31 23 17, of these Specifications.

PART 3 EXECUTION

3.1 GENERAL

A. Pipe shall be off loaded, loaded, installed, handled, stored, and stacked per the pipe supplier's written guidelines. These guidelines include compliance with the minimum recommended bend radius and maximum safe pull force for the specific pipe being used.

B. The general best practices of the industry per AWWA M23 shall also be observed.

C. Trench excavation, bracing methods, foundation preparation, pipe bedding, trench backfill, and related operations shall be in accordance with the requirements of Section 31 23 17, Trenching.

D. The water pipe shall be constructed to the alignment and grade shown. The grade line shown on the profile is the invert or interior bottom of the pipe. The excavation shall be made a sufficient distance below the grade line to allow for the placing of the potable water pipe and the supporting bedding if such bedding is shown. Should the trench be excavated to a depth greater than required, the Contractor shall refill such excess excavation with the same fill material as specified for the overlying fill or bedding and compacted as required for such overlying fill or bedding.

E. Water pipelines shall never be used as drains for removing water that has infiltrated into the trenches.

3.2 FACTORY TESTING

A. Not Used

3.3 FUSION PROCESS

A. Fusible polyvinyl chloride pipe will be handled in a safe and non-destructive manner before, during, and after the fusion process and in accordance with this specification and pipe supplier's guidelines.

B. Fusible polyvinyl chloride pipe will be fused by qualified fusion technicians holding current qualification credentials for the pipe size being fused, as documented by the pipe supplier.

C. Pipe supplier's written procedures shall be followed.

D. Provide a sample joint and conduct testing to verify fusion on site.

E. Each fusion joint shall be recorded and logged by an approved electronic monitoring device (data logger) connected to the fusion machine, which utilizes a current version of the pipe supplier's recommended and compatible software.

F. Only appropriately sized and outfitted fusion machines that have been approved by the pipe supplier shall be used for the fusion process. This includes requirements for safety, maintenance, and operation with modifications made for PVC.

G. The FPVC shall not be placed in tension or compression for installation until the pipe has cooled to within 5°F of the ambient temperature as measured in the shade.

3.4 GENERAL INSTALLATION

A. Installation guidelines from the pipe supplier shall be followed for all installations.

B. The fusible polyvinyl chloride pipe will be installed in a manner so as not to exceed the recommended bending radius guidelines.

C. Where fusible polyvinyl chloride pipe is installed by pulling in tension, the recommended maximum safe pulling force, established by the pipe supplier, shall not be exceeded.

D. Internal and external rolled up beads formed at joints during fusion process shall be removed from the inside and outside of the pipe. Removal shall take place immediately after welding is complete. Contractor shall exercise caution to avoid damage to the joint and pipe while removing the bead and shall be responsible for repairs and/or replacement of any damaged joint or pipe.

3.5 FIELD WELDING QUALITY CONTROL

A. General: Contractor shall be responsible for employing a rigorous quality control procedure for field welding quality control and documentation. All field-welding shall be accomplished with Owner-Approved Equipment. Documentation of each field weld shall be submitted to the Owner within two days of weld completion.

B. Data Collector and Recording Device: Contractor shall utilize data collection and recording equipment to verify proper fusion procedures have been followed prior to installation. The Data collector shall consist of a rugged computer to record and report key weld parameters including the heater temperature and fusion pressure profile over time..

3.6 DAMAGED PIPE

A. Pipe sections with gouges or cuts deeper than ten percent (10%) of the wall thickness shall be cut out, removed, and replaced. Undamaged pipe portions may be rejoined using butt-fusion joining methods. No pipe segment shall have an adjacent weld within 10 feet without written acceptance of Owner.

3.7 TESTING AND ACCEPTANCE

A. GENERAL

1. Scope. All water pipe and appurtenances shall be hydrostatically tested for below grade piping systems for pipe material structural integrity and leaks. Bacteriological testing shall also be completed to confirm that piping systems are properly disinfected.

B. HYDROSTATIC AND LEAKAGE TEST

1. Test Fluid. The test fluid is to be the distribution system potable water. The Contractor shall be responsible for conveying test water from the source to the point of usage, and also for proper disposal, as required, of water used in the testing operations. All costs associated with supply and disposal of test water shall be at the Contractor's expense.
2. No direct connection to the existing sterile water system shall be made until satisfactory completion of all testing (i.e., hydrostatic testing, chlorination, and bacteriological testing). The Contractor shall install temporary jumper pipe assemblies and temporary blow-offs to facilitate testing of the pipeline in segments as needed. The temporary facilities shall be removed by the Contractor prior to making the connections. The Contractor is responsible for all final closures and connections.
3. Test Equipment
    a. Water: Sufficient quantity to fill pipeline section under test. Contractor shall arrange with the Owner for locations for acquiring potable water for testing. Contractor shall be responsible for all temporary piping, fittings, meters, and appurtenances.
    b. Valves: Suitable to isolate pipeline section under test without leaking.
    c. Relief Valve: To permit pressure relief if pressure exceeds 20 to 25 percent above the required test pressure to prevent pipeline failure
    d. Pressure Gauge(s): Provide sufficient number of pressure gauges with capable of measuring pressure 50 percent over the intended test pressure. Location of the gauges shall be determined by the Contractor and submitted with the pressure test plan. Contractor shall furnish all necessary equipment and make all taps in pipe required to perform testing.
    e. Pressure gauges and relief valves shall be checked for accuracy prior before being used during actual testing of the pipeline.
4. Preparation for Test
    a. Notify Owner a minimum of 3 (three) working days prior to performance of testing. Owner shall monitor all tests.
    b. Temporarily isolate the piping system into segments for testing purposes. Expansion joints shall be isolated, temporarily restrained, or removed prior to start of the test.
    c. Confirm that the pipeline is properly backfilled up to a minimum of the primary backfill levels and that all required thrust blocks and/or in-line restraints are in place prior to start of the pressure test.
    d. Connect booster pump and provide temporary closures for all of the external openings in the system. Use caution to ensure that the closures are properly designed and strong enough to withstand the test pressure.
    e. Tighten any flange connections loosened to vent air before applying test pressure.
    f. Permit the test fluid and the pipeline to set undisturbed for a minimum of 24 hours to achieve temperature equilibrium.

5. Test Pressure: 150 percent of the working pressure (225 psi) at point of test and no less than 125 percent of normal working pressure (190 psi) at highest elevation.

6. Test Duration: The hydrostatic and leakage test duration shall be two (2.0) hours.

7. Test Procedure
   a. The test procedures described herein shall be performed for each of the designated pipeline segments.
   b. Completely fill pipeline to be tested with water. The maximum rate of filling shall be limited so that the fluid filling the pipeline produces a maximum flow velocity of one (1.0) foot per second.
   c. Completely bleed off all trapped air during filling.
   d. Close all vents used to vent air from the pipe and restrict access in the test area to only those required for the test.
   e. During the initial expansion phase, slowly raise the pressure utilizing the booster pump until the desired test pressure is achieved.
   f. Add sufficient make-up test fluid to the system, at one hour intervals for three hours, to maintain the system test pressure. The pipe should have obtained equilibrium.
   g. Turn off the booster pump and hold the final test pressure for the required test duration period.
   h. At the end of the test period add sufficient make-up water to return the pipe to the required test pressure. Record the value of make-up water required to return to test pressure. If the test pressure is not returned within the allowable volume of water indicated in the table below, the test fails.

Make-up Water Allowance (U.S. Gallons / 100 Feet of Pipe)		
Nominal DI Pipe Size	**1 Hour Test**	**2 Hour Test**
3	0.10	0.15
4	0.13	0.25
8	0.50	1.00
10	0.75	1.30
12	1.10	2.30
18	2.30	4.50

* These allowances only apply to the test period and not to the initial expansion phase.

   i. Total test time shall not exceed eight (8.0) hours at the required test pressure. If the test is not completed due to leakage, equipment failure, etc. the test pressure shall be relieved and the test section shall be allowed to "relax" for a minimum of eight (8.0) hours before another test can be attempted.

8. Flushing
   a. Lines tested with water shall be completely drained.
   b. Pipelines tested shall be flushed after the test and draining is complete.
   c. All water drained from pipelines shall be dechlorinated and disposed of per Section 33 13 00 – Disinfection of Water Utility Distribution.

9. Test Records
    a. Records shall be maintained of all tests performed.
    b. Test records shall include as minimum:
        1) Date and time of beginning and end of pipeline testing
        2) Identification of pipeline being tested
        3) Test Fluid
        4) Test Pressure
        5) Ambient temperature
        6) Pressure gauge reading taken during the test
        7) Quantities of make-up water added during the test
        8) Signatures of Test Technician, Contractor representative whom witnessed the test and the Owner's Representative who witnessed the test
10. Prior to acceptance of the Work by the Owner, the Contractor shall perform pressure testing on potable water distribution systems in accordance with AWWA C600/ C605.
11. When tests indicate Work does not meet specified requirements, remove Work, replace and retest at the Contractor's expense.

C. BACTERIOLOGICAL TESTING
    1. Refer to Section 33 13 00 – Disinfection of Water Utility Distribution.

D. Disinfection
    1. Refer to Specification 33 13 00 - Disinfection of Water Utility Distribution

END OF SECTION

SECTION 33 05 31.20

FUSABLE HDPE PIPE

PART 1 GENERAL

1.1 DESCRIPTION

A. This section provides specifications for high density polyethylene (HDPE) pipe (4-inch diameter and larger), HDPE pipe accessories, including fittings, and piping appurtenances. The Contractor shall furnish all material, tools, and equipment and shall perform all labor required to complete the work as indicated in the Standard Specifications, General Conditions and Special Conditions to construct an operating pipeline that conforms to the design.

B. HDPE pipe shall comply fully with AWWA C906 and ASTM D3350. HDPE pipe shall be of same ID to avoid generating thrust loads, unless noted otherwise. HDPE pipe joints shall be fused, except where detailed otherwise on the plans.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. All work specified herein shall conform to or exceed the applicable requirements of the referenced portions of the following publications to the extent that the provisions thereof are not in conflict with the provisions of these Specifications.

B. Comply with the applicable editions of the following codes, regulations and standards, current at the time of bid.

1. AWWA C906-Polyethylene (PE) Pressure Pipe and Fittings, For Water Distribution
2. ASTM D2774-Standard Practice for Underground Installation of Thermoplastic Pressure Piping
3. ASTM D3261-Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
4. ASTM D3350-Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
5. ASTM F714-Standard Specification for Polyethylene (PE) Plastic Pipe (SDR- PR) Based on Outside Diameter

1.4 SUBMITTALS

A. Submittals shall be in accordance with the Section 01 33 00 as specified herein.

B. Submittals shall be coordinated with all relevant submittals, assembled, and submitted as a single complete and comprehensive submittal.

C. Qualifying submittals:
   1. Contractor's pipe designer PE.
   2. Certification from pipe manufacturer that Contractor is qualified to join, lay and handle pipe.
   3. HDPE fusion technician's experience and qualifications demonstrating conformance with Quality Assurance requirements specified herein.
   4. Written certification from the HDPE pipe fusion equipment supplier that the fusion technician has received training in the proper use of the fusion equipment and the manufacturer's recommended fusion equipment.

D. Pre-construction submittals:
   1. Manufacturer's technical data showing complete information on material composition, physical properties, pressure rating and dimensions of the HDPE pipe
   2. Certification from Plastic Pipe Institute that pipe manufacturer meets recipe and mixing requirements for resin used to manufacture pipe for this project
   3. Manufacturer's written recommendations for transport, handling, storage, and repair of the HDPE pipe
   4. Specifications of fusing machine and fusing procedures and restrictions, including machine cut sheet
   5. Fusion machine data logger capabilities including temperature, date and pressure recording elements
   6. Design calculations for each pipe size and pipe SDR to be furnished signed and stamped by a PE
   7. Pipe manufacturers' joint assembly procedure including cool down time and data logger equipment.
   8. Submittals shall include detailed drawings of the pipe, gaskets, joints, pipe special sections, pipe-laying diagrams, and test reports on the properties of the gasket material.
   9. Specifications and data sheets for pipe accessories, including but not limited to special adaptors for connections to ductile iron fittings.
   10. Specifications and data sheets for flange and mechanical joint adapters, including hardware and backer rings. Information shall include manufacturer's written installation directions including alignment and bolt tightening recommendations.
   11. Detailed Pipe Laying Schedule.

E. Post-construction submittals:
   1. Fusion Data (heater plate temperature, hydraulic cylinder interface pressures, time/duration, etc.) shall be submitted to the Owner within two workdays following the completion of any joint.
   2. HDPE pipe manufacturer shall furnish an affidavit of compliance that all delivered materials comply with the requirements of these specifications.

3. As-built drawings including pipe joints and appurtenance installations.

1.5 QUALIFICATIONS

A. Experience requirements outlined below shall be met at the time of bid and remain in force through completion of the Project. Work subcontracted out does not qualify as experience.

B. HDPE pipe joining shall be performed by personnel trained in the use of butt-fusion equipment and the recommended methods for new pipe connections.

C. Personnel directly involved with installing the new pipe shall receive training in the proper methods for handling and installing HDPE pipe.

D. Personnel performing fusion welding of HDPE shall have the following minimum experience:

1. Performed fusion bonding on at least three previous projects
2. Performed fusion bonding on at least 20,000 feet of 4-inch to 24-inch HDPE pipe.

1.6 CARE AND HANDLING

A. All pipe shall be bundled or packaged in such a manner as to provide adequate protection of the ends during transportation to the site. Any pipe damaged in shipment shall be replaced as directed by the Owner.

B. Pipe shall be loaded, off-loaded, and otherwise handled in accordance with AWWA M23, and all of the pipe supplier's written guidelines shall be followed.

C. Any scratch or gouge greater than 10% of the wall thickness will be considered significant and can be rejected unless determined acceptable by the Owner.

D. Pipe lengths should be stored and placed on level ground. Pipe should be stored at the job site in the unit packaging provided by the manufacturer. Caution should be exercised to avoid compression, damage, or deformation to the ends of the pipe. The interior of the pipe, as well as all end surfaces, should be kept free from dirt and foreign matter.

E. The Contractor shall not store pipe upon the roadway or parkway of residential streets for more than 5 days or upon commercial streets for more than 3 days.

F. Pipe shall be stored and stacked per the pipe supplier's guidelines.

1.7 QUALITY ASSURANCE

A. Experience records shall list the five (5) most recent projects, including all PTM projects completed for the OWNER, and all projects demonstrating the specified experience. The experience record shall include name of project; owner of the project; names of contacts including all contact information; HAB size; ground conditions as measured by UCS, ground type per USCS, ground water pressure, longest drive planned and completed; and total footage planned and completed.

B. Weld Quality Control Documentation: Report shall provide the following information, at a minimum:
   1. Date, time, and ambient temperature
   2. Joint Number that correlates to Project pipeline stationing.
   3. Employee Identification that is unique to Project-approved HDPE Fusion Technician
   4. Equipment Identification and specifications including piston area
   5. Pipe Data including material, size, Dimension Ratio
   6. Interfacial Pressures in pounds per square inch (psi) including Heat, Soak, Fuse, and Cool
   7. Recommended Gauge Pressures in pounds per square inch (psi) including Heat Soak, Fuse, and Cool
   8. Recorded data including drag pressure, weld temperature
   9. Graphs of pressure and temperature over time. Provide one graph for the first five minutes of weld procedure and a summary plot of the entire weld and cool down process.

C. HDPE Fabricated Fittings:

   1. The fitting fabricator shall have at least three (3) years experience in the fabrication of pressure-rated HDPE fittings of similar size and complexity as this project.
   2. The Fabrication Shop Supervisor must have at least one (1) year experience of shop supervision and three (3) years of experience fabricating HDPE fittings.
   3. The technician fabricating the HDPE fabricated fittings shall have the following minimum experience:
      a. Two (2) years experience fabricating HDPE fittings.
      b. Fabricated at least forty (40) fittings that are DR21 or thicker and 4-inch to 24-inch diameter.

D. HDPE Fabricated Fittings:

   1. The fitting fabricator shall have at least three (3) years experience in the fabrication of pressure-rated HDPE fittings of similar size and complexity as this project.

PART 2 PRODUCTS

2.1 SIZE AND DIMENSIONAL TOLERANCES

A. Pipe shall be round and true. The internal diameter of any portion of each piece of pipe shall be uniform and not vary more than plus or minus 5 percent. The wall thickness shall not be more than 5 percent less than that shown in the design, but in no case more than 3/16 inch less. A wall thickness greater than that required in the design shall not be cause for rejection. Deflected piping shall be installed with the long axis vertical.

B. The variation in laying length of two opposite sides of pipe shall not be more than 1/8 inch per foot of diameter with a maximum of 3/8 inch in any length of pipe, except where beveled pipe is used. The under run in length of a section of pipe shall not be more than 1/8 inch per foot of diameter with a maximum of 1/2 inch in any length of pipe.

C. Lengths: Pipe shall be supplied in nominal lengths of 20 feet or greater. Actual laying length shall be nominal +1 inches or -4 inches. At least 90% of the total footage of each size and class of pipe, excluding special order lengths, shall be furnished in nominal length sections.

2.2 MATERIALS

A. Pipe and Fittings: The pipe and fittings shall be a high performance, high molecular weight, PE 3608 high density polyethylene pipe. Minimum cell classification value shall be 345464E as referenced in ASTM D 3350. Material shall have a minimum Hydrostatic Design Basis (HDB) of 1600 psi at 73 degrees (F) when tested in accordance with ASTM D2837 and shall be listed in PPI TR-4 by name of the pipe and fitting manufacturer. The fittings shall be fabricated or molded from a polyethylene compound having a cell classification equal to or exceeding the compound used in the pipe or shall be manufactured using the polyethylene compound having a cell qualification equal to or exceeding the cell classification of the pipe supplied.

B. Pipe Size: See Section 33 05 07-23, Carrier Pipe Installation for pipe size.

C. The Owner shall request certified lab data to verify the physical properties of the pipe or may take random samples and have them tested by an independent testing laboratory.

D. Physical Properties of Pipe Compound.
   a. Density – The natural density shall be no less than 0.941 – 0.955 grams/cm3 as referenced in ASTM D 1505.
   b. Melt Flow – Melt flow shall be no greater than 4.0 grams/10 mins. when tested in accordance with ASTM D 1238 – Condition F.
   c. Flex Modulus – Flexural Modulus shall be 110,000 to 160,000 psi as referenced in ASTM D 790.

d. Tensile Strength at Yield – Tensile strength shall be 3000 to 3500 psi as referenced in ASTM D 638.

E. Contractor shall provide a new pipe sufficient in diameter as specified on the Drawings. The HDPE pipe shall be provided with blue stripes for identification as a potable water application.

F. The wall thickness (SDR) of the new HDPE pipe shall conform to ASTM to withstand all of the forces that will be imposed on the pipe during the tunneling installation, as well as the final in-place loading conditions.

G. Joints

1. General
   a. HDPE pipe joints shall be butt-fused, except where otherwise indicated on the plans or specified herein.
   b. Electro-fusion joints may be used, with Owner approval, to join HDPE pipe to HDPE pipe within open trenches where butt fusion cannot be practically performed.
   c. Friction or pressure couplings are not acceptable and will not be allowed except where specifically detailed on the plans.
2. Butt Fusion Joints Butt fusion techniques shall meet all requirements of ASTM D2657 and D3261.
3. Flanged Joints
   a. Flanged joints shall consist of HDPE flange adapters and flange backing ring, unless otherwise shown on the Drawings.
   b. Full face flat ring gaskets of 1/8-inch black reinforced rubber conforming to ANSI B-16.21 shall be installed between the flange adapter and opposing flange. Gaskets shall be full-faced with bolt holes and be held in position by the through-bolts.
   c. Flanged backing rings (flanges) shall be ductile iron with polypropylene coating or ductile iron.
   d. Flange backing rings shall be compatible with AWWA C110 flanges with ANSI B-16.1, class 125 flange bolting.
   e. Flanged backing rings pressure ratings shall meet or exceed the pressure class of the pipe.
   f. Flanged Joints shall have a type 316 stainless steel bolt sets (bolt, nut, and washers) or Tripac 2000 Blue coated bolts and nuts. Diameter, number and length of the bolts shall be as determined by the flange adapter manufacturer. Stainless steel hardware shall be installed with anti-seize lubricant.
4. Electro-fusion Joints
   a. Shall only be used as system closures with prior written approval of Owner.
   b. Electro-fusion joints must have a five (5) year satisfactory history of performance based on information submitted by Contractor for each size and DR of coupling.
   c. Joints shall meet AWWA C906 requirements.
   d. Joint pressure ratings shall meet or exceed the pipe pressure rating of the adjoining pipe.
   e. The inside diameter of an electro-fusion coupling shall match the outside diameter of the adjoining pipe.

H. Fittings

1. HDPE Fittings: Polyethylene (HDPE) fittings shall be made from material meeting the same requirements as the pipe. Polyethylene fittings shall be molded, turned or otherwise fabricated by the manufacturer of the pipe. All fittings shall be marked with size, dimension ratio (DR), and appropriate ASTM specification number.
   a. All fittings shall be pressure tested to four (4) times working pressure of pipe for five seconds or alternative back-bend test as provided for in AWWA C906.

2. Fabricated Fittings: Fabricated Fittings above 24" shall meet the requirements of AWWA C906 with the pressure testing waived.
   a. All fittings shall have the same DR as the adjoining pipe.
   b. Field fabricated fittings below 24" that do not comply with AWWA C906 or ASTM F2206 are not permissible for this project.

3. Molded Fittings: Molded fittings shall be socket fusion type for fittings under 4-inches, manufactured in accordance with ASTM D2683. Molded fittings shall be butt-fusion type for fitting 4-inches and larger, manufactured in accordance with ASTM D3261.

4. Flange Adapters: Polyethylene flange adapters shall be made with sufficient through-bore length to be clamped in a butt-fusion machine without the use of a stub-end holder. The sealing surface of the flange adapter shall be machined with a series of small v-shaped grooves to provide gasket-less sealing to prevent gasket blow-out.

I. Any section of the pipe with a gash, blister, abrasion, nick, scar, or other deleterious fault greater in depth than ten (10) percent of the wall thickness shall not be used and must be removed from the site. However, a defective area of the pipe may be cut out and the joint fused in accordance with the manufacturer's recommendations.

J. Any section of the pipe having other defects such as concentrated ridges, discoloration, excessive spot roughness, pitting, variable wall thickness or any other defect of manufacturing or handling as determined by the Owner shall be discarded and removed from the site.

K. Terminal sections of pipe that are joined within the insertion pits shall be connected with a mechanical coupling (full circle 316 stainless steel long-body repair coupling), electro fusion couplings or two HDPE flanges with type 316 stainless steel back-up rings (join flanges using type 316 stainless steel nuts, bolts and washers). All connections shall be in conformance with the manufacturer's installation procedures.

L. Manhole connections shall be done using HDPE flange with type 316 stainless steel back-up ring, minimum of two 1-1/8" diameter adhesive anchor bolts connected to the manhole base, and HDPE spool with wall anchor imbedded in the cast manhole base. In lieu of the wall anchor and anchor bolts, the Contractor can submit for

approval an alternative method recommended by the HDPE pipe manufacturer to resist pullout.

PART 3 EXECUTION

3.1 GENERAL

A. General: HDPE pipe shall be installed in conformance with the manufacturer's written recommendations, and shall comply with the alignment and profile indicated by the design drawings.

B. Shipping and Storage: HDPE pressure pipe shall be shipped and stored by supporting the pipe uniformly. Pipe shall be stored in the unit packages provided by the manufacturer.

C. Installation Manual: The manufacturer shall supply an installation manual to the Owner which outlines guidelines for handling, joining, installing, embedding and testing of polyethylene pipeline. These guidelines shall be used as reference material for the Owner in the determination of the required procedures.

3.2 FACTORY TESTING

NOT USED

3.3 JOINING OF PIPE

A. Heat Fusion Joining: Joints between plain end pipes shall be made by the butt fusion method. All internal and external beads shall be removed to within 1/8-inch of the existing sidewall. The bead shall be removed down to, or just above the pipe’s sidewall surface, but never below it.

B. HDPE pipe shall not be joined to existing pipe or adjacent segments until a minimum of 12 hours has elapsed to allow for temperature equalization and stress relief. HDPE pipe stretched beyond its elastic limit or damaged in any way shall be rejected.

C. Conduct a sample weld and test for complete fusion on site.

D. For pipe sizes larger than 36 inches in diameter, struts must be provided and installed per the manufacturer's recommendations. However, the struts shall not cause more than 12% vertical elongation; in no case will horizontal elongation be permitted.

E. For open trench portions of the alignment, adjustment of pipes to lines and grade shall be made by scraping away or filling in and tamping material under the body of the pipe throughout its entire length, and not by blocking or wedging. All bedding materials must be mechanically compacted/consolidated to a minimum of 90% standard proctor or as required by the Owner.

F. The HDPE shall not be placed in tension or compression for installation until the pipe has cooled to within 5°F of the ambient pipe temperature.

G. Pipe is subject to UV damage. Pipe is to be protected from direct sunlight

3.4 INSTALLATION OF PIPE

A. For installation requirements of Pilot Tube Method, see Section 33 05 07-22. Refer to the paragraphs below for installation with other types of construction methods.

B. Joints: Joints between plain ends of polyethylene pipe shall be made by butt fusion when possible. The pipe manufacturer's fusion procedures shall be followed at all times as well as the recommendations of the fusion machine manufacturer. The wall thicknesses of the adjoining pipes and fittings shall have the same DR.

C. Mechanical Fittings: If mechanical fittings (which are designed for or tested and found acceptable for use with polyethylene pipe) are utilized for transitions between pipe materials, repairs, joining pipe sections, saddle connections, or at other locations; the recommendations of the mechanical fitting manufacturer must be followed. These procedures may differ from other pipe materials.

D. Butt Fused Joints: A bend back test shall be performed for every 50 fusions or 3000 ft. of pipe. The trial fusion shall be allowed to cool completely, then fusion test straps shall be cut out. The test strap shall be 12-inches or 30 times the wall thickness in length (minimum) and one inch, or 1.5 times the wall thickness in width (minimum). Bend the test strap until the ends of the strap touch. If the fusion fails at the joint, a new trail fusion shall be made, cooled completely and tested. Butt fusion of pipe to be installed shall not commence until a trial fusion has passed the bent strap test.

3.5 FIELD WELDING QUALITY CONTROL

A. General: Contractor shall be responsible for employing a rigorous quality control procedure for field welding quality control and documentation.

B. Weld Quality Control Documentation: Contractor shall produce and submit field weld reports within two days of welding activity.

3.6 DAMAGED PIPE

A. Pipe sections with gouges or cuts deeper than ten percent (10%) of the wall thickness shall be cut out, removed and replaced. Undamaged pipe portions may be rejoined using butt-fusion joining methods

3.7 FLANGE AND MJ ADAPTER INSTALLATION

A. Flanges/MJ adapters shall be attached to pipe and fittings using butt fusion. The flanges/MJ adapters shall be aligned and centered relative to the pipe. Flanges/MJ adapters should be square with the valve or other flange before tightening of bolts. Bolts should not be used to draw flanges into alignment. Bolt threads shall be

lubricated, and flat washers shall be used under flange nuts. Bolts shall be tightened using a "star tightening pattern". See manufacturer's recommendations. Twenty-four hours after first tightening the flange bolts, they must be re-tightened using the same "star tightening patter" used above. The final tightening torque shall be as indicated by the manufacturer.

3.8 TESTING AND ACCEPTANCE

A. GENERAL
   1. Scope. All water pipe and appurtenances shall be hydrostatically tested for below grade piping systems for pipe material structural integrity and leaks. Bacteriological testing shall also be completed to confirm that piping systems are properly disinfected.

B. HYDROSTATIC AND LEAKAGE TEST
   1. Test Fluid. The test fluid is to be the distribution system potable water. The Contractor shall be responsible for conveying test water from the source to the point of usage, and also for proper disposal, as required, of water used in the testing operations. All costs associated with supply and disposal of test water shall be at the Contractor's expense.
   2. No direct connection to the existing sterile water system shall be made until satisfactory completion of all testing (i.e., hydrostatic testing, chlorination, and bacteriological testing). The Contractor shall install temporary jumper pipe assemblies and temporary blow-offs to facilitate testing of the pipeline in segments as needed. The temporary facilities shall be removed by the Contractor prior to making the connections. The Contractor is responsible for all final closures and connections.
   3. Test Equipment
      a. Water: Sufficient quantity to fill pipeline section under test. Contractor shall arrange with the Owner for locations for acquiring potable water for testing. Contractor shall be responsible for all temporary piping, fittings, meters, and appurtenances.
      b. Valves: Suitable to isolate pipeline section under test without leaking.
      c. Relief Valve: To permit pressure relief if pressure exceeds 20 to 25 percent above the required test pressure to prevent pipeline failure
      d. Pressure Gauge(s): Provide sufficient number of pressure gauges with capable of measuring pressure 50 percent over the intended test pressure. Location of the gauges shall be determined by the Contractor and submitted with the pressure test plan. Contractor shall furnish all necessary equipment and make all taps in pipe required to perform testing.
      e. Pressure gauges and relief valves shall be checked for accuracy prior before being used during actual testing of the pipeline.
   4. Preparation for Test
      a. Notify Owner a minimum of 3 (three) working days prior to performance of testing. Owner shall monitor all tests.
      b. Temporarily isolate the piping system into segments for testing purposes. Expansion joints shall be isolated, temporarily restrained, or removed prior to start of the test.

c. Confirm that the pipeline is properly backfilled up to a minimum of the primary backfill levels and that all required thrust blocks and in-line restraints are in place prior to start of the pressure test.
d. Connect booster pump and provide temporary closures for all of the external openings in the system. Use caution to ensure that the closures are properly designed and strong enough to withstand the test pressure.
e. Tighten any flange connections loosened to vent air before applying test pressure.
f. Permit the test fluid and the pipeline to set undisturbed for a minimum of 24 hours to achieve temperature equilibrium.

5. Test Pressure: 150 percent of the working pressure (225 psi) at point of test and no less than 125 percent of normal working pressure (190 psi) at highest elevation.
6. Test Duration: The hydrostatic and leakage test duration shall be two (2.0) hours.
7. Test Procedure
   a. The test procedures described herein shall be performed for each of the designated pipeline segments.
   b. Completely fill pipeline to be tested with water. The maximum rate of filling shall be limited so that the fluid filling the pipeline produces a maximum flow velocity of one (1.0) foot per second.
   c. Completely bleed off all trapped air during filling.
   d. Close all vents used to vent air from the pipe and restrict access in the test area to only those required for the test.
   e. During the initial expansion phase, slowly raise the pressure utilizing the booster pump until the desired test pressure is achieved.
   f. Add sufficient make-up test fluid to the system, at one hour intervals for three hours, to maintain the system test pressure. The pipe should have obtained equilibrium.
   g. Turn off the booster pump and hold the final test pressure for the required test duration period.
   h. At the end of the test period add sufficient make-up water to return the pipe to the required test pressure. Record the value of make-up water required to return to test pressure. If the test pressure is not returned within the allowable volume of water indicated in the table below, the test fails.

Make-up Water Allowance (U.S. Gallons / 100 Feet of Pipe)		
Nominal DI Pipe Size	**1 Hour Test**	**2 Hour Test**
3	0.10	0.15
4	0.13	0.25
8	0.50	1.00
10	0.75	1.30
12	1.10	2.30
18	2.30	4.50

* These allowances only apply to the test period and not to the initial expansion phase.

   i. Total test time shall not exceed eight (8.0) hours at the required test pressure. If the test is not completed due to leakage, equipment failure, etc. the test pressure shall be relieved and the test section shall be allowed to

"relax" for a minimum of eight (8.0) hours before another test can be attempted.

8. Flushing
   a. Lines tested with water shall be completely drained.
   b. Pipelines tested shall be flushed after the test and draining is complete.
   c. All water drained from pipelines shall be dechlorinated and disposed of per Section 33 13 00 – Disinfection of Water Utility Distribution.
9. Test Records
   a. Records shall be maintained of all tests performed.
   b. Test records shall include as minimum:
      1) Date and time of beginning and end of pipeline testing
      2) Identification of pipeline being tested
      3) Test Fluid
      4) Test Pressure
      5) Ambient temperature
      6) Pressure gauge reading taken during the test
      7) Quantities of make-up water added during the test
      8) Signatures of Test Technician, Contractor representative whom witnessed the test and the Owner's Representative who witnessed the test
10. Prior to acceptance of the Work by the Owner, the Contractor shall perform pressure testing on potable water distribution systems in accordance with AWWA C600/ C605.
11. When tests indicate Work does not meet specified requirements, remove Work, replace and retest at the Contractor's expense.

C. BACTERIOLOGICAL TESTING
   1. Refer to Section 33 13 00 – Disinfection of Water Utility Distribution.

D. Disinfection
   1. Refer to Specification 33 13 00 - Disinfection of Water Utility Distribution

END OF SECTION

SECTION 33 11 16

SITE WATER UTILITY DISTRIBUTION PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe and fittings for site water line including domestic water line, and fire water line
   2. Valves.
   3. Backflow preventers.
   4. Underground pipe markers.
   5. Bedding and cover materials.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:
   1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 10-lb Rammer and a 18-in. Drop.

B. American Society of Sanitary Engineering:
   1. ASSE 1012 - Backflow Preventer with Intermediate Atmospheric Vent.
   2. ASSE 1013 - Reduced Pressure Principle Backflow Preventers.

C. ASTM International:
   1. ASTM A48/A48M - Standard Specification for Gray Iron Castings.
   2. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
   3. ASTM C858 - Standard Specification for Underground Precast Concrete Utility Structures.
   4. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3).
   5. ASTM D1785 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
   6. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
   7. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
   8. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
   9. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
   10. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

D. American Society of Mechanical Engineers:
   1. ASME B16 – Standards of Pipes and Fittings

E. American Welding Society:
   1. AWS A5.8/A5.8M – Specification for Filler Metals for Brazing and Braze Welding.

F. American Water Works Association:
   1. AWWA C508 - Swing-Check Valves for Waterworks Service, 2 in. (50 mm) Through 24 in. (600 mm) NPS.
   2. AWWA C509 - Resilient-Seated Gate Valves for Water-Supply Service.
   3. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. through 12 in., for Water Distribution.

G. Underwriters Laboratories Inc.:
   1. UL 246 - Hydrants for Fire - Protection Service.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit data on pipe materials, pipe fittings, valves and accessories.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.6 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.

B. Perform Work in accordance with California Waterworks Standards.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Deliver and store valves in shipping containers with labeling in place.

PART 2 PRODUCTS

2.1 WATER PIPING

A. Copper Tubing: ASTM B88, Type K, annealed:

1. Fittings: ASME B16.18, cast copper, or ASME B16.22, wrought copper.
2. Joints: Compression connection or AWS A5.8, BCuP silver braze.

B. PVC Pipe: Schedule 40, SDR-26 for 160 psig pressure rating:
1. Fittings: ASTM D2466, PVC.
2. Joints: ASTM D2855, solvent weld.

C. PVC Pipe: AWWA C900 Class 125:
1. Fittings: AWWA C111, cast iron.
2. Joints: ASTM D3139 compression gasket ring.

2.2 GATE VALVES

A. 2-1/2 inches and Smaller: Brass or Bronze body, non-rising stem, inside screw, single wedge or disc, IPS ends, with control rod, extension box.

B. 3 inches and Larger: AWWA C509, Iron body, bronze trim, non-rising stem with square nut, single wedge, resilient seat, flanged or mechanical joint ends, control rod, extension box.

2.3 BALL VALVES

A. 2 inches and Smaller: Brass body, teflon coated brass ball, rubber seats and stem seals, Tee stem pre-drilled for control rod, IPS inlet end, IPS outlet.

2.4 SWING CHECK VALVES

A. 2 inches to 24 inches: AWWA C508, iron body, bronze trim, renewable disc and seat, flanged ends per California Waterworks Standards.

2.5 BACKFLOW PREVENTERS

A. Furnish materials in accordance with California Waterworks Standards.

B. Reduced Pressure Backflow Preventers:
1. Comply with ASSE 1013.
2. Bronze body, with bronze internal parts and stainless steel springs.
3. Two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve opening under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two gate valves, strainer, and four test cocks.

2.6 UNDERGROUND PIPE MARKERS

A. Plastic Ribbon Tape: Bright colored, continuously printed, minimum 4 inches wide by 4 mil thick, manufactured for direct burial service.

B. Tracer Wire: Electronic detection materials for non-conductive piping products.
1. Unshielded 10 gage THWN insulated copper wire.
2. Conductive tape.

2.7 BEDDING AND COVER MATERIALS

A. Bedding: Fine Aggregate as specified in Section 31 05 16.

B. Soil Backfill from Above Pipe to Finish Grade: Soil Type Select Fill, as specified in Section 31 05 13.

2.8 ACCESSORIES

A. Concrete for Thrust Restraints: Concrete type specified in Section 03 30 00.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify building service connection and municipal utility water main size, location, and invert are as indicated on Drawings.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.

C. Remove scale and dirt on inside and outside before assembly.

D. Prepare pipe connections to equipment with flanges or unions.

3.3 BEDDING

A. Excavate pipe trench in accordance with Section 31 23 17 for Work of this Section.

B. Form and place concrete for pipe thrust restraints at change of pipe direction. Place concrete to permit full access to pipe and pipe accessories. Provide thrust restraint bearing on subsoil per drawings.

C. Place bedding material at trench bottom, level fill materials in one continuous layer not exceeding 6 inches depth.

D. Backfill around sides and to top of pipe with cover fill, tamp in place and compact to 95 percent.

E. Maintain optimum moisture content of fill material to attain required compaction density.

3.4 INSTALLATION - PIPE

A. Group piping with other site piping work whenever practical.

B. Install pipe to indicated elevation to within tolerance of 5/8 inch.

C. Install ductile iron fittings to AWWA C600.

D. Route pipe in straight line.

E. Install pipe to allow for expansion and contraction without stressing pipe or joints.

F. Install access fittings to permit disinfection of water system.

G. Form and place concrete for thrust restraints at each elbow or change of direction of pipe main.

H. Establish elevations of buried piping with not less than 3 ft of cover.

I. Install plastic ribbon tape continuous buried 12 inches below finish grade, above pipe line; coordinate with Section 31 23 23.

J. Install trace wire continuous over top of pipe, above pipe line.

3.5 INSTALLATION - VALVES AND HYDRANTS

A. Set valves on solid bearing.

B. Center and plumb valve box over valve. Set box cover flush with finished grade.

C. Set hydrants plumb; locate pumper nozzle perpendicular to and facing roadway.

D. Set hydrants to grade, with nozzles at least 20 inches above ground.

E. Locate control valve 12 inches away from hydrant.

F. Install Work in accordance with the California Waterworks Standards.

3.6 INSTALLATION - METERS

A. Meters to be installed by the Contractor as shown on the plans.

3.7 SERVICE CONNECTIONS

A. Install water service and fire line in accordance with California Waterworks Standards requirements with reduced pressure backflow preventer, or double check valve backflow preventer with water meter.

B. Install water meter and backflow preventer above grade.

C. Install Work in accordance with California Waterworks Standards.

3.8 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Flush and disinfect system in accordance with California Waterworks Standards.

3.9 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting, testing.

B. Perform pressure test on domestic site water distribution system in accordance with AWWA C600.

C. Compaction Testing for Bedding: In accordance with ASTM D698. ASTM D2922. ASTM D3017.

D. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

E. Frequency of Compaction Tests: One test for each 12 inches of fill in each 100 feet of trench.

END OF SECTION

SECTION 33 13 00

DISINFECTION OF WATER UTILITY DISTRIBUTION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes disinfection of potable water distribution and transmission system; and testing and reporting results.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 – Measurement and Payment

1.3 REFERENCES

A. American Water Works Association:
   1. AWWA B300 - Hypochlorites.
   2. AWWA B301 - Liquid Chlorine.
   3. AWWA B302 - Ammonium Sulfate.
   4. AWWA B303 - Sodium Chlorite.
   5. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
   6. AWWA C651 - Disinfecting Water Mains.

B. California Waterworks Standards

C. Water Pollution Control Federation and other applicable standard methods for the Examination of Water and Wastewater.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures.

B. Name and experience of competent person(s) responsible for the disinfection process and performing the required bacteriological sampling. Engineer shall approve in advance.

C. Product Data: Submit procedures, proposed chemicals, and treatment levels for review.

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

E. Certified results for all bacterial sampling prior to restoring or placing the distribution system into service.

F. Contractor shall submit a Disinfection Plan and Schedule for approval by the Engineer a minimum of fourteen (14) calendar days in advance of the planned performance of the Work. Plan shall detail proposed disinfection procedures including injection and sampling points, proposed chemical and amounts, proposed hold time,

proposed sectioning of the system, proposed water disposal and de-chlorination procedure.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Disinfection Report:
1. Type and form of disinfectant used.
2. Date and time of disinfectant injection start and time of completion.
3. Test locations.
4. Name of person collecting samples.
5. Initial and 24 hour disinfectant residuals in treated water in ppm for each outlet tested.
6. Date and time of flushing start and completion.
7. Disinfectant residual after flushing in ppm for each outlet tested.

C. Bacteriological Report:
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. Certify water conforms, or fails to conform, to bacterial standards of California Department of Health Services.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with AWWA C651.

1.7 QUALIFICATIONS

A. Testing Firm: Company specializing in testing potable water systems, certified by State

B. The competent person(s) responsible for disinfection processes and bacteriological

C. The Engineer shall approve Disinfection Plan and Schedule prior to implementation.

D. Submit bacteriologist's signature and authority associated with testing.

E. The Engineer shall observe disinfection and bacteriological sampling procedures.

PART 2 PRODUCTS

2.1 DISINFECTION CHEMICALS

A. Chemicals: AWWA B300, Hypochlorite, AWWA B301, Liquid Chlorine, AWWA B302, Ammonium Sulfate, and AWWA B303, Sodium Chlorite.

B. Material Safety Data Sheets (MSDS) of any chemicals used shall be available on site.

C. Competent person(s) responsible for the disinfection process shall be fully trained in the first aid requirements and procedures to address exposure to chemicals.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements.

B. Verification of existing conditions before starting work.

C. Verify piping system has been cleaned, inspected, and pressure tested.

D. Perform scheduling and disinfecting activity with start-up, water pressure testing, adjusting and balancing, demonstration procedures, including coordination with related systems.

3.2 DISINFECTION

A. Before being placed into service, all new water pipelines shall be chlorinated using the Continuous Feed Method specified in AWWA C651. The Engineer shall approve the procedure in advance.
   1. The Contractor will determine the location of the chlorination and sampling points in the field. The Contractor shall install taps for chlorinating, sampling and expulsion of air and shall uncover, backfill and plug the taps as required.
   2. Prior to disinfecting the water main, the main shall be completely filled to remove all air pockets and then flushed to remove particulate. The flushing velocity in the main shall not be less than 2.5 feet per second unless the Engineer and/or Owner determine that the conditions do not permit the required flow to be discharged to waste.

Required Flow to Flush Pipelines (40 PSI Residual Pressure in Water Main)*	
Pipe Diameter (in)	Flow Required to Produce 2.5 ft/s (Approximate Velocity in Main)
4	100 gpm
6	200 gpm
7	400 gpm
10	600 gpm
12	900 gpm
16	1600 gpm

*AWWA C651, AWWA Standard for Disinfecting Water Mains

3. At a point not more than 10 feet downstream from the beginning of the new main, water entering a new main shall receive a dose of chlorine fed at a constant rate such that the water will not have less than 25 mg/L (PPM) free chlorine throughout the entire section of pipe to be chlorinated.

Chlorine Required to Produce 25-mg/L Concentration in 100 Feet of Pipe-by Diameter*		
Pipe Diameter (in)	100% Chlorine (lbs)	1% Chlorine Solution (gals)
4	0.013	0.16
6	0.030	0.36
7	0.054	0.65
10	0.085	1.02
12	0.120	1.44
16	0.217	2.60
*AWWA C651, AWWA Standard for Disinfecting Water Mains		

4. The chlorinated water is to remain in the new pipeline for at least 24-hours. After a contact time of 24-hours there should be a free chlorine concentration of not less than 10 mg/L (PPM). During this period, proper precautions are to be taken to prevent this chlorinated water from flowing back into the existing system.
5. All valves and hydrants within the treated section shall be operated to ensure disinfection of the appurtenances.

B. The Tablet Method consisting of placing calcium hypochlorite granules or tablets in the water main as it is being installed and then filling the main with potable water and allowing it to set for a contact period is not acceptable.

C. The interior of all pipe, fittings, and valves used in making a repair or tie-in shall be swabbed or sprayed with a one percent (1%) hypochlorite solution before they are installed.

3.3 FINAL FLUSHING

A. Following the chlorination period, all treated water shall be flushed from the lines at their extremities and replaced with water from the distribution system.
   1. Flushing the main is to be accomplished at as high a velocity as possible consistent with the ability of the Contractor to collect the discharge water for proper disposal.
   2. All treated water flushed from the lines shall be disposed of by discharging to the nearest sanitary sewer or by other approved means provide in AWWA C651.
   3. Flushing shall be done in strict conformance with all applicable local, state, and federal regulations. No discharge to any storm sewer or natural watercourse will be allowed.

B. The discharge of chlorinated water will be harmful to vegetation and wildlife. Measures must be taken to impound the highly chlorinated water or to neutralize the chlorine prior to discharge of the water.

C. Federal, state and local environmental regulations may require special provisions or permits prior to the disposal of chlorinated water.

D. Coordinate disposal of chlorinated water with the Owner. Legally dispose of chlorinated water in accordance with regulatory agency requirements.

E. Neutralize the chlorine residual of the water being disposed with one of the chemicals listed below:
   1. Sodium Thiosulfate
   2. Sodium Bisulite
   3. Sodium Metabisulfite
   4. Sodium Sulfite

3.4 BACTERIOLOGICAL ANALYSES

A. After the 24-hour disinfection period and all chlorine solution has been thoroughly flushed, the bacteriological sampling and analysis of the replacement water may then be performed.
   1. Bacteriological sampling shall be made by the Contractor's competent person(s) in full accordance with AWWA C651 – Section 7, Bacteriological Tests and under the supervision of the Engineer.
   2. Analysis shall be performed by an independent commercial laboratory certified by the State Department of Environmental Protection and US Environmental Protection Agency for analyzing public drinking water supplies. All results shall be provided to the Engineer for review.
   3. Two consecutive sets of acceptable samples, taken at least 24-hours apart are required prior to placing the main into service. Failure of any one of the bacteriological test samples shall require re-chlorination and retesting by the Contractor.
   4. The line shall not be placed in service until the bacteriological requirements of AWWA C651 are met.

END OF SECTION 33 13 00

SECTION 33 13 13

WATER RESERVOIR DISINFECTION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:
   1. Water reservoir disinfection
   2. Bacteriological testing

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCES

A. American Water Works Association:
   1. AWWA C652 - Disinfection of Water Storage Facilities.

1.4 SUBMITTALS

A. Make all submittals in accordance with Section 01 33 00 - Submittal Procedures

B. Disinfection Procedure: Submit procedure description including type of disinfectant and calculations indicating quantities of disinfectants required to produce specified chlorine concentration in accordance with Section 4.3 of AWWA C652.

C. Test Reports: Indicate results of bacteriological and residual chlorine laboratory test reports.

D. Manufacturer's Certificate:
   1. Certify disinfectants meet or exceed AWWA Standards requirements.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with AWWA C652.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store disinfectants in cool, dry place away from combustibles such as wood, rags, oils and grease.

B. Handle disinfectants with caution; protect skin and eyes from contact; avoid breathing vapors; wear gloves, aprons, goggles, and vapor masks.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Furnish personnel working inside reservoir during disinfection with equipment to comply with Federal and State regulations for work conducted in hazardous atmosphere.

B. Neutralize disinfectant solution before disposal.

C. Legally dispose of disinfection solution off Project site.
   1. If a chlorination method is selected that requires the reservoir to be drained in order to dispose of highly chlorinated water, thorough consideration should be given to the effect on the receiving environment. If there is any question as to whether a chlorinated-waste discharge may cause damage to fish life, plant life, physical installations, or other downstream water uses of any type, an adequate amount of reducing agent should be applied to the discharged water in order to thoroughly neutralize the chlorine residual.

D. Repair damage caused by disinfectant solution and disinfection procedures.

PART 2 PRODUCTS

2.1 DISINFECTANTS

A. Chlorine Forms: In accordance with AWWA C652, Section 4.2.

PART 3 EXECUTION

3.1 EXAMINATION

A. Conduct inspection of reservoir interior before beginning disinfection.
   1. Verify reservoir is clean and free of polluting materials.
   2. Verify reservoir pipe and vent connections are properly made and clear of obstructions.

3.2 APPLICATION

A. Disinfection of the reservoir shall take place after all other items of work relating to the tank have been completed, inspected, and declared sufficient by the NACE certified inspector, the Engineer, and the Owner.

B. Use any one or a combination of the three methods for disinfecting reservoir, including the roof, specified in Section 4 of AWWA C652:
   1. Chlorination Method 1.
   2. Chlorination Method 2.
   3. Chlorination Method 3.

C. Contractor responsible for proper disposal of disinfection water.

D. Contractor responsible for protection of aquatic life and vegetation from damage from disinfectant solution purged from reservoir.

3.3 FIELD QUALITY CONTROL

A. Conduct bacteriological sampling and testing in accordance with AWWA C652.

END OF SECTION

SECTION 33 16 21

BOLTED STEEL WATER STORAGE TANKS AND APPURTENANCES

PART 1 GENERAL

1.1 SUMMARY

A. Furnish and erect a glass-fused-to-steel bolted water storage tank, including foundation, tank structure and tank appurtenances as shown on the submittal drawings and described herein.

B. All required labor, materials and equipment shall be included.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCES

A. American Water Works Association (AWWA):
   1. AWWA D103 - Factory-Coated Bolted Carbon Steel Tanks for Water Storage.

B. SSPC SP-10 - Surface Preparation Standard – Near-White Metal Blast Cleaning

C. ASTM C633-79 - Standard Test Method for Adhesion or Cohesive Strength of Flame-Sprayed Coatings

D. ISO 28706-1:2008 - Vitreous and Porcelain Enamels -- Determination of Resistance to Chemical Corrosion

E. ISO 2859 – Sampling Procedures for Inspection by Attributes

F. ISO 6370-2 – Vitreous and Porcelain Enamels – Determination of Resistance to Abrasion

G. EN 14430:2004 – Vitreous and Porcelain Enamels – High Voltage Test

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal requirements.

B. Construction shall be governed by the Owner's drawings and specifications showing general dimensions and construction details, after written approval by the Engineer of detailed erection drawings prepared by the tank Contractor. There shall be no deviation from the Owner’s drawings and specifications, except upon written order from the Engineer.

C. The Contractor is required to furnish, for the approval of the Engineer and at no increase in contract price, 1 set of complete specifications and construction drawings

for all work not shown in complete detail on the submittal drawings. A complete set of structural calculations shall be provided for the tank structure, foundation and anchorage. Structural calculations shall also include anchorage for all attached accessories and appurtenances. All such submissions shall be stamped by a Licensed Professional Engineer licensed in the State of California, as well as, by a Licensed Professional Engineer employed by the tank manufacturer's engineering staff. Where the tank manufacturer's P.E. is licensed in the state of the project location, only one stamp is required.

D. When approved, two sets of such prints and submittal information will be returned to the Contractor marked "APPROVED FOR CONSTRUCTION" and these drawings will then govern the work detailed thereon. The approval by the Engineer of the tank supplier's drawings shall be an approval relating only to their general conformity with the bidding drawings and specifications and shall not guarantee detail dimensions and quantities, which remains the Contractor's responsibility.

E. The tank manufacturer's standard published warranty shall be included with submittal information.

F. The Contractor shall include the tank manufacturer’s standard Operation and Maintenance Manual upon receipt of approved drawings.

G. The Contractor shall include the manufacturer’s fabrication/installation data for the water tank.

1.5 QUALITY ASSURANCE

A. Qualifications of Tank Supplier
   1. The Engineer's selection of factory applied glass-fused-to-steel bolted tank construction for this facility has been predicated upon specific criteria, construction methods, and an optimum coating for resistance to internal and external tank corrosion. Deviations from the specified design, construction or coating details, will not be permitted.
   2. The Contractor shall offer a new tank structure as supplied from a manufacturer specializing in the design, fabrication and erection of factory applied glass-fused-to-steel bolted tanks. The manufacturer shall employ a staff of full time design engineers, and shall own and operate its steel fabrication facilities and glass coating facilities.
   3. Glass-fused-to-steel bolted tank products, as provided by manufacturers, will be considered for prior approval by the Engineer. Manufacturers lacking the experience requirement will be considered, if the manufacturer provides a satisfactory 5-year 100% Performance Bond in lieu of evidence of experience and long term operation.
   4. Strict adherence to the standards of design, fabrication, erection, product quality, and long term performance established in this Specification will be required by the Owner and Engineer.
   5. Tank suppliers wishing to pre-qualify shall submit the following to the Engineer/Owner for consideration:
      a. Typical structure and foundation drawing(s).
      b. List of tank materials, appurtenances and tank coating specifications.

c. List of 5 tanks presently in potable water service designed to AWWA D103 Standard, of equal or greater size and character specified herein, operating satisfactorily for a minimum of 5 years, including the name and telephone number of Owner and Engineer.

1.6 DESIGN CRITERIA

A. Tank Size
1. The factory coated glass-fused-to-steel bolted tank shall be determined by the manufacturer with sidewall height no greater than 20 feet.

B. Tank Capacity
1. Tank capacity shall be 150,000 gallons (nominal, U.S. gallons).

C. Floor Elevation
1. Finished floor elevation shall be set at elevation shown on plans

D. Tank Design Standards
1. The materials, design, fabrication and erection of the bolted steel tank shall conform to the AWWA Standard for "Factory-Coated Bolted Steel Tanks For Water Storage" - ANSI/AWWA D103, latest revision.
2. The tank shall have a steel floor. AWWA D103 Type 6 tank foundations with embedded steel base setting ring are not allowed.
3. The tank coating system shall conform solely to Section 10.4 of ANSI/AWWA D103 latest revision.
4. All materials furnished by the tank manufacturer, which are in contact with the stored water shall be certified and listed by the National Sanitation Foundation (NSF) to meet ANSI/NSF Additives Standard No. 61. Certification of a coating type alone will not be sufficient to meet this requirement.

E. Seismic Design
1. Site Coordinates: 40.8520, -124.1659
2. Site Class: D
3. Seismic Response Accelerations, S_s: 2.607 g
4. Seismic Response Accelerations, S_1: 1.040 g
5. Use simultaneous combination of vertical and horizontal acceleration.
6. Use direct sum hoop stress combination.
7. Pressure stability to be considered for seismic loading.
8. Seismic design of roof, ladders, hatches, piping and other facilities is required.
9. Tank supplier shall submit stamped anchorage and foundation calculations prepared by an engineer licensed to practice in the State of California.

F. Design Loads
1. Refer to project geotechnical report “Manila Community Services District Water Tank Replacement Project” prepared by Crawford & Associates, Inc., dated December 2017 for site specific parameters
2. Specific Gravity : To be determined by tank manufacturer
3. Design Freeboard: To be determined by tank manufacturer
4. Wind Velocity (AWWA D103 Std. 100 mph [161 kph]): To be determined by tank manufacturer
5. Allowable Soil Bearing Capacity: Per Geotechnical Report

6. Roof Snow Load: To be determined by tank manufacturer
7. Earthquake Seismic Zone, AWWA D103: To be determined by tank manufacturer

PART 2 PRODUCTS

2.1 GLASS FUSED TO STEEL WATER STORAGE TANK

A. Furnish materials in accordance with AWWA standards.

2.2 MATERIALS

A. Foundation
1. The tank foundation shall be designed by the manufacturer to safely sustain the structure and its live loads.
2. Tank foundation design shall be based on the soil bearing capacity. Copies of the soil report are to be provided to the Contractor prior to bid date by the Owner or Engineer.

B. Plates and Sheets
1. Steel plates and sheets used in the construction of the tank shell, tank floor (when supplied) and tank roof, shall comply with the minimum standards of AWWA D103, latest edition.
2. Design requirements for mild strength steel shall be ASTM A1011 Grade 30 with a maximum allowable tensile stress of 14,566 psi (100 MPa).
3. Design requirements for high strength steel shall be ASTM A1011 Grade 50 with a maximum allowable tensile stress of 26,000 psi (179 MPa).
4. The annealing effect created from the glass coated firing process shall be considered in determining ultimate steel strength. In no event shall a yield strength greater than 50,000 psi (345 MPa) be utilized for calculations detailed in AWWA D103, Sections 3.4 and 3.5.
5. When multiple vertical bolt line sheets and plates of ASTM A1011 Grade 50 are used, the effective net section area shall not be taken as greater than 85% of the gross area.

C. Rolled Structural Shapes
1. Material shall conform to minimum standards of ASTM A36 or ASTM A992.

D. Horizontal Wind Stiffeners
1. Design requirements for intermediate horizontal wind stiffeners shall be of the "web truss" type with an extended tail creating multiple layers of stiffener, permitting wind loads to be distributed around the tank.
2. Web truss stiffeners shall be of steel with hot dipped galvanized coating.
3. Rolled steel angle stiffeners are not permitted for use as intermediate horizontal wind stiffeners.

E. Bolt Fasteners
1. Bolts used in tank lap joints shall be ½" - 13 UNC- 2A rolled thread, and shall meet the minimum requirements of AWWA D103, Section 2.2.
2. Bolt Material
   a. SAE J429 Grade 2 (1inch [25 mm] bolt length)

1) Tensile Strength - 74,000 psi (510 MPa) Min.
2) Proof Load - 55,000 psi (379 MPa) Min.
3) Allowable shear stress with threads excluded from the shear plane - 18,163 psi (125 MPa) Min.

b. SAE J429 Grade 5 (1 ¼ inch [32 mm] bolt length)
1) Tensile Strength - 120,000 psi (827 MPa) Min.
2) Proof Load - 85,000 psi (586 MPa) Min.
3) Allowable shear stress with threads excluded from the shear plane – 29,454 psi (203 MPa) Min.

c. SAE J429 Grade 8 (>1 ¼ inch [32 mm] bolt length)
1) Tensile Strength - 150,000 psi (1034 MPa) Min.
2) Proof Load - 120,000 psi (827 MPa) Min.
3) Allowable shear stress with threads excluded from the shear plane – 36,818 psi (254 MPa) Min.

d. Bolt Finish - Zinc, mechanically deposited.
1) 2.0 mils (0.002 inches) Min. - under bolt head, on shank and threads.

e. Bolt Head and Nut Encapsulation
1) High impact polypropylene copolymer encapsulation of entire bolt head up to the splines on the shank.
2) Resin shall be stabilized with an ultraviolet light resistant material such that the color shall appear black.
3) The bolt head encapsulation shall be certified to meet the ANSI/NSF Standard 61 for indirect additives.
4) In addition to the bolt head, after the nut has been tightened, a color match nut cap made of the same above material shall be place over the steel nut.

f. All bolts on the vertical tank wall shall be installed such that the head portion is located inside the tank, and the washer and nut are on the exterior.

g. All lap joint bolts shall be properly selected such that threaded portions of the bolts will not be exposed to the "shear plane" between tank sheets.

h. Bolt lengths shall be sized to achieve a neat and uniform appearance. Excessive threads extending beyond the nut after torquing will not be permitted.

i. All lap joint bolts shall include a minimum of 4 splines on the underside of the bolt head at the shank in order to resist rotation during torquing.

F. Sealants
1. The lap joint sealant shall be a one component, moisture cured, polyurethane compound. The sealant shall be suitable for contact with potable water and shall be certified to meet ANSI/NSF Additives Standard 61 for indirect additives.
2. The sealant shall be used to seal lap joints and bolt connections and edge fillets for sheet notches and starter sheets. The sealant shall cure to a rubber-like consistency, have excellent adhesion to the glass coating, low shrinkage, and be suitable for interior and exterior use.
3. Sealant curing rate at 73°F (23°F) and 50% RH.
a. Tack-free time: 6 to 8 hours.
b. Final cure time: 10 to 12 days.
4. Neoprene gaskets and tape type sealer shall not be used.

G. Glass Coated Bolted Steel Floor

1. Bolted steel panels shall be either placed over a 3 inch (76 mm) compacted sand base contained by a steel or concrete ring wall, or a non-extruding and resilient bituminous type filler meeting the requirements of ASTM D1751 if set on a concrete slab.
2. A plastic encapsulated nut shall be used to cover the bolt threads exposed on the inside of the floor. The plastic encapsulation shall be NSF compliant.
3. Leveling of the starter ring shall be required and the maximum differential elevation within the ring shall not exceed 1/8 inch (3 mm) , nor exceed 1/16 inch (2 mm) within any 10 feet (3048 mm) of length.

H. Sidewall Structure
1. Field erection of the glass-coated, bolted-steel tank shall be in strict accordance with the procedures outlined in the manufacturer's erection manual, and performed by an authorized dealer of the tank manufacturer, regularly engaged in erection of these tanks, using factory trained erectors.
2. Specialized erection jacks and building equipment developed and manufactured by the tank manufacturer shall be used to erect the tanks. This special erection equipment has induce a staggered vertical seam in the tank.
3. Particular care shall be taken in handling and bolting of the tank panels, structural members, and appurtenances to avoid abrasion of the coating system. Prior to a liquid test, all surface areas shall be visually inspected by the Engineer.
4. An electrical leak test shall be performed during erection using a wet sponge 9 volt leak detection device. All electrical leak points found on the inside surface shall be repaired in accordance with manufacturer's published touch up procedure.
5. No backfill shall be placed against the tank sidewall without prior written approval of the tank manufacturer. Any backfill allowed shall be placed according to the strict instructions of the tank manufacturer.

I. Roof
1. Tanks with diameters of 14 to 31 feet (4267 to 9449 mm) shall include a radially sectioned roof fabricated from glass - coated, bolted steel panels, as produced by the tank manufacturer, and shall be assembled in a similar manner as the sidewall panels utilizing the same sealant and bolting techniques, to assure a weather tight assembly. The roof shall be clear - span and self-supporting. Both live and dead loads shall be carried by the tank walls. The roof shall be of a rolled knuckle design, with no rolled angle connection between sidewall and roof panels. The manufacturer shall furnish a roof opening which shall be placed near the outside tank ladder and which shall be provided with a hinged cover and a hasp for locking. The opening shall have a clear dimension of at least 24 inches (610 mm) in one direction and 15 inches (381 mm) in the other direction. The opening shall have a curb at least 4 inches (102 mm) in height, and the cover shall have a downward overlap of at least 2 inches (51 mm), or a gasketed weather-tight cover in lieu of the 4 inch (102 mm) curb and 2 inch (51 mm) overlap.
2. Roofs for tanks greater than 31 feet (9449 mm) in diameter shall be constructed of non-corrugated triangular aluminum panels which are sealed and firmly clamped in an interlocking manner to a fully triangulated aluminum space truss system of wide flange extrusions, thus forming a dome structure.
    a. The dome shall be clear span and designed to be self-supporting from the periphery structure with primary horizontal thrust contained by an integral tension ring.

b. The dome and tank shall be designed to act as an integral unit. The tank shall be designed to support an aluminum dome roof including all specified live loads.
c. Materials:
    1) Triangulated dome frame struts: AA6005A-T6 aluminum.
    2) Structural frame node plates: 0.375 inch (10 mm) nominal thickness, AA6061-T6 aluminum,
    3) Triangular dome panels: 0.050 inch (1 mm) nominal thickness, AA3003-H16 aluminum Sheet.
    4) Perimeter tension/compression ring: AA6005A-T6 aluminum.
    5) Fasteners: AA2024-T4 aluminum or austenitic series 300 stainless steel as required by the manufacturers design.
    6) Sealant: Silicone, conforming to Federal Specification TT-S-00230.
    7) Gaskets: Silicone, conforming to Federal Specification ZZ-R-765, Class 2, Grade 50 or equal or Neoprene conforming to ASTM C509-00.
    8) Dormers, doors, and hatches: AA6061-T6, AA6005A-T6, AA5086-H34 or AA5052-H36 aluminum, 0.090inch (2 mm) nominal thickness.

3. Roof Vent
    a. A properly sized vent assembly in accordance with AWWA D103 shall be furnished and installed above the maximum water level of sufficient capacity so that at maximum design rate of water fill or withdrawal, the resulting interior pressure or vacuum will not exceed ½ inch (13 mm) water column.
    b. The overflow pipe shall not be considered to be a tank vent.
    c. The vent shall be constructed of aluminum such that the hood can be unbolted and used as a secondary roof access.
    d. The vent shall be so designed in construction as to prevent the entrance of birds and/or animals by including an expanded aluminum screen (½ inch [13 mm]) opening. An insect screen of 23 to 25 mesh polyester monofilament shall be provided and designed to open should the screen become plugged by ice formation.

J. Appurtenances
1. Pipe Connections
    a. Where pipe connections are shown to pass through tank panels.
    b. Overflow piping shall be 6 inches diameter steel.
2. Flush Cleanout
    a. One (1) 30-inch bolt on flush cleanout shall be fabricated and installed in accordance with AWWA specifications and as shown on the Plans.
3. Fire Connection Assembly
    a. One (1) fire connection assembly with shutoff shall be provided per the tank manufacturer. All piping connecting to the tank feeding the fire connection assembly shall meet NFPA standards.
4. Outside Tank Ladder
    a. An outside tank ladder shall be furnished and installed as shown on the submittal drawings.
    b. Ladders shall be fabricated of aluminum and utilize grooved, skid-resistant rungs.
    c. Safety cage and step-off platforms shall be fabricated of galvanized steel. Ladders shall be equipped with a hinged lockable entry device.
5. Access Doors

a. One (1) bottom access door shall be provided as shown on the submittal drawings in accordance with AWWA D103.
b. The manhole opening shall be a minimum of 30 inches in diameter. The access door (shell manhole) and the tank shell reinforcing shall comply with AWWA D103 latest edition, Sec. 5.1.

6. Exterior Ladder
   a. The ladder shall be designed in accordance with AWWA Specifications and shall be positioned as shown on the Plans. Exterior ladder shall conform to the latest OSHA requirements. Friction brakes and sliding attachments shall be Saf-T-Climb with removable extension rail as manufactured by Norton Company, Cerritos, CA, or approved equal. Two (2) life belts shall be furnished. Exterior ladder shall be equipped with a ladder gate to prevent unauthorized entry.
7. Interior Ladder
   a. Provide interior ladder assembly as shown on Plans. Ladder shall be galvanized steel, and conforming to the latest OSHA requirements.
8. Roof Hatch
   a. Roof hatch on tank shall be positioned as shown on the Plans, along with handrails around roof hatch meeting OSHA and AWWA standards. The cover shall have automatic hold-open arm, with compression spring operator for easy opening and closing, with inside and outside handles and locking hasp on the top side. The hatch shall be weathertight.
9. Identification Plate
   a. A manufacturer's nameplate shall list the tank serial number, tank diameter and height, and maximum design capacity. The nameplate shall be affixed to the tank exterior sidewall at a location approximately 5 feet (1524 mm) from grade elevation in a position of unobstructed view.
10. Sampling Station
    a. One (1) tank sampling station shall be provided per the tank manufacturer.
11. Gauge Board
    a. The Contractor shall furnish and install a level gauge board. Gauge board shall be full length having letters at least four (4") inches high. Face may be constructed of aluminum or a similar material. Gauge must be straight and plumb in both directions. The wires holding the ceramic or equal float and level gauge marker shall be stainless steel and shall be tied top and bottom inside and outside with enclosed teflon pulleys where required for smooth, easy, trouble-free operation. Gauge board shall not be located within reach of the tank ladder. Gauge board shall be visible from the access road. Unit shall be Varec Liquid Level indicator, Fig. 6700 or approved equal.
12. Safety Ties
    a. Safety tie off eyes shall be installed on the roof.
13. Padlocks
    a. The Contractor shall provide padlocks for the tank roof hatch and ladder as manufactured by Schlage (No. 45-221), Assa (No. 5941794), or equal of a type master-keyed to the Owner's system.
14. Cathodic Protection
    a. A passive cathodic protection system shall be designed and supplied by the tank manufacturer based upon information supplied by the Engineer or Owner.
15. Lightning Protection
    a. Lightning protection to be provide and installed per NFPA 780.

2.3 GLASS COATING

A. Surface Preparation
   1. Sheets shall be steel grit-blasted on both sides to the equivalent of SSPC SP-10 (Near–White Metal Blast Cleaning).
   2. The surface anchor pattern shall be not less than 1.0 mil (0.001 inches).

B. Sheet Edges
   1. After initial sheet preparation, all full height vertical wall sheets and all rectangular shaped floor sheets shall be beveled. A metal coating of 316 stainless steel shall then be thermally bonded on these edges at a thickness of 1.5 to 5 mils (0.0015 to 0.005 inches). The coating shall have a tensile strength of >1500 psi (10 MPa) (per ASTM C633-79).

C. Cleaning
   1. After fabrication and prior to application of the coating system, all sheets shall be thoroughly cleaned by a caustic wash and hot rinse process followed immediately by hot air drying.
   2. Inspection of the sheets shall be made for traces of foreign matter, soil particles, grease or rust.

D. Coating
   1. A base coat of glass frit containing nickel oxide shall be applied to both side of the sheet.
   2. A second coat of milled cobalt blue glass shall be applied to both sides of the sheets.
   3. A third coat of glass shall be applied to all interior sidewall and floor sheet surfaces which must be a titanium dioxide reinforced mixture, white glass. The specified coating shall be per the tank manufacturer. An acceptable alternate three coat system must be submitted for approval prior to the bid.
   4. The same glass coating as applied to the exterior sheet surfaces shall be applied to the exposed edges.
   5. The sheets shall then be fired at a minimum temperature of 1500° F (816° C) in strict accordance with the manufacturer's ISO 9001 quality control procedures, including firing time, furnace humidity, temperature control, etc.
   6. The interior coating process for sidewall sheets and floor must be a 3 coat process. The interior color shall be white. The exterior color shall be green.
   7. The dry film interior coating thickness shall be 10.0 to 18.0 mils (0.010 to 0.018 inches) minimum.
   8. The dry film exterior coating thickness shall be 7.0 to 15.0 mils (0.007 to 0.015 inches) minimum.

E. Factory Inspection
   1. The manufacturer’s quality system shall be ISO 9001 certified and refer to ISO (International Organization for Standardization) for the following testing and procedures.

F. Chemical Resistance of Glass Coating
   1. Frits shall be individually tested in accordance with pertinent sections of ISO 28706-1:2008.

G. Factory Holiday Test
   1. A dry volt test using a minimum of 1100 volts is required.
   2. Frequency of the test shall be every sheet. Any sheet registering a discontinuity on the interior surface or floor shall be rejected.

H. Measurement of Glass Thickness
   1. Glass thickness shall be measured using an electronic dry film thickness gage (magnetic induction type) approved by CST Storage. The thickness gage shall have a valid calibration record.
   2. The thickness of the glass shall be between 10.0 and 18.0 mils (0.010 and 0.018 inches).

I. Measurement of Color
   1. The exterior color of the sheets shall be measured using a colorimeter approved by CST Storage. The colorimeter shall have a valid calibration record.
   2. The color must fall within the tolerance specified by CST Storage, else the panel shall be rejected.

J. Impact Adherence Test
   1. The adherence of the glass coating to the steel shall be tested in accordance with ISO standards. Any sheet that has poor adherence shall be rejected.

K. Fishscale Test
   1. The glass coating shall be tested in-house for fishscale by placing the full size production sheets in an oven at 400º F (204º C) for one hour. The sheets will then be examined for signs of fishscale. Any sheet exhibiting fishscale shall be rejected and all sheets from that gage lot will be similarly tested.

L. Packaging
   1. All sheets that pass Factory Inspection and Quality Control checks shall be protected from damage prior to packing for shipment.
   2. Heavy paper or plastic foam sheets shall be placed between each panel to eliminate sheet-to-sheet abrasion during shipment.
   3. Individual stacks of panels will be wrapped in heavy mil plastic and steel banded to special wood pallets built to maintain the roll-radius of the tank panels and minimize contact or movement of finished panels during shipment.
   4. Shipment from the factory will be by truck, hauling the tank components exclusively.

2.4 TANK MANUFACTURER'S WARRANTY

A. The tank manufacturer shall include a warranty for the tank materials and coating. As a minimum, this warranty shall provide assurance against defects in material or

workmanship for the period of 1 year and corrosion of the glass coated surface for the period of 5 years.

PART 3 EXECUTION

3.1 INSTALLATION

A. Erection
   1. Erection shall be in conformance with Section 8 of AWWA D103.
   2. Foundation:
      a. The tank foundation is a part of this contract and shall be installed by the tank bidder. All grading is the responsibility of the Contractor.
   3. Tank Floor, Walls and Roof
      a. The tank floor, walls, and roof shall be installed per the manufacturer's recommendations and as per the requirements of AWWA D103. The tank shall be anchored to the foundation to meet the intent of the design specifications.

3.2 FIELD TESTING

A. Hydrostatic
   1. Following completion of erection and cleaning of the tank, the structure shall be tested for liquid tightness by filling tank to its overflow elevation.
   2. Any leaks disclosed by this test shall be corrected by the authorized dealer in accordance with the manufacturer's recommendations.
   3. Water required for testing shall be furnished by the Owner at the time of tank erection completion, and at no charge to the tank erector. Disposal of test water shall be the responsibility of the Owner.
   4. Labor and equipment necessary for hydrostatic tank testing is to be included in the price of the tank.

3.3 DISINFECTION

A. Standards
   1. The tank structure shall be disinfected at the time of testing by chlorination in accordance with AWWA Standard C652-02 "Disinfection of Water Storage Facilities" as modified by the tank manufacturer.
   2. Disinfection shall not take place until tank sealant is fully cured.
   3. Acceptable forms of chlorine for disinfection shall be:
      a. Liquid chlorine as specified in AWWA C652-02.
      b. Sodium hypochlorite as specified in AWWA C652-02.
   4. Acceptable methods of chlorination shall be:
      a. Chlorination method 1 as outlined in AWWA C652-02 Section 4.3.
      b. Chlorination method 2 as outlined in AWWA C652-02 Section 4.3.
      c. Chlorination method 3 as outlined in AWWA C652-02 Section 4.3.
   5. Acceptable application methods shall be:
      a. Chemical feed pump.
      b. Spraying, brushing, or painting of all water-contact surfaces.

END OF SECTION

SECTION 33 31 00

SANITARY UTILITY SEWERAGE PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sanitary sewage pipe.
   2. Underground pipe markers.
   3. Bedding and cover materials.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCES

A. American Association of State Highway and Transportation Officials:
   1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 10-lb Rammer and a 18-in. Drop.

B. ASTM International:
   1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3).
   2. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3).
   3. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
   4. ASTM D2729 - Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
   5. ASTM D2751 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
   6. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
   7. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
   8. ASTM D3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
   9. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

1.4 DEFINITIONS

A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit data indicating pipe material used and pipe accessories.

C. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record location of pipe runs, connections, manholes, cleanouts, and invert elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance Caltrans Standard Plans.

1.8 FIELD MEASUREMENTS

A. Verify field measurements and elevations are as indicated.

1.9 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Coordinate the Work with termination of sanitary sewer connection outside building, connection to municipal sewer utility service, and trenching.

PART 2 PRODUCTS

2.1 SANITARY SEWAGE PIPE

A. Plastic Pipe: ASTM D3034, Poly (Vinyl Chloride) (PVC) material; inside nominal diameter of 6 inches, bell and spigot style rubber ring sealed gasket joint.
   1. Fittings: PVC.
   2. Joints: ASTM F477, elastomeric gaskets.

2.2 UNDERGROUND PIPE MARKERS

A. Plastic Ribbon Tape: Bright colored, continuously printed, minimum 4 inches wide by 4 mil thick, manufactured for direct burial service.

2.3 BEDDING AND COVER MATERIALS

A. Bedding: Fine Aggregate Fill as specified in Section 31 05 16.

B. Soil Backfill from Above Pipe to Finish Grade: Select Fill Soil Type, as specified in Section 31 05 13.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on drawings.

3.2 PREPARATION

A. Correct over excavation with fine aggregate.

B. Remove large stones or other hard matter which could damage pipe or impede consistent backfilling or compaction.

3.3 BEDDING

A. Excavate pipe trench in accordance with Section 31 23 17.

B. Place bedding material at trench bottom, level materials in continuous layer not exceeding 6 inches.

C. Maintain optimum moisture content of bedding material to attain required compaction density.

3.4 INSTALLATION - PIPE

A. Install pipe, fittings, and accessories in accordance with ASTM D2321. Seal joints watertight.

B. Lay pipe to slope gradients noted on drawings; with maximum variation from indicated slope of 1/8 inch in 10 feet.

C. Install bedding at sides and over top of pipe to minimum compacted thickness of 6 inches.

D. Refer to Section 31 23 17 for backfilling and compacting requirements. Do not displace or damage pipe when compacting.

E. Connect to building sanitary sewer outlet and municipal sewer system.

F. Install plastic ribbon tape continuous over top of pipe buried 12 inches below finish grade, above pipe line; coordinate with Section 31 23 23.

G. Install site sanitary sewage system piping to 5 feet of building. Connect to building sanitary waste system.

H. Install Work in accordance with American Water Works Association standards.

3.5 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.

B. Perform test on site sanitary sewage system in accordance with American Water Works Association standards and Section 33 01 32.

C. Pressure Test: Test in accordance with Section 33 01 32.

D. Deflection Test: Test in accordance with Section 33 01 32.

E. Request inspection prior to placing bedding.

F. Compaction Testing: In accordance with ASTM D698, ASTM D2922, ASTM D3017.

G. When tests indicate Work does not meet specified requirements, remove work, replace and retest.

H. Frequency of Compaction Tests: One test for each 12 inches of fill in each 100 feet of trench.

3.6 PROTECTION OF FINISHED WORK

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

SECTION 40 71 13

MAGNETIC FLOW MEASUREMENT INSTRUMENTATION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes magnetic flow meters.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCES - CODES AND STANDARDS

A. NECA (National Electrical Contractors Association) Standard of Installation

B. NEMA ICS 1 (National Electrical Manufacturers Association) - Industrial Control and Systems: General Requirements.

C. NEMA ICS 2 (National Electrical Manufacturers Association) - Industrial Control Devices, Controllers and Assemblies.

1.4 SUBMITTALS

A. Shop Drawings: Comply with NEMA ICS 1 and submit control panel layouts, point-to-point wiring diagrams, interconnection wiring diagrams, dimensions, and support points, layout of completed assemblies, dimensions, weights, and external power requirements.

B. Schematics: Provide complete elementary and schematic wiring diagrams with wires and terminal block numbered for all control systems. Show all internal and external devices and equipment, control panel devices, etc., in detail on the elementary diagram with all terminal points of such devices and equipment indicated.

C. Product Data:
   1. Submit catalog data for each component being furnished showing control characteristics and connection requirements including supply voltage, frequency, electrical load, accuracy, and description of operation, operating instructions, and calibration procedure.
   2. For measuring instruments and devices, submit completed ISA S20 forms for each device including physical dimensions manufacturer’s recommended upstream and downstream straight piping lengths, recommended location of any pressure taps and estimates of pressure losses through the device.

D. Installation Method: The proposed method of mounting sensors and instruments shall accompany all shop drawings.

E. Parts List: Submit a Parts List with current net prices and a list of recommended spares. Test Reports: Indicate procedures and results for field calibration and functionality test results of each assembly and component.

F. Coordinate and identify all interconnection wiring between motor control panel, field devices, control panels and other devices. Identification tag designations for each wire shall match those shown on the wiring diagrams.

G. Factory Testing and Calibration: All measuring devices and meters shall be factory tested. Provide a certification of calibration from an independent test laboratory. Calibration curves based on factory and/or laboratory testing (see option below) shall be provided for the Engineer's review. Furnish calibration curves in units of output versus measured process parameter. Upon receipt of the Engineer's review, Contractor may release the meter(s) for shipment to the job site.
   1. As an option to laboratory testing each meter, the calibration curves of six (6) "like devices" may be substituted provided the calibration data is available from at least one identical device (pipe size, flow range, and type plus accessories such as extension registers).

H. O&M Manuals: Furnish manufacturer's installation, lubrication, operation and maintenance manuals, bulletins, and spare parts lists.

I. Affidavits: Furnish affidavits from the manufacturers stating that the meters have been properly installed and tested and each is ready for full time operation.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Include interconnection wire and cabling information.

B. Calibration data sheets: Show full-scale and zero-range for each analog instrument.

C. Operation and Maintenance Data: Submit bound copies of O&M manuals for each device, including instructions for adjustments, calibration and preventative maintenance.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.7 COORDINATION

A. Coordinate work with installation of systems being controlled.

PART 2 PRODUCTS

2.1 MAGNETIC FLOWMETERS:

A. Magnetic flow measuring systems shall be of the low frequency electromagnetic induction type and produce a DC pulsed signal directly proportional to and linear with the liquid flow rate. Complete zero stability shall be an inherent characteristic of the

flowmeter system. Each magnetic flow metering system shall include a metering tube, signal cable, transmitter, and flowmeter grounding rings.

1. The metering tube shall have the following attributes:
    a. Constructed of Type 316 stainless steel with flanged connections.
    b. Use a minimum of 2 bullet-nosed, self-cleaning electrodes.
    c. Electrodes constructed of materials that are in conformance with the manufacturer's recommendation for the intended service.
    d. Meter coating consisting of epoxy paint finish.
    e. Two grounding rings that conform to the manufacturer's bore and material recommendation for the intended service. Grounding rings shall be designed to protect and shield from abrasion the liner edge interface at the meter end.
2. The microprocessor-based signal converter/transmitter shall have the following attributes:
    a. Use DC pulse technique to drive flux-producing coils.
    b. Convert DC pulse signal from the tube to a standardized 4-20 mA signal into a minimum of 700 ohms.
    c. A 6 digit LCD display for flow rate, percent of span, and totalizer.
    d. An operator interface consisting of keypads which respond to English text entry.
    e. Integral zero return to provide a consistent zero output signal in response to an external dry contact closure.
    f. Integral low flow cutoff and zero return.
    g. Automatic range change.
    h. Programmable parameters including meter size, full scale Q, magnetic field frequency, primary constant, time constant.
    i. Data retention for a minimum of 5 years without auxiliary power (main or battery).
    j. Self diagnostics and automatic data checking.
    k. Protected terminals and fuses in a separate compartment that isolates field connection from electronics.
    l. Tolerate ambient temperature operating limits of -20 to +140 degrees F.

B. Calibration: Each magnetic flowmeter system shall be hydraulically calibrated at a facility that is traceable to the National Institute of Standards and Technologies. The calibrations procedure shall conform to the requirements of ANSI/NCSL-2540-1.

C. Performance: The flow metering system shall conform to the following requirements:
    1. Accuracy: 0.25% of flow rate from 10 to 100% full scale for velocities over 3 feet per second.
    2. Repeatability: 0.25% full scale.
    3. Power consumption: 20 watts or less.
    4. Power Requirements: 120 VAC, ± 10%.”

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Make electrical wiring interconnections.

C. Provide grounding and bonding of devices.

D. Install engraved plastic nameplates.

3.2 ADJUSTING

A. Each device shall be factory calibrated over its operating range.

B. Each device shall be field tested, adjusted and tuned to operate with the process loop. Submit field test results for record purposes.

3.3 FIELD TESTING

A. All flow devices shall be field tested against a secondary standard at the normal (or expected) process flow rates.

B. The Contractor may select, at his option, to either install a second flow device of known calibration in the line to verify flow device calibration or perform tests such as volumetric measurement per unit time.

END OF SECTION

SECTION 40 91 19

PRESSURE PROCESS MEASUREMENT INSTRUMENTATION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes pipeline pressure sensors and transmitters.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCES - CODES AND STANDARDS

A. NECA (National Electrical Contractors Association) Standard of Installation

B. NEMA ICS 1 (National Electrical Manufacturers Association) - Industrial Control and Systems: General Requirements.

C. NEMA ICS 2 (National Electrical Manufacturers Association) - Industrial Control Devices, Controllers and Assemblies.

1.4 SUBMITTALS

A. Shop Drawings: Comply with NEMA ICS 1 and submit control panel layouts, point-to-point wiring diagrams, interconnection wiring diagrams, dimensions, and support points, layout of completed assemblies, dimensions, weights, and external power requirements.

B. Schematics: Provide complete elementary and schematic wiring diagrams with wires and terminal block numbered for all control systems. Show all internal and external devices and equipment, control panel devices, etc., in detail on the elementary diagram with all terminal points of such devices and equipment indicated.

C. Product Data:
   1. Submit catalog data for each component being furnished showing control characteristics and connection requirements including supply voltage, frequency, electrical load, accuracy, and description of operation, operating instructions, and calibration procedure.
   2. For measuring instruments and devices, submit completed ISA S20 forms for each device including physical dimensions manufacturer’s recommended upstream and downstream straight piping lengths, recommended location of any pressure taps and estimates of pressure losses through the device.

D. Installation Method: The proposed method of mounting sensors and instruments shall accompany all shop drawings.

E. Parts List: Submit a Parts List with current net prices and a list of recommended spares. Test Reports: Indicate procedures and results for field calibration and functionality test results of each assembly and component.

F. Coordinate and identify all interconnection wiring between motor control panel, field devices, control panels and other devices. Identification tag designations for each wire shall match those shown on the wiring diagrams.

G. Factory Testing and Calibration: All measuring devices and meters shall be factory tested. Provide a certification of calibration from an independent test laboratory. Calibration curves based on factory and/or laboratory testing (see option below) shall be provided for the Engineer's review. Furnish calibration curves in units of output versus measured process parameter. Upon receipt of the Engineer's review, Contractor may release the meter(s) for shipment to the job site.
   1. As an option to laboratory testing each meter, the calibration curves of six (6) "like devices" may be substituted provided the calibration data is available from at least one identical device (pipe size, flow range, and type plus accessories such as extension registers).

H. O&M Manuals: Furnish manufacturer's installation, lubrication, operation and maintenance manuals, bulletins, and spare parts lists.

I. Affidavits: Furnish affidavits from the manufacturers stating that the meters have been properly installed and tested and each is ready for full time operation.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Include interconnection wire and cabling information.

B. Calibration data sheets: Show full-scale and zero-range for each analog instrument.

C. Operation and Maintenance Data: Submit bound copies of O&M manuals for each device, including instructions for adjustments, calibration and preventative maintenance.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.7 COORDINATION

A. Coordinate work with installation of systems being controlled.

PART 2 PRODUCTS

2.1 PRESSURE TRANSMITTERS

A. Manufacturer: Endress+Hauser Cerabar PMC 71, Rosemount 3051, or approved equal.

B. Measurement Principle: Process pressure acts on a diaphragm, causing a pressure-dependent change in capacitance, which in turn, causes a pressure-dependent change in instrument output.

C. Materials and construction suitable for application measuring digester gas in an outdoor environment.

D. Range: 0-10 inches water column.

E. Accuracy: +/- 0.01% of measuring range.

F. Ambient Temperature Range: 20 to +120 degrees F.

G. Process Connection: 1/2” NPT.

H. Power Supply: 24 VDC, loop powered.

I. Device Output: HART digital communication via 4-20 mA loop, proportional to pressure.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Make electrical wiring interconnections.

C. Provide grounding and bonding of devices.

D. Install engraved plastic nameplates.

3.2 ADJUSTING

A. Each device shall be factory calibrated over its operating range.

B. Each device shall be field tested, adjusted and tuned to operate with the process loop. Submit field test results for record purposes.

END OF SECTION

SECTION 40 91 23

LEVEL PROCESS MEASUREMENT DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Hydrostatic-level measurement devices.
   2. Float switches

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCE STANDARDS

A. National Sanitation Foundation:
   1. NSF 61 - Drinking Water System Components - Health Effects.
   2. NSF 372 - Drinking Water System Components - Lead Content.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer's Product Data for system materials and component equipment, including connection requirements.

C. Shop Drawings:
   1. Indicate system materials and component equipment.
   2. Submit installation requirements and other details.

D. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout procedures.

B. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

1.6 QUALITY ASSURANCE

A. Ensure that materials of construction of wetted parts are compatible with process liquid.

B. Materials in Contact with Potable Water: Comply with NSF Standard 61 and NSF Standard 372.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept equipment on-Site in manufacturer's original packaging and inspect for damage.

C. Store equipment according to manufacturer's instructions.

1.9 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

PART 2 PRODUCTS

2.1 DESCRIPTION:

A. Furnish sensors, field preamplifiers, signal conditioners, offset and span adjustments, amplifiers, transducers, transmitters, control devices, and unit conversions and algorithms as required for application.

2.2 HYDROSTATIC-LEVEL MEASUREMENT DEVICES

A. Manufacturer List:
   1. VEGAPULS PSWL61.KFAXXHA9X
   2. Substitutions: Section 01 60 00 - Product Requirements.

B. Sensor:
   1. Description: Level measuring instrument based on radar technology, suitable for hazardous and corrosive locations.
   2. Housing: aluminum, IP68.
   3. Output: 2-wire, 4-20mA.
   4. Cable entry: ½” NPT, with cable gland.
   5. Measuring range: 0-114 feet.
   6. Measuring Cell:
      a. Hermetically sealed.
      b. Material: PVDF.
      c. Accuracy: Plus or minus 2 millimeters.
   7. Approval: CSA, Class I, Div 1, intrinsically safe.

C. Accessories: Provide 316SS mounting bracket.

2.3 FLOAT SWITCHES

A. Manufacturer List:
   1. Flygt ENM-10
   2. Madison M4549
   3. SJE PumpMaster
   4. Substitutions: Section 01 60 00 - Product Requirements

B. Product Description:
   1. Liquid level sensing float-type switch, with restraint device to allow adjustment of contact elevation.
   2. All wetted parts of float shall be constructed from non-corrodible material, hermetically sealed and suitable for Class I, Division 1 hazardous environment.
   3. Meets NSF 61 standard.
   4. Output switch shall be of the non-mercury wetted contact type, capable of conducting a minimum of 5-Amps of current at 120-VAC.
   5. Switch contacts shall be form A or B, as required.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that items provided by other Sections of Work are ready to receive Work of this Section.

3.2 INSTALLATION

A. Coordinate location and orientation of level assemblies with final equipment installations.

B. Ensure that instruments and devices are located to be easily accessible for maintenance.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Equipment Acceptance:
   1. Adjust, repair, modify, or replace components failing to perform as specified, and rerun tests.
   2. Make final adjustments to equipment under direction of manufacturer's representative.

C. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.4 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION

SECTION 40 95 13

PROCESS CONTROL PANELS AND HARDWARE

PART 1 GENERAL

1.1 SUMMARY

A. Section includes pump control system including power disconnect, pump alternation, intrinsically safe control, lightning protection, push buttons, indicating lights, and control relays.

1.2 MEASUREMENT AND PAYMENT

A. Refer to Section 01 15 00 Measurement and Payment.

1.3 REFERENCES

A. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

B. Underwriters' Laboratories
   1. UL 508 - Industrial Control Equipment.

1.4 PERFORMANCE REQUIREMENTS

A. Effluent Lift Station Sequence of Operation:
   1. Operate three pumps in lead/lag/standby mode.
   2. Control pumps by individual Hand-Off-Auto selector switches located on pump control panel. Provide manual start-stop control of pumps using "hand" and "off" positions of each Hand-Off-Auto switch. Automatically control pumps in "auto" position based on wet well level as follows:
      a. When liquid level in wet well rises to elevation of "lead pump start", start lead pump. When lead pump is started, run pump until liquid level in wet well is drawn down to "pump stop" elevation, and then shut down lead pump.
      b. When lead pump cannot keep up with influent flow, liquid level in wet well rises to "lag pump start" elevation that starts lag pump. When lag pump is started, run pump until liquid level in wet well is pumped down to "pump stop" elevation and shut down lead and lag pumps.
      c. Automatically alternate lead and lag status of pumps after each pumping cycle. Provide manual selection of lead pump.
      d. Provide a switch for “Enable 3rd Pump”. If 3rd pump is enabled, and when liquid level in wet well rises to elevation just below the high level float switch, energize “Wet Well Level Pre-Warning” alarm light on pump control panel.
   3. When liquid level in wet well rises to elevation of “wet well high level” float switch, energize “Wet Well High Level” alarm light located on pump control panel.

4. When liquid level in wet well is pumped down to elevation of "wet well low level" float switch, energize "Wet Well Low Level" alarm light located on pump control panel and shut down pumps.
5. When thermal switches are provided in motor windings to detect high temperature in motor, wire switch to relay located in pump control panel. Provide normally open contact on relay wired in series with pump starter, and normally closed contact on relay wired to "Motor High Temperature" alarm light located on control panel. When high temperature occurs in motor windings, shut down pump and energize high temperature alarm light.
6. When pump seal leak sensor is provided and located in pump housing, wire sensor to seal failure relay located in pump control panel. Wire normally open contact on relay to "Seal Failure" alarm light located on control panel. When seal leak occurs, energize seal failure alarm light.
7. Provide dry contacts in pump control panel for each of following:
    a. Power Failure.
    b. Pump No. 1 Motor High Temperature/Seal Failure.
    c. Pump No. 2 Motor High Temperature/Seal Failure.
    d. Pump No. 3 Motor High Temperature/Seal Failure.
    e. Wet Well High Level Pre-warning
    f. Wet Well High Level.
    g. Wet Well Low Level.
8. Dry contacts to be wired to terminal strip for connection to Building Management System.

B. Recirculation Pump Station Sequence of Operation:
1. Operate two pumps in alternation mode.
2. Control pumps by individual Hand-Off-Auto selector switches located on pump control panel. Provide manual start-stop control of pumps using "hand" and "off" positions of each Hand-Off-Auto switch. Automatically control pumps in "auto" position as follows:
    a. Run the lead pump based on a timer, on a 30-minute cycle. The pump cycle shall be 5 minutes on, then 25 minutes off. Automatically alternate lead and standby status of pumps after each pumping cycle. Provide manual selection of lead pump.
3. When liquid level in wet well rises to elevation of “wet well high level” float switch, energize “Wet Well High Level” alarm light located on pump control panel.
4. When liquid level in wet well is pumped down to elevation of "wet well low level" float switch, energize "Wet Well Low Level" alarm light located on pump control panel and shut down pumps.
5. When thermal switches are provided in motor windings to detect high temperature in motor, wire switch to relay located in pump control panel. Provide normally open contact on relay wired in series with pump starter, and normally closed contact on relay wired to "Motor High Temperature" alarm light located on control panel. When high temperature occurs in motor windings, shut down pump and energize high temperature alarm light.
6. When pump seal leak sensor is provided and located in pump housing, wire sensor to seal failure relay located in pump control panel. Wire

normally open contact on relay to "Seal Failure" alarm light located on control panel. When seal leak occurs, energize seal failure alarm light.

7. Provide dry contacts in pump control panel for each of following:
   a. Power Failure.
   b. Pump No. 1 Motor High Temperature/Seal Failure.
   c. Pump No. 2 Motor High Temperature/Seal Failure.
   d. Wet Well High Level.
   e. Wet Well Low Level.
8. Dry contacts to be wired to terminal strip for connection to Building Management System.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Submit complete bill of materials, wiring diagrams and panel layout drawings showing dimensions to devices.

C. Product Data: Submit catalog information and descriptive literature for components.

D. Test Reports: Submit certified factory test report indicating control panel successfully performs functions specified.

E. Manufacturer's Installation Instructions: Submit instructions on installation and field wiring connections.

F. Manufacturer's Field Reports: Submit certification after installation that control panel has been installed in accordance with manufacturer’s instructions and has been successfully field tested.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of control panel and final wiring diagrams and connections.

C. Operation and Maintenance Data: Submit operation and maintenance instructions for components and devices.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with UL 508.

B. Provide components compatible with functions required to form complete working system.

C. Provide UL 508 label on complete assembly.

1.8 QUALIFICATIONS

A. Manufacturer and Fabricator: Company specializing in manufacturing and assembling products specified in this section with minimum three years' experience.

1.9 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspect for damage.

C. Store in areas protected from weather, moisture, or possible damage; do not store directly on ground; handle to prevent damage to wiring and components.

1.11 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

B. Coordinate work and component requirements with controlled pumps.

1.12 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for extra materials.

B. Furnish the following spare parts:
   1. 4 fuses for each type and size utilized.
   2. 1 general purpose relay for each type utilized.
   3. 1 intrinsically safe relay.

PART 2 PRODUCTS

2.1 PUMP CONTROL PANEL

A. Manufacturers:
   1. Healy-Ruff Pumpak B.
   2. Substitutions: Section 01 60 00 - Product Requirements.

2.2 DESCRIPTION

A. Duplex or triplex pump control panel, to operate on 240 Volt, 3 Phase, 60 Hertz, 4 wire service. Unit will monitor the level in the wet well via loop powered level transmitter (primary) and float (backup) system to provide pump control for 3-phase motors. An independent float backup system logic is included in case of primary

controller or transducer failure. Unit includes battery backup allowing (~ 4 Hours) continued operation in the event of a power interruption.

2.3 COMPONENTS

A. Liquid Level Controller:
   1. Micro-VPAC IIT LSC Controller
   2. 160 x 128 3.5” Touch Screen Display
   3. Discrete Inputs
      a. Pump Running
      b. Pump HOA In Auto
      c. Pump Seal Failure
      d. Pump Overtemp
      e. Backup Active
      f. High Level
      g. Low Level
      h. Phase Failure
      i. Intrusion (switch provided by others)
   4. Discrete Outputs
      a. Pump Call
      b. Pump Failure
      c. Common Alarm
      d. Alarm Horn
      e. Alarm Horn Reset
      f. Backup Reset
      g. Analog Inputs
      h. Wet Well Level
      i. Station Flow (flow meter optional and provided by others)

B. Control Panel Enclosure:
   1. Furnish NEMA 250 Type 12 free-standing enclosure fabricated of 10 gage steel with continuously welded seams.
      a. Enclosure door gasketed with neoprene.
      b. Heavy-duty three-point latching mechanism.
      c. Power: 120/240 volt, 3 phase, 4 wire open delta service.
   2. Identify control panel components with engraved nameplate mounted on inside of panel.
   3. Mount components, not mounted on front of panel, on removable back panel secured to enclosure with collar studs.
   4. Install wiring in neat, workmanlike manner and group, bundle, support and route horizontally and vertically for neat appearance.
   5. Terminate wires leaving panel at terminal strips inside enclosure.
   6. Identify terminals and wires in accordance with panel wiring diagrams.
   7. Furnish copper grounding plate inside control panel for terminating ground wires.

C. Transient Voltage Surge Suppressor: Furnish three phase transient voltage surge suppressor in pump control panel to protect panel components from potential damage from transient voltages caused by lightning or surges on incoming power line. Furnish indication light to indicate unit is functioning.

D. Three Phase Monitor:
   1. Furnish three phase monitor in pump control panel to monitor incoming power and sense loss of any one of three phases.
      a. Inhibit pump operation when phase loss occurs.
      b. Surface mounted.

E. Motor Circuit Protector Type Circuit Breakers:
   1. Furnish properly sized motor circuit protector type molded case circuit breaker for each pump motor starter.
      a. Type: Quick-make, quick-break, individually mounted.
      b. Minimum Interrupting Capacity: 22,000 amperes rms symmetrical at 240 volts.

F. Pump Motor Starters:
   1. Furnish across-the-line magnetic type rated in accordance with NEMA standards, sizes and horsepower ratings. Size for pump motor horsepower.
   2. Furnish each motor starter with three pole overload relay. Furnish heater element in each phase of relay, sized for motor nameplate full load amps.
   3. Furnish overload reset button for each motor starter.

G. Control Transformer: Furnish 240 volt to 120 volt control transformer in pump control panel to provide 120 VAC control power. Size transformer to power connected devices and protect with primary and secondary fusing.

H. Circuit Breakers:
   1. Furnish quick-make, quick-break thermal-magnetic molded case type, individually mounted and identified.

I. Selector Switches:
   1. NEMA Type 4X, 30.5 mm, heavy-duty, non-illuminated, maintained contact type with double-break silver contacts.

J. Push Buttons: NEMA Type 4X, 30.5 mm, heavy-duty, non-illuminated, momentary contact type with double-break silver contacts.

K. Pilot Lights:
   1. NEMA Type 4X, 30.5 mm, heavy-duty, full-voltage LED type.
      a. Voltage Rating: 120 volts AC.
      b. Color Caps: Green for "run" and red for "alarm".
   2. Furnish "run" pilot light for each pump. Energize each light through auxiliary contact on pump motor starter.
   3. Furnish "motor high temperature" and "seal failure" alarm pilot light for each pump.
   4. Furnish wet well "high level" and "low level" alarm pilot lights.

L. Legend Plates for Pilot Devices:
   1. Furnish 2-1/4 inch (60 mm) square plastic legend plate for each selector switch, push button and pilot light.
   2. Color: Gray with white lettering.

M. Relays:
1. Heavy-duty, general purpose type, with 10 amp contacts.
   a. Blade type terminals that plug-in to socket.
   b. DIN rail mounted to inside of panel enclosure.
   c. Contact Configuration: As required for proper operation of control logic.
   d. Operating Power: 120 volts AC, unless noted otherwise.
   e. Furnish indicator light to indicate relay coil is energized.

N. Seal Failure Relays: Provide seal failure relay in pump control panel for each pump. Coordinate seal failure relays with controlled pump.

O. Intrinsically Safe Relays: Furnish intrinsically safe relay in pump control panel for each wet well float switch.

P. Elapsed Time Meters:
1. Resettable, time totalizer type.
   a. Furnish synchronous motor to drive set of digit readout wheels to indicate total time pump motor starter is energized.
   b. Readout: Six-digit including 1/10 digit.
   c. Range: 0 to 99999.9 hours.
   d. Voltage Rating: 120 volts.
2. Furnish elapsed time meter for each pump. Energize each elapsed time meter through auxiliary contact on pump motor starter.

Q. Terminal Blocks:
1. Furnish terminal blocks in control panel for field wiring.
   a. NEMA type, rated for 600 volts AC.
   b. Identify with permanent machine printed marking in accordance with terminal numbers shown on panel wiring diagrams.
   c. Furnish twenty percent spare terminal blocks in control panel.

R. Wiring:
1. Furnish pump control panel completely wired by manufacturer.
2. Furnish wiring, workmanship, and schematic wiring diagrams in compliance with UL 508. Isolate wiring and terminal blocks by voltage levels to greatest extent possible.
3. Wiring: Stranded copper, Type MTW or THW, 600 volts, color coded as follows:
   a. Line and Load Circuits, AC Power: Black.
   b. AC Control Circuit Less than Line Voltage: Red.
   c. DC Control Circuit: Blue.
   d. Interlock Control Circuits from External Source: Yellow.
   e. Equipment Grounding Conductor: Green.
   f. Current Carrying Ground: White.
4. Minimum Size of Control Wiring: Number 16.
5. Tag control wiring at both ends in control panel with legible permanent coded wire marking sleeve. Mark with white PVC tubing sleeves with machine printed black marking. Mark in accordance with wire numbers shown on control wiring diagrams and terminal strip numbers.

S. Nameplates:
1. Furnish laminated phenolic nameplates on front of pump control panel.
2. Color: White with black engraved letters.
3. Minimum Size of Engraving: 1/4 inch (6 mm).

2.4 Equipment Furnished Loose For Field Mounting By Others:

A. Loop Powered Submersible Pressure Transducer
1. 0-34' Range
2. 75' Cable
3. 3" Diaphragm
4. Cable Hanger

2.5 SOURCE QUALITY CONTROL AND TESTS

A. Perform a factory test of completed control panel by demonstrating operation of control functions. Provide certified test results.

B. Factory assemble and test each control and alarm function.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify correct power supply is available.

C. Verify pumps are installed.

3.2 INSTALLATION

A. Install control panel at location indicated on Drawings.

B. Install control panel in accordance with manufacturer's instructions.

3.3 CONFIGURATION

A. Configure the pump controllers using the following setpoints, with reference to the bottom of the respective wet well:
1. Effluent Lift Station
a. Low level alarm: 1.8 ft
b. Lead pump stop: 2.3 ft
c. Lead pump start: 4.3 ft
d. Lag pump stop: 5.3 ft
e. Lag pump start: 6.3 ft
f. High level alarm: 7.3 ft
2. Recirculation Pump Station
a. Low level alarm: 2.0 ft
b. High level alarm: 8.0 ft

3.4 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.

B. Start-up pump control system by energizing system equipment and testing operation of hardware and process control logic under supervision of manufacturer's representative and in presence of Architect/Engineer.

C. Equipment Acceptance:
   1. Adjust, repair, modify or replace system components that fail to perform as specified and rerun tests. Make final adjustments to equipment under direction of manufacturer's representative.
   2. Document adjustments, repairs and replacements in manufacturer’s field services certification.

3.5 MANUFACTURER'S FIELD SERVICES

A. Section 01 40 00 - Quality Requirements: Requirements for manufacturer’s field services.

B. Furnish services of manufacturer's representative experienced in installation of products furnished under this specification for not less than two (2) working days on-site for installation inspection and field testing, and instructing Owner's personnel in maintenance of equipment.

C. Certify that equipment has been properly installed and is ready for start-up and testing.

3.6 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, alarm condition responses, and emergency repair procedures to Owner’s personnel.

END OF SECTION