Fullerton Community College

Heating and Hot Water Replacement Parking Lot 10

DSA Back Check - Specifications

P2S ENG

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January 8, 2020

P2S Project #J9570

SEALS PAGE

1.1 DESIGN PROFESSIONALS OF RECORD

A. Mechanical Engineer

SIGNED: 1/6/2020

Anthony Mueller
Mechanical Engineer
License: M38377

B. Structural Engineer

SIGNED: 1/7/2020

Terry Fernandez
Structural Engineer
License: S3256

IDENTIFICATION STAMP
DIV. OF THE STATE ARCHITECT
APP. 04-118731 INC:
REVIEWED FOR
SS ☑ FLS ☑ ACS ☑
DATE: 01.09.20

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SECTION 230000 – GENERAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE

A. Basic mechanical requirements specifically applicable to Division 23 and 33 Sections.

B. Work includes but is not necessarily limited to the following:

1. Labor, materials, services, equipment, and appliances required for completion of tasks as indicated on drawing or in specification or as inherently necessary to prepare spaces and systems for new installations as follows:

a. Steam piping systems and equipment
b. Testing, adjusting and balancing

1.3 DRAWINGS AND SPECIFICATIONS

A. Drawings accompanying these Specifications show intent of Work to be done. Specifications shall identify quality and grade of installation and where equipment and hardware is not particularly specified, Contractor shall provide submittals for all products and install them per manufacturers' recommendations, and in a first class manner.

B. Examine Drawings and Specifications for elements in connection with this Work; determine existing and new general construction conditions and be familiar with all limitations caused by such conditions.

C. Plans are intended to show general arrangement and extent of Work contemplated. Exact location and arrangement of parts shall be determined after the University has reviewed equipment, as Work progresses, to conform in best possible manner with surroundings, and as directed by the University's Representative.

D. Contract Documents are in part diagrammatic and intended to show the scope and general arrangement of the Work under this Contract. The Contractor shall follow these drawings in laying out the equipment, piping and ductwork. Drawings are not intended to be scaled for roughing in measurements or to serve as shop drawings. Where job conditions require minor changes or adjustments in the indicated locations or arrangement of the Work, such changes shall be made without change in the Contract amount.

E. Follow dimensions without regard to scale. Where no figures or notations are given, the Plans shall be followed.

1.4 UTILITIES

A. Location and sizes of electrical, mechanical and plumbing service facilities are shown in accordance with data secured from existing record drawings and site observations. Data shown are offered as an estimating guide without guarantee of accuracy. Check and verify all data given, and verify exact location of all utility services pertaining to Work prior to excavation or performing Work.

1.5 APPLICABLE REFERENCE STANDARDS, CODES AND REGULATIONS

A. Meet requirements of all state codes having jurisdiction.

B. State of California Code of Regulations:

1. Title 8, Industrial Relations
2. Title 19, State Fire Marshal Regulations
3. Current California Building Code (CBC), Title 24, Part 2
4. Current California Electrical Code, Title 24, Part 3
5. Current California Mechanical Code, Title 24, Part 4
6. Current California Plumbing Code, Title 24, Part 5
7. Current California Fire Code, Title 24, Part 9
8. Current California Standards Code, Title 24, Part 12
9. Title 24, Energy Conservation Standards

C. Additional Referenced Standards:

1.	AABC	Associated Air Balance Council
2.	AMCA	Air Moving and Conditioning Association
3.	ARI	Air-Conditioning and Refrigeration Institute
4.	ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
5.	ASME	American Society of Mechanical Engineers
6.	ASTM	American Society for Testing and Materials
7.	NEMA	National Electrical Manufacturer's Association
8.	NFPA	National Fire Protection Association Standards
9.	PDI	Plumbing and Drainage Institute
10.	UL	Underwriters Laboratories

D. Codes and ordinances having jurisdiction over Work are minimum requirements; but, if Contract Documents indicate requirements, which are in excess of those minimum requirements, then requirements of the Contract Documents shall be followed. Should there be any conflicts between Contract Documents or codes or any ordinances having jurisdiction, report these to the University's Representative.

E. Obtain permits, and request inspections from authority having jurisdiction.

1.6 PROJECT AND SITE CONDITIONS

A. The arrangement of and connection to equipment shown on the Drawings is based upon information available and is not intended to show exact dimensions peculiar to a specific manufacturer. The Drawings are, in part, diagrammatic and some features of the illustrated equipment installations may require revision to meet actual equipment installation requirements. Structural supports, housekeeping pads, piping connections and adjacent equipment may have to be altered to accommodate the equipment provided. No additional payment will be made for such revisions or alterations.

B. Examine all Drawings and Specifications to be fully cognizant of all work required under this Division.

C. Examine site related work and surfaces before starting work of any Section.

D. Install Work in locations shown on approved Drawings, unless prevented by Project conditions.

E. Prepare revised shop drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission from the University's Representative before proceeding.

F. Beginning work of any Section constitutes acceptance of conditions.

1.7 COOPERATION WITH WORK UNDER OTHER DIVISIONS

A. Cooperate with other trades to facilitate general progress of Work. Allow all other trades every reasonable opportunity for installation of their work.

B. Work under this Division shall follow general building construction closely. Set pipe sleeves and inserts and verify that openings for chases and pipes are provided.

C. Work with other trades in determining exact location of outlets, pipes, and pieces of equipment to avoid interference with lines required to maintain proper installation of Work.

D. Make such progress in the Work to not delay work of other trades.

1.8 DISCREPANCIES

A. The Contractor shall check all Drawings furnished him immediately upon their receipt and shall promptly notify the University's Representative of any discrepancies. Figures marked on Drawings shall in general be followed in preference to scale measurements. Piping and instrumentation diagrams shall in general govern floor plans and sections. Large-scale drawings shall in general govern small-scale drawings.

B. Where requirements between Drawings and Specifications conflict, the more restrictive provisions shall apply.

C. If any part of the Specifications or Drawings appears unclear or contradictory, apply to University's Representative for interpretation and decision as early as possible, including during bidding period. Do not proceed with such work without University Representatives decision. Beginning work of any Section constitutes acceptance of conditions.

1.9 CHANGES

A. The Contractor shall be responsible to make and obtain approval from the University's Representative for all necessary adjustments in piping and equipment layouts as required to accommodate the relocations of equipment and/or devices, which are affected by any approved authorized changes or Product substitutions. All changes shall be clearly indicated on the "Record" drawings.

1.10 SUBMITTALS

A. Refer to Division 01 for additional requirements.

B. The manufacturer, contractor or supplier shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular specification section.

C. The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section.

D. All **exceptions** shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.

E. Note that prior to acceptance of shop drawings for review, a submittal schedule shall be submitted to the University's Representative.

F. Submit all Division 23 shop drawings and product data grouped and referenced by the specification technical section numbers in one complete submittal package.

G. Shop Drawings:

1. Provide all shop drawings in latest version of AutoCAD format.
2. Piping drawings shall be a minimum of 8.5 inches by 11 inches in size with a minimum scale of one inch per foot, except as specified otherwise.
3. Include installation details of equipment indicating proposed location, layout and arrangement, accessories, piping, and other items that must be shown to assure a coordinated installation.
4. Indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.
5. If equipment is disapproved, revise drawings to show acceptable equipment and resubmit.
6. Whenever more than one (1) manufacturer's product is specified, the first named product is the basis of design used in the Work and the use of alternate-named manufacturer's products or substitutes may require modifications in that design.
7. Proposed Products List: Include Products as required by the individual section in this Division.
8. The Contractor shall be responsible for all equipment ordered and/or installed prior to receipt of shop drawings returned from the University's Representative bearing the University's Representative stamp of "Reviewed". All corrections or modifications to the equipment as noted on the shop drawings shall be performed and equipment removed from the job site at the request of the University's Representative without additional compensation.
9. Manufacturer's Data: For each manufactured item, provide current manufacturer's descriptive literature of cataloged products, certified equipment drawings, diagrams, performance and characteristic curves if applicable, and catalog cuts.
10. Standard Compliance: When materials or equipment provided by the Contractor must conform to the standards of organizations such as American National Standards Institute (ANSI) or American Water Works Association (AWWA), submit proof of such conformance to the University Representative for approval. If an organization uses a label or listing to indicate compliance with a particular standard, the label or listing will be acceptable evidence, unless otherwise specified. In lieu of the label or listing, submit a certificate from an independent testing organization, which is competent to perform acceptance testing and is approved by the University Representative. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard.

11. Certified Test Reports: Before delivery of materials and equipment, certified copies of all test reports specified in individual sections shall be submitted for approval.
12. Certificates of Compliance or Conformance: Submit manufacturer's certifications as required on products, materials, finish, and equipment indicated in the technical sections. Certifications shall be documents prepared specifically for this Contract. Pre-printed certifications and copies of previously submitted documents will not be acceptable. The manufacturer's certifications shall name the appropriate products, equipment, or materials and the publication specified as controlling the quality of that item. Certification shall not contain statements to imply that the item does not meet requirements specified, such as "as good as"; or "achieve the same end use and results as materials formulated in accordance with the referenced publications"; or "equal or exceed the service and performance of the specified material." Certifications shall simply state that the item conforms to the requirements specified. Certificates shall be printed on the manufacturer's letterhead and shall be signed by the manufacturer's official authorized to sign certificates of compliance or conformance.

1.11 PRODUCT ALTERNATIVES OR SUBSTITUTIONS

A. Refer to General Conditions and Division 01 for additional requirements.

1.12 OPERATING INSTRUCTIONS

A. Furnish approved operating instructions for systems and equipment indicated in the technical sections for use by operation and maintenance personnel.

1.13 MANUFACTURER'S RECOMMENDATIONS

A. Where installation procedures or any part thereof are required to be in accordance with manufacturer's recommendations, furnish printed copies of the recommendations prior to installation. Installation of the item shall not proceed until recommendations are received. Failure to furnish recommendations shall be cause for rejection of the equipment or material.

1.14 DELIVERY AND STORAGE

A. Refer to Division 01 for additional requirements.

B. Handle, store, and protect equipment and materials in accordance with the manufacturer's recommendations and with the requirements of NFPA 70B P, Appendix I, titled "Equipment Storage and Maintenance During Construction." Replace damaged or defective items with new items.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 GENERAL

A. Obtain and pay for all permits and inspections, including any independent testing required to verify standard compliance, and deliver certificates for same to the University's Representative.

3.2 WORK RESPONSIBILITIES

A. The drawings indicate diagrammatically the desired locations or arrangement of piping, equipment, etc., and are to be followed as closely as possible. Proper judgment must be exercised in executing the work to secure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference with structural conditions.

B. The Contractor is responsible for the correct placing of Work and the proper location and connection of Work in relation to the work of other trades. Advise appropriate trade as to locations of access panels.

C. In the event changes in the indicated locations or arrangements are necessary, due to developed conditions in the building construction or rearrangement of furnishings or equipment, such changes shall be made without extra cost, providing the change is ordered before the ductwork, piping, etc. and work directly connected to same is installed and no extra materials are required.

D. Where equipment is furnished by others, verify dimensions and the correct locations of this equipment before proceeding with the roughing-in of connections.

E. All scaled and figured dimensions are approximate of typical equipment of the class indicated. Before proceeding with any work, carefully check and verify all dimensions, sizes, etc. with the drawings to see that the equipment will fit into the spaces provided without violation of applicable codes.

F. Should any changes to the Work indicated on the Drawings or described in the Specifications be necessary in order to comply with the above requirements, notify the University immediately and cease work on all parts of the contract, which are affected until approval for any required modifications to the construction has been obtained from the University.

G. Be responsible for any cooperative work, which must be altered due to lack of proper supervision or failure to make proper provisions in time. Such changes shall be under direction of the University and shall be made to his satisfaction. Perform all Work with competent and skilled personnel.

H. All work, including aesthetic as well as mechanical aspects of the Work, shall be of the highest quality consistent with the best practices of the trade.

I. Replace or repair, without additional compensation, any Work, which, in the opinion of the University, does not comply with these requirements.

END OF SECTION 230000

SECTION 230516 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Expansion Joints
2. Alignment guides.

1.3 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

1.4 ACTION SUBMITTALS

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

B. Delegated-Design Submittal: For each anchor and alignment guide 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. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
2. Alignment Guide Details: Detail field assembly and attachment to building structure.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Certificates: For each type of expansion joint, from manufacturer.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For expansion joints to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 EXPANSION JOINTS

A. Expansion Joints:

1. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the following:
   a. The Metraflex Company, MNLC 150 long
   b. Hyspan Precision Products, 1502

2. Description:
   a. Bellows: Two ply stainless steel construction.
   b. Connections: Weld ends.
   c. Tie rods: Include integral tie rods capable of controlling bellows to avoid over extension if anchor fails or if section of piping is removed. Tie rods and attachment hardware shall be of stainless steel construction.
   d. Size: Expansion joint shall match sizes shown on plans. Bellows shall be long configuration.
   e. Capacity: Shall be capable of handling a minimum of 2.5” axial compression.
   f. Rating: Shall be rated for 150 psig operation.

2.2 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides:

1. Guides shall be constructed as shown on the Drawings.
2. Materials of construction shall be a combination of hot dipped galvanized steel or stainless steel.

PART 3 - EXECUTION

3.1 ALIGNMENT-GUIDE INSTALLATION

A. The distance from end of expansion joint to guide shall be a maximum of 4 pipe diameters. Manhole wall penetrations shall be considered a guide.

B. Attach guides to structure and pipe as shown in the Drawings.

END OF SECTION 230516

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.

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. Cast-Iron Wall Pipe for Anchorage:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Cast Iron Pipe Company
   b. Or Approved Equal
2. Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe.
3. If Wall Pipe is to be used for anchorage of PVC or Ductile Iron lines they shall be provided with an allowable load rating of 16,000 lbs force for 8” lines and 59,000 lbs force for 16” lines.
4. Wall Pipe Anchors shall be provided with MJ-Thrust Collar on end outside of manhole and either plain pipe or Flange on other end.

2.2 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. Pipeline Seal and Insulator, Inc.
3. Proco Products, Inc.
4. CCI Pipeline Systems

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber for pipelines temperature up to 250 deg F. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel or Plastic to be chosen for pipeline temperature.
3. Integral bolt packages to be stainless steel.
4. 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: Nonshrink; 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 new manholes.

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 walls as new walls are constructed.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Anchors:

1. Where anchors are shown on drawings provide cast into wall as you would a sleeve.
2. Corrosion Protection:
   a. Surface Preparation: Remove loose scale, rust, dirt, excessive moisture, or frost from the surface prior to application.
3. Application:

a. All surfaces shall be hand rubbed or brushed with Denso Paste priming paste. Sharp projections such as threads, irregular contours, or badly pitted areas shall receive a liberal amount of priming paste to ensure maximum protection of metal throughout.
b. On irregular shaped surfaces, i.e., nuts, bolts, flanges, valves, etc., Contractor shall use either of the following systems listed below:
   1) Apply Denso Petrolatum Tape Mastic by hand in sufficient quantity to build an even contour over the entire surface. Contractor shall pay particular attention to ensure that all folds and air pockets within the mastic layer are thoroughly pressed out prior to subsequent application of tape.
   2) An extra layer shall be cut and carefully molded around all sharp projections, nuts, bolts, etc., before final application of tape, in order to meet specified system thickness.
c. Tape shall be spirally wrapped to a 55 percent overlap with sufficient tension and pressure to provide continuous adhesion without stretching the tape. Edges of tape must be continuously smoothed and sealed by hand during wrapping. On vertical application, Contractor shall begin at bottom and proceed upward creating a weather board overlap.

4. System Thickness: Smooth contours shall have a minimum thickness of 50 mil while nuts, bolts, and sharp projections shall be 100 mil.
5. This system shall be provided in addition to other corrosion protection systems listed in Division 23 specifications.
6. Testing: The corrosion protection system shall be tested with a Tinker-Razor “holiday” test prior to acceptance and backfill.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in manhole concrete walls.

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-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete walls. Position waterstop flange to be centered in concrete wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Piping in Manholes and Valve Pits:
   a. Cast-iron wall sleeves with sleeve-seal system.

b. Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system. Where coring is to be used select core size to match the same criteria.
c. Provide anchors where shown on the drawings.

2. Data or conduit in Manholes and Valve Pits:
   a. Grout penetrations.

END OF SECTION 230517

SECTION 230523 – GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Bronze ball valves.
2. Butterfly valves high-performance.
3. Butterfly valves for below grade.

B. Related Sections:

1. Section 23 0553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

1.4 ACTION SUBMITTALS

A. Product Data:

1. For each type of valve indicated.

1.5 QUALITY ASSURANCE

A. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.

3. ASME B31.9 for building services piping valves.
4. AWWA C504-87for rubber seated butterfly valves.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to HVAC 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. Gear Actuator: For quarter-turn valves NPS 8 and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Handlever: For quarter-turn valves NPS 6 and smaller.
4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 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.

a. Provide 2-inch extension handle for heating hot water application to extend handle beyond insulation jacketing.
b. Provide insulating handle for chilled water application to ensure condensation does not occur.

2. Butterfly Valves: With extended neck.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Threaded: With threads according to ASME B1.20.1.

2.2 BRONZE BALL VALVES (SIZES 1/2 THROUGH 2-1/2 INCH):

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Nibco Inc. – T-585-70
b. Conbraco Industries, Inc.; Apollo Valves.
c. Crane Co.; Crane Valve Group; Crane Valves.
d. Milwaukee Valve Company.

2. Description:

a. Valve must be manufactured in the United States.
b. Standard: MSS SP-110.
c. SWP Rating: 150 psig .
d. CWP Rating: 600 psig.
e. Body Design: Two piece.
f. Body Material: Bronze.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel. Provide NIB-Seal or equal plastic extension handle for chilled water valves.
i. Ball: Stainless steel, vented.
j. Port: Full.

2.3 BUTTERFLY VALVES (SIZE 3 INCH AND LARGER):

A. Class 150, Single-Flange, Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Nibco Inc. – LC 2000
b. Crane Co.; Crane Valve Group; Stockham Division.
c. Jamesbury; a crane subsidiary of Metso Automation.
d. Keystone

2. Description:

a. Valve must be manufactured in the United States.
b. Standard: MSS SP-68.
c. CWP Rating: 200 psig.
d. Temperature Rating: 225 deg F continuous operation.
e. Body Design: Lug type.
f. Body Material: Carbon steel, or ductile iron.

g. Seat: EPDM molded-in seat liner.
h. Stem: Stainless Steel ASTM A582 Type 416.
i. Disc: Aluminum Bronze.
j. Service: Bidirectional, capable of deadhead service without closing end flange.
k. Finish: Powder finished epoxy coating.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 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. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for butterfly and gate valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

3.3 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.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball or butterfly.
2. High Performance Butterfly Valve Dead-End Service: Single-flange (lug) type.
3. Throttling Service: Globe, ball, or high performance butterfly valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes 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.
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.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 CHILLED-WATER VALVE SCHEDULE

A. Aboveground Application (including within manholes):

1. NPS 2 and below: Bronze Ball Valves - May be provided with threaded ends instead of flanged ends. Shall be used for Air Vent and Drain locations.
2. NPS 2-1/2 and above: Butterfly Valves Class 150, single flange.

3.6 HEATING HOT-WATER VALVE SCHEDULE

A. Aboveground Application (including within manholes):

1. NPS 2 and below: Bronze Ball Valves - May be provided with threaded ends instead of flanged ends. Shall be used for Air Vent and Drain locations.
2. NPS 2-1/2 and above: Butterfly Valves Class 150, single flange.

END OF SECTION 230523

SECTION 230529 – HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal-hanger shield inserts.
4. Fastener systems.
5. Pipe stands.
6. Piping supports.
7. Equipment supports.

B. Related Sections:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 230100 "Mechanical Manholes and Valve Pits" for manhole special construction requirements.
3. Section 230516 "Expansion Fittings and Loops for HVAC Piping" for expansion joints and guides.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 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, including pipe stands, 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.

1.5 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. Pipe anchors.
2. Pipe guides.
3. Pipe stands.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 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: Hot dipped.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

B. 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 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

B. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

C. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

D. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air

temperature.

2.3 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type, stainless-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.

2.4 EQUIPMENT SUPPORTS

A. Manufacturer shall be Mason, MW Sausse or approved equal.

B. Description:

1. Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.
2. Provide seismic support design based on the selected equipment.

2.5 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, nonshrink 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. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

C. Fastener System Installation:

1. Powder-actuated fasteners are not allowed.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

E. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

F. 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.

G. Install lateral bracing with pipe hangers and supports to prevent swaying.

H. 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.

I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

J. 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.

K. 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 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.

D. Provide seismic support design based on the selected equipment. Manufacturer shall be Mason, MW Sausse or approved equal.

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. Nuts and Bolts: Use SAE J429 Grade 8 nuts and bolts within manholes and vault pits.

D. 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 SUPPORTS IN STEAM MANHOLES AND UTILIDORS

A. Refer to Section 230100 “Mechanical Manholes and Valve Pits” for special requirements for supports in these environments.

3.6 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. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.7 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 copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

I. 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 noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Steel Pipe Clamps (MSS Type 4): For suspension of cold pipes NPS 1/2 to NPS if little or no insulation is required.
3. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
4. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
5. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
6. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
7. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
9. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
10. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
11. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
12. 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.
13. 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.
14. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

J. 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.

K. 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.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

L. 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. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
4. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
5. C-Clamps (MSS Type 23): For structural shapes.
6. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
7. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
8. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
9. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
10. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
11. 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 .

12. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
13. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
14. Installer should be certified by Powder Actuated Tool Manufacturer.

M. 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.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. 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.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

9. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
10. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
11. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 230549 - SEISMIC CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Scope: This section specifies seismic restraints for bracing all piping systems specified in Section 23 21 13.

B. This Section includes the following:

1. Restraint channel bracings.
2. Restraining cables.
3. Seismic-restraint accessories

1.2 DEFINITIONS

A. A_v: Effective peak velocity related acceleration coefficient.

B. Longitudinal direction - Parallel to the run.

C. Transverse (lateral) direction - Perpendicular to the run.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:

1. Site Class as Defined in the CBC: **D**.
2. Assigned Seismic Use Group or Building Category as Defined in the CBC: **II**.

a. Component Importance Factor: 1.0.
b. Component Response Modification Factor: 2.5.
c. Component Amplification Factor: 6.0.

3. Design Spectral Response Acceleration at Short Periods 0.2 Second: S_S = 2.01, S_{DS} = 1.36
4. Design Spectral Response Acceleration at 1-Second Period: S_1 = 0.79, S_{1S} = 0.78

1.4 RESTRAINT SELECTION

A. Unless otherwise specified, the Contractor shall select, locate and provide seismic restraints for piping in accordance with paragraph 23 05 48-1.02-C. The Contractor shall review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the restraints to be used at each point. Seismic restraints may be omitted from the following:

1. Piping in mechanical equipment rooms less than 1-1/4 inch nominal diameter.
2. All other piping less than 2-1/2 inch nominal diameter.

3. All piping suspended by individual hangers 12 inches or less in length, as measured from the top of the pipe to the bottom of the support where the hanger is attached.

Piping systems shall not be braced to dissimilar parts of a building or to dissimilar building systems that may respond in a different mode during an earthquake (i.e. - wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill, etc.). Restraints shall be sized to fit the outside diameter of the pipe, tubing, or, where specified, the outside diameter of insulation. There shall be no contact between a pipe and restraint component of dissimilar metals. The Contractor shall prevent contact between dissimilar metals when restraining copper tubing by the use of copper-plated, rubber, plastic or vinyl coated, or stainless steel restraint components.

B. Branch lines shall not be used to brace main lines. Seismic bracing shall not be used to limit the expansion and contraction of the piping system.

1.5 SUBMITTALS

A. Product Data: Include load deflection curves for each vibration isolation device.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Include the following:

C. Delegated-Design Submittal: For seismic-restraint details 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. Design Calculations: Calculate static loading due to equipment weight and operational seismic restraints.
2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
3. Seismic Restraint Details:

    a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
    b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
    c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.

D. Welding certificates.

E. Manufacturer Seismic Qualification Certification: Submit certification that all specified equipment will withstand seismic forces identified in "Performance Requirements" Article above. Include the following:

F. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.

a. 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."
b. 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 and the unit will be fully operational after the seismic event."

G. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

1. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 CODES AND REFERENCES

A. References: This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

AISC M016	Manual of Steel Construction - 9th Edition
ANSI A58.1	Minimum Design Loads for Buildings and Other Structures.
FEDSPEC WW-H-171e	Hangers and Supports, Pipe.
MFMA-1	Metal Framing Standards Publication.
MSS SP-58	Pipe Hangers and Supports - Materials, Design and Manufacturers.
MSS SP-69	Pipe Hangers and Supports - Selection and Application.
SMACNA	Seismic Restraint Manual Guidelines for Mechanical Systems.
UBC 23 Part III	Earthquake Design

1.7 QUALITY ASSURANCE

A. Seismic-restraint devices shall have horizontal and vertical load testing and analysis performed according to OSHPD and shall bear anchorage preapproval "R" number, from OSHPD or another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Testing and calculations must include both shear and tensile loads and 1 test or analysis at 45 degrees to the weakest mode.

B. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

C. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional structural engineer licensed in the State of California.

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 3.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

B. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 SEISMIC BRACING

A. Manufacturers

1. Carpenter & Patterson,
2. B-line,
3. Tolco,
4. Kin-line,
5. ITT Grinnell,
6. Michigan Pipe Hangers
7. Pipe Shields Incorporated,
8. Superstrut,
9. Unistrut

B. Pipe Attachments:

1. Clevis Restraint Attachment: Clevis attachment shall be MSS Type 1, Clevis pipe hanger.
2. Roller Restraint Attachment: Roller attachment shall be MSS Type 43, adjustable roller hanger. Hold down strap shall be carbon steel and sized as follows: pipe size 1 inch through 2 inches shall be 1 inch by 1/8 inch thick, pipe sizes 2-1/2 inch through 4 inch shall be 1-1/4 inch by 3/16 inch tick, 6 inch pipe shall be 2 inch by 3/16 inch thick, 8 inch pipe shall be 2-1/2 by 3/16 inch thick, 10 inch through 16 inch pipe shall be 2-1/2 inch by 1/4 inch thick, 20 inch pipe shall be 3 inch by 1/4 inch thick, and 24 inch pipe shall be 3 inch by 3/8 inch thick.
3. U-Bolt Restraint: U-bolt restraint shall be MSS Type 24 as specified in Section 23 05 29.
4. Framing Channel Pipe Strap: Pipe strap shall be carbon steel, with configuration equivalent to MSS Type 26.

C. Trapeze Restraints

1. General: Unless otherwise specified, trapeze members shall have a minimum steel thickness of 12 gage, with a maximum deflection 1/240 of the span.
2. Single Channel Lateral Restraint: Trapeze restraint cross member shall be 1-5/8 inch square carbon steel framing channel, Unistrut P1000, Superstrut A-1200, or equal. Pipe attachments shall be equivalent to those indicated on the plans for single pipe support.

D. Tangential and Longitudinal Structural Attachments: Unless otherwise specified, structural attachments for tangential and longitudinal seismic braces shall conform to SMACNA Seismic Restraint Manual Table 8-1.

E. Accessories:

1. Hanger Rods: Rods shall be carbon steel or 304 stainless steel, threaded on both ends or continuous threaded and sized per SMACNA Seismic Restraint Manual.
2. Framing Channel: Framing channel shall conform to the Metal Framing Manufacturers Association Standard MFMA-1. Framing channel shall be roll formed, with 12-gage of carbon steel as indicated.
3. Rod Coupling: Rod coupling shall be carbon steel, with sight hole in center of coupling body, Grinnell Fig. 135, Superstrut H-119, or equal.

F. Thermal shields shall be provided at seismic restraint locations on pipe requiring insulation. Thermal pipe hanger shields shall be as specified in paragraph 23 05 29-2.03-G. Stainless steel band clamps shall be provided on thermal shields at longitudinal pipe restraint locations.

2.3 SEISMIC-RESTRAINT DEVICES

A. Manufacturers:

1. B-Line Systems, Inc.
2. Amber/Booth Company, Inc.
3. California Dynamics Corp.
4. Kinetics Noise Control, Inc.
5. Loos & Co., Inc.; Cableware Technology Division.
6. Mason Industries, Inc.
7. TOLCO Incorporated.
8. Unistrut Diversified Products Co.; Wayne Manufacturing Division.
9. Vibration Eliminator Co., Inc.
10. Vibration Isolation Co., Inc.
11. Vibration Mountings & Controls/Korfund.

B. Resilient Isolation Washers and Bushings: 1-piece, molded, bridge-bearing neoprene complying with AASHTO M 251 and having a durometer of 50, plus or minus 5, with a flat washer face.

C. Seismic Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

D. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.

1. Resilient Isolation Washers and Bushings: 1-piece, molded, bridge-bearing neoprene complying with AASHTO M 251 and having a durometer of 50, plus or minus 5.

E. Restraining Cables: Galvanized steel aircraft cables with end connections made of steel assemblies that swivel to final installation angle and utilize two clamping bolts for cable engagement.

F. Anchor Bolts: Seismic-rated, drill-in, and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488/E 488M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install restraining cables at each trapeze and individual pipe hanger. At trapeze anchor locations, shackle piping to trapeze. Install cables so they do not bend across sharp edges of adjacent equipment or building structure.

B. Install steel angles or channel, sized to prevent buckling from a seismic event, clamped with ductile-iron clamps to hanger rods for trapeze and individual pipe hangers. At trapeze anchor locations, shackle piping to trapeze. Requirements apply equally to hanging equipment. Do not weld angles to rods.

C. Rod stiffener assemblies shall be used at seismic restraints for hanger rods over 6 inches in length. A minimum of two rod stiffener clamps shall be used on any rod stiffener assembly.

D. Lateral and longitudinal bracing shall be installed between 45 degrees above 45 degrees below horizontal, inclusive, relative to the horizontal centerline of the pipe.

E. Welded and bolted attachments to the building structural steel shall be in accordance with the requirements of SMACNA Seismic Restraint Guide and AISC M016. There shall be no drilling or burning of holes in the building structural steel without approval of the University's representative.

F. The Contractor shall install thermal pipe hanger shields on insulated piping at required locations during restraint installation. Butt joint connections to pipe insulations shall be made at the time of insulation installation in accordance with the manufacturer's recommendations.

G. Restraint components in contact with plastic and FRP pipe shall be free of burrs and sharp edges.

H. Roller shall roll freely without binding.

I. Plastic or rubber end caps shall be provided at the exposed ends of all framing channels that are located up to 7 feet above the floor.

3.3 ADJUSTING

A. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.

B. Torque anchor bolts according to equipment manufacturer's written recommendations to resist seismic forces.

3.4 CLEANING

A. After completing equipment installation, inspect seismic-control devices. Remove paint splatters and other spots, dirt, and debris.

END OF SECTION 230549

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Warning signs and labels.
2. Pipe labels.
3. Stencils.
4. Valve tags.
5. Warning tags.

1.3 ACTION SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Red.

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-fourths 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.

2.2 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.3 VALVE TAGS

A. Valve Tags: Stamped or engraved with ¼-inch letters for piping system abbreviation and pipe size and ½ inch sequenced numbers giving valve name.

1. Tag Material: Brass, 0.032-inch minimum thickness and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2 by 11 inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve tag schedule shall be included in operation and maintenance data.

2.4 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: Approximately 4 by 7 inches.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as “DANGER”, “CAUTION” or “DO NOT OPERATE.”
4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed; accessible maintenance spaces such as manholes; locations as follows:

1. Near each valve and control device.
2. Near each branch connection. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Spaced at maximum intervals of 40 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

B. Pipe Label Color Schedule:

1. Heating Hot Water Piping:

a. Background Color: Yellow.
b. Letter Color: Black.
c. Symbol: HHWS or HHWR

2. Chilled Water Piping:

a. Background Color: Green.
b. Letter Color: White.
c. Symbol: CHWS or CHWR

3.3 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; and shutoff valves. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

    a. Chilled Water: 2 inches, round.
    b. Heating Hot Water: 2 inches, round.

2. Valve-Tag Color:

    a. Chilled Water: Natural.
    b. Heating Hot Water: Natural.

3. Letter Color:

    a. Chilled Water: Black.
    b. Heating Hot Water: Black.

3.4 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 230553

SECTION 230719 – HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes insulating the following HVAC piping systems:

1. Chilled-water and Heating Hot Water piping, indoors and outdoors.

1.3 ACTION SUBMITTALS

A. 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 pipe expansion joints for each type of insulation.
3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
4. Detail removable insulation at piping specialties.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting 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.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Products shall not contain CFC, asbestos, lead, mercury, or mercury compounds.

B. Insulation shall meet fire and smoke hazard ratings as tested under procedure ASTM E-84, NFPA 255, and UL 723 and shall not exceed flame spread rating of 25 and maximum smoke developed rating of 50.

C. Phenolic Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Dyplast Products. Dytherm Phenolic
   b. Resolco Inc. Insul-Phen Green.

2. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
3. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
5. Chilled water piping shall be provided with integral vapor barrier from the factory.

2.2 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. Phenolic Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand CP-96.
b. Foster Brand 81-33.

C. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of 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.

2.3 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand CP-76.
b. Foster Brand 95-44.
c. 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.
6. Water Vapor Permeance: Shall comply with ASTM F-1249
7. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand 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.
6. Water Vapor Permeance: Shall comply with ASTM F-1249 Testing.
7. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 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, provide one of 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. PVC Jacket Color:

   a. Chilled-Water Piping:
      1) White

   b. Heating Hot Water Piping:
      1) 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, provide one of 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. Factory cut and rolled to size.
3. Finish and thickness are indicated in field-applied jacket schedules.
4. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper 2.5-mil- thick polysurlyn.
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.

2.5 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, provide one of the following:

   a. ABI, Ideal Tape Division; 428 AWF ASJ.
   b. Compac Corporation; 104 and 105.
   c. Strouse; Ideal Tape 428 ASJ

2. Width: 3 inches.
3. Thickness: Maximum thickness of 11.5 mils.
4. Adhesion: Minimum of 70 ounces force/inch in width.
5. Elongation: Minimum 1 percent.
6. Tensile Strength: Minimum of 45 lbf/inch in width.
7. Operating Temperature: -25˚F to 280˚F
8. 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, provide one of 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.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 80 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, provide one of the following:

   a. ABI, Ideal Tape Division; 370 White PVC tape.
   b. Compac Corporation; 130.

2. Width: 2 inches.
3. Thickness: Minimum 5 mils.
4. Adhesion: Min 18 ounces force/inch in width.
5. Elongation: 150 percent.
6. Tensile Strength: Minimum 14 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Compac Corporation; 120.
   b. Venture Tape; 3520 CW.

2. Width: 2 inches.

3. Thickness: 2 mils.
4. Adhesion: Minimum 60 ounces force/inch in width.
5. Elongation: Minimum 1 percent, Maximum 5%
6. Tensile Strength: Minimum of 15 lbf/inch in width.

2.6 SECUREMENTS

A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch 3/4 inch wide with 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, Seals, and Springs.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, stainless steel.

1. Manufacturers: Subject to compliance with requirements, provide product by:

a. C & F Wire.

2.7 REMOVABLE INSULATION JACKETS

A. Manufacturers:
1. INSULTECH.
2. Firwin.

B. Insulation:

1. Minimum of 1" insulation thickness
2. Minimum Operating Temperature: 250 ˚F

C. Jacket:

1. Hot Side
a. PTFE Fiberglass Composite Jacketing, 16.5 oz/sq. yd. minimum
b. Estimation of Maximum Use Temperature 550 deg F.

2. Cold Side
a. PTFE Fiberglass Composite Jacketing, 16.5 oz/sq. yd. minimum
b. Estimation of Maximum Use Temperature 600 deg F.

D. Thread:

1. Does not decompose below 800 deg F.
2. Does not melt.
3. Diameter: 0.0114
4. Break Point: 35 Lbs.

E. Construction:

1. Double sewn lock stitch with a minimum 4 to 6 stitches per inch. Jackets shall be sewn with two (2) parallel rows of stitching. The thread must be able to withstand the skin temperatures without degradation.
2. Hog rings, staples and wire are not are not acceptable methods of closure.
3. No raw cut jacket edges shall be exposed.
4. Jackets shall be fastened using hook and loop (Velcro) straps and 1” slide buckles.
5. Provide a permanently attached aluminum or stainless steel nameplate on each jacket to identify its location, size and tag number.
6. Provide a stainless steel or brass grommet at the low point of each jacket, in wet areas for moisture drain (on horizontal jackets as required).
7. The insulation shall be designed to minimize the convection current in the space between the hot metal surface and the inner layer of insulation. To this end, during jacket fabrication, the layers of insulating mat shall be placed in an overlapping pattern.
8. All jacket pieces which match mating seams must include an extended 2" flap constructed from the exterior fabric and shall be secured using hook & loop closure (Velcro) parallel to the seam.
9. Insulation must be sewn as integral part of the jacket to prevent shifting of the insulation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Insulation shall not be installed until the following have been completed and documentation has been submitted to University Representative and USC Facility Management Services (FMS) for approval and record:

1. Cleaning and flushing
2. Pressure testing

B. 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.

C. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

D. 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.

E. Install insulation with longitudinal seams at top and bottom of horizontal runs.

F. Install multiple layers of insulation with longitudinal and end seams staggered.

G. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

H. Keep insulation materials dry during application and finishing.

I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

J. Install insulation with least number of joints practical.

K. Install rigid pre-insulated pipe supports to protect from compression of insulation material due to point loads.

L. Provide aluminum sleeves at all pipe support joints, between hanger support and exterior layer of insulating systems, to protect from compression of insulation material due to point loads.

M. Install insulation on piping accessories requiring future reoccuring access and service with factory fabricated insulation covers that are easily removed and reapplied.

N. 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.

O. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

P. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches 4 inches o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at

ends adjacent to pipe flanges and fittings.

Q. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

R. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

S. 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.

T. 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. Manholes.
5. Handholes.
6. Cleanouts.

3.4 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.

3.5 GENERAL PIPE INSULATION INSTALLATION

A. 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.

    a. For HHW Isolation Valves and Expansion Joints provide removable insulation jackets for service.

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, 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.

B. 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.

C. 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.

D. Insulation Installation on Butterfly Valves and Expansion Joints:

1. Insulate valves using removable insulation jackets. Insulate up to and including the flanges, bonnets, valve stuffing-box studs, bolts, and nuts. Pipe insulation shall stop 3 inches prior to flange to allow flange bolt removal.
2. Insulate expansion joints using removable insulation jackets. Insulate up to and including the flanges, bolts, and nuts. Pipe insulation shall stop 3 inches prior to edge of expansion joint to allow connection removal.

3.6 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; for horizontal applications. 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 bands 12 inches o.c. and at end joints.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.8 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range.

3.9 ABOVEGROUND (INCLUDING MANHOLES) PIPING INSULATION SCHEDULE

A. Chilled Water - 39°F and above:

1. All Pipe Sizes: Phenolic Insulation:

a. Indoor: 1-1/2 inches thick.

B. Heating Hot Water - 120°F and above:

1. All Pipe Sizes: Phenolic Insulation:

a. Indoor: 2 inches thick.
b. Outdoor: 2 inches thick.

3.10 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material.

B. Piping, Exposed:

1. PVC, white: 30 mils thick for all indoor applications.

3.11 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material.

B. Piping, Exposed:

1. Aluminum, Stucco Embossed: 0.020 inch thick.
2. Color to match exterior wall.

END OF SECTION 230719

SECTION 232113 – HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specify pipe and fitting materials manufactured exclusively in the United States, joining methods, special-duty valves, and specialties for the following:

1. Chilled-water piping.
2. Heating hot-water piping.
3. Air-vent piping.
4. Safety-valve-inlet and -outlet piping.

B. Related Sections include the following:

1. Section 232123 "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.
2. Section 232116 “Hydronic Piping Specialties” for piping accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. All piping data. Submit data indicating that pipe, tube and fittings are manufactured exclusively in the United States.
2. Air control devices.

B. Shop Drawings: Detail, at 1/4 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Welding certificates.

C. Field quality-control test reports.

D. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:

1. Chilled-Water Piping: 125 psig at 100°F.
2. Heating Hot-Water Piping: 125 psig at 225°F.
3. Air-Vent Piping: 125 psig at 225°F.
4. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 STEEL PIPE AND FITTINGS

A. Piping and fittings shall be manufactured exclusively in the United States and meet the following requirements:

1. Steel Pipe: ASTM A 53, black steel with plain ends; ERW, grade B, and wall thickness as indicated in Part 3 "Piping Applications" Article.
2. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150 as indicated in Part 3 "Piping Applications" Article.
3. Malleable-Iron Unions: ASME B16.39; Class 150 as indicated in Part 3 "Piping Applications"

Article.

4. Forged-Steel Flanges and Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

    a. Material Group: 1.1.
    b. End Connections: Butt welding, fittings.
    c. Flanges: Raised face, slip-on or flat.

B. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thickness as pipe in which they are installed.

2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

    a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, stainless steel, unless otherwise indicated.

C. 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.

D. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.4 VALVES

A. Gate, Globe, Check, Ball, and High Performance Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."

B. Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Direct Digital Control Systems.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Chilled-water piping aboveground and in manholes, all pipe sizes shall be the following:

1. Standard thickness black steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints. All piping materials shall be exclusively manufactured in the United States.

B. Heating hot-water piping aboveground and in manholes, all pipe sizes shall be the following:

1. Standard thickness black steel pipe, wrought-steel fittings and wrought-cast or forged-steel

flanges and flange fittings, and welded and flanged joints. All piping materials shall be exclusively manufactured in the United States.

C. Air-Vent Piping shall be the following:

1. Inlet: Same as service where installed.
2. Outlet: Type K, annealed-temper copper tubing with brazed joints.

3.2 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such 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 Shop 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 to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 2" ball valve, and short NPS 2" threaded nipple with cap, at low points in piping system mains, where shown on the drawings and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up. Level side down reducers shall be used in manholes to allow even trenching.

O. Install branch connections to mains using tee fittings to main pipe. Connect branch tee fittings to the bottom or side of the main pipe based on connection requirements. For up-feed risers, connect the branch to the top of the main pipe. Saddle fittings are not acceptable.

P. Install valves according to Section 230523 "General-Duty Valves for HVAC Piping."

Q. Install unions in piping, NPS 2” and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Identify piping as specified in Section 230553 "Identification for HVAC Piping and Equipment."

T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.3 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.

B. Seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

C. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Provide spring hangers to support vertical runs for the first five hangers for all mechanical piping mains connected to pumps.
3. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
4. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.
8. NPS 6: Maximum span, 17 feet; minimum rod size, 1/2 inch.
9. NPS 8: Maximum span, 19 feet; minimum rod size, 5/8 inch.
10. NPS 10: Maximum span, 20 feet; minimum rod size, 3/4 inch.
11. NPS 12: Maximum span, 23 feet; minimum rod size, 7/8 inch.
12. NPS 14: Maximum span, 25 feet; minimum rod size, 1 inch.
13. NPS 16: Maximum span, 27 feet; minimum rod size, 1 inch.
14. NPS 18: Maximum span, 28 feet; minimum rod size, 1-1/4 inches.
15. NPS 20: Maximum span, 30 feet; minimum rod size, 1-1/4 inches.
16. NPS 24: Maximum span, 30 feet; minimum rod size, 1-1/4 inches.

E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet ; minimum rod size, 1/4 inch.
2. NPS 1 : Maximum span, 6 feet ; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 8 feet ; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
6. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.

F. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

G. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.4 PIPE 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 pipe 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 unless dry seal threading is specified.
2. 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: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

F. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

3.5 EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install ports for pressure gages and thermometers at equipment inlet and outlet connections. Comply with requirements in Section 230519 "Meters and Gages for HVAC Piping."

3.6 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Per 2013 California Mechanical Code, Chapter 12 Hydronics, 1201.3.9.2 Pressure Test:

    a. Piping shall be tested with a hydrostatic pressure of not less than 100 psig, but at least fifty (50) psig greater than operating pressure.
    b. This pressure shall be maintained for at least thirty (30) minutes.
    c. Required tests shall be conducted by the contractor in the presence of an authorized inspector.
    d. The piping being tested shall remain exposed to the inspector and shall not leak during the test.

5. After hydrostatic test pressure has been applied for at least 30 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Inspect and set operating temperatures of hydronic equipment.
6. Verify lubrication of motors and bearings.

END OF SECTION 232113

SECTION 232113.13 - UNDERGROUND HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Underground pre-insulated steel pipes and fittings.
2. Underground pre-insulated PEX pipes and fittings.

1.3 PERFORMANCE REQUIREMENTS

A. For steel, ductile iron, PVC, and HDPE piping, provide components and installation capable of producing hydronic piping systems with the following minimum working-pressure ratings:

1. Heating Hot Water Piping: 150 psig at 200 deg F.

B. For PEX pipes, provide components and installation capable of producing hydronic piping systems with the following minimum working-pressure ratings:

1. Heating Hot Water Piping: 80 psig at 180 deg F.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. All piping data. Submit data indicating that pipe, tube and fittings are manufactured exclusively in North America, Germany or Italy.

B. Shop Drawings: For underground hydronic piping. Signed and sealed by a professional engineer.

1. Calculate requirements for expansion compensation for underground piping.
2. Show expansion compensators, offsets, and loops with appropriate materials to allow piping movement in the required locations. Show anchors and guides that restrain piping movement with calculated loads.
3. Show pipe sizes, locations, and elevations. Show piping in trench, conduit, and cased pipe with details showing clearances between piping, and show insulation thickness.
4. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the pipe vault structure.
5. Show locations of pipe anchors and alignment guides and expansion joints and loops.

1.5 INFORMATIONAL SUBMITTALS

A. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1 inch equals 50 feet and at vertical scale of not less than 1 inch equals 5 feet. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing hydronic piping.

B. Qualification Data: For qualified Installer.

C. Welding certificates.

D. Material Test Reports: For piping.

E. Source quality-control reports.

F. Field quality-control reports.

G. Butt fusion welding joint reports.

H. HDPE fusion welded joint kit reports.

I. PEX joint reports.

1.6 CLOSEOUT SUBMITTALS

A. Joint Images: Provide images of every direct-buried field joint constructed on the project.

1. Include an image (or multiple images) that clearly show location of joint with respect to project area.
2. Include images (or multiple images) of completed joint. Complete perimeter of seam shall be visible. Images shall show jacketing extending two-feet on both sides of seam.

1.7 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31.9, "Building Services Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

B. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. For steel, ductile iron, PVC, and HDPE piping, provide components and installation capable of producing hydronic piping systems with the following minimum working-pressure ratings:

1. Heating Hot Water Piping: 150 psig at 200 deg F.
2. Chilled Water Piping: 125 psig at 100 deg F.
3. Air-vent piping: match performance of connected pipe.

B. For PEX pipes, provide components and installation capable of producing hydronic piping systems with the following minimum working-pressure ratings:

1. Heating Hot Water Piping: 80 psig at 180 deg F.
2. Air-vent piping: match performance of connected pipe.

2.2 UNDERGROUND PRE-INSULATED STEEL PIPES AND FITTINGS

A. Description: Factory-fabricated piping with carrier pipe, insulation, and casing. All pre-insulated pipe, fittings, insulating materials, and technical support shall be provided by the pre-insulated piping system manufacturer.

B. Manufacturers:

1. Thermacor Process Inc. Thermacor Process, Inc. is the campus hydronic piping standard; no substitutions are permitted.

C. Carrier Pipe: Ferro-Therm PTS, ASTM A 53 ERW Grade B, Standard Weight, Black Steel.

D. Carrier Pipe Insulation:

1. Polyurethane Foam Pipe Insulation: Rigid, cellular, spray applied to the carrier pipe.

a. Comply with ASTM C 591; thermal conductivity (k-value) shall not exceed 0.16 BTU x in/h x sq. ft. x deg F at 75 deg F after 180 days of aging aging or to EN253 with lambda value not exceeding 0.0241W/m*K
b. Insulation shall have a minimum density of 2lb/ft3 and shall be a minimum 90% closed cell in structure.

E. Insulating Diffusion Barrier:

1. A diffusion barrier shall be applied on the outside of the insulation before application of the outer jacket. The barrier shall prevent the diffusion of the blowing agent out of the foam to prevent the foam from aging.

a. Said diffusion barrier shall be applied to all joint closure kits as well to ensure continuity of the barrier.

F. Casing: HDPE having a wall thickness not less than 125 mils for pipe sizes less than or equal to 12” and shall be extruded onto the Polyurethane foam. No tape jacket allowed. A corona treated boding layer shall be applied onto the Polyurethane foam to ensure a secure bond between the jacket and foam insulation preventing any ingression of water at the jacket / foam interface.

G. Casing accessories shall include the following:

1. Joint Kit: Pressure-testable. Exterior jacket shall be high strength polyethylene sleeve that is electro-fusion welded and field insulated using pourable urethane foam to the thickness specified, preformed split insulation will not be acceptable.

a. Fusion welding shall be done using split sleeves with embedded wires or mesh that is heated with an electro-fusion welder.
b. Joint kit shall be pressure testable to 5psi.
c. Fusion welder shall have archiving capability.
d. A report showing the temperatures, times and pressure testing of each joint and its location shall be submitted at the end of the job.

2. Expansion Blanket: Elastomeric foam, formed to fit over piping.
3. End Seals: Shrink wrap the casing material to seal watertight around casing and carrier pipe. This includes each end of all factory fabricated fittings.

H. Straight Run Joints: Shall be insulated to the same thickness as the pipe and jacketed with an electro-fusion welded split sleeve.

1. The manufacturer shall provide the fusion machine, straps, bands, pressure gauges and closure patches for the pressure testable joint cover.

a. 20 extra straps and pressure testing caps shall be provided to the campus as well as an extra electro fusion welder for future repairs on the system. All sleeves shall be sized for 8” diameter piping.

2. Heat shrink materials will not be accepted for field joints or the repair of the field joints that do not pass the pressure tests
3. All field joints shall be pressure tested to ensure air tightness at 5psi for 5 minutes while being soap tested for leaks.
4. Joint closure kits shall occur at straight runs only. All fittings shall be pre-manufactured.

I. Fittings: Shall be factory pre-fabricated and pre-insulated fittings with polyurethane foam and jacketed with a butt fusion welded, or an extrusion welded and mitered HDPE jacket. Carrier pipe fittings shall be butt-welded. Fittings include expansion loops, elbows, tees, reducers, and anchors. Elbows, loops, or any other direction changes shall conform to the standards set by ASME B31.1, Code for Power Piping.

J. Expansion / Contraction Compensation: Shall be accomplished utilizing factory pre-fabricated and pre-insulated expansion elbows, Z-bends, expansion loops, and anchors specifically designed for the intended application. External expansion compensation utilizing flexible expansion pads (minimum one inch thickness), extending on either side, both inside and outside the radius of the fittings used with all fittings having expansion in excess of ½”.

K. Steel Welding Fittings: ASTM A 234/A 234M, seamless or welded.

1. ASME B31.1; Class 125.
2. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

L. Leak Detection:

1. The system shall include two wires between the carrier pipe and the HDPE jacket. The piping system manufacturer shall install the wire in a manner that has the wire embedded in the foam insulation and incorporated into each piece of pre-insulated pipe and fittings. This wire is to be capable of detection through the entire run including field joints and fittings.
2. The system shall be capable of alarming based upon impedance and shall consist of two wires for detection.

3. A detector (or multiple detectors if necessary) shall be provided and installed (including routing power to the unit and integration of alarms to the campus EMS system). The detector shall include an integral TDR impulse reflectometer.
4. A Cablescout TV220 TDR device and its associated software shall be provided to campus.
5. A web based interface shall be provided along with any necessary data connections. This shall be provided in addition to the integration with the EMS system called for in paragraph 3.

    a. The web-based interface shall be accessible from any location with internet access.
    b. If the service is fee based a 10-year subscription shall be provided by the contractor.
    c. The system shall be capable of alerting facilities personnel via email or text if an event were to occur.

6. The installed system shall be capable of monitoring the entire piping distribution system being provided as part of this project.
7. During the commissioning of the system a location map shall be provided with the system indicating the "As Installed" system configuration and sensing string layout. Footage along the cable shall be provided as references to locate leaks.

2.3 UNDERGROUND PRE-INSULATED PEX PIPES AND FITTINGS

A. Description: Crosslinked polyethylene (PEX) is a modified polyethylene material, typically high-density polyethylene (HDPE), which has undergone a change in the molecular structure using a chemical or a physical process whereby the polymer chains are permanently linked to each other. This crosslinking of the polymer chains results in improved performance properties such as elevated temperature strength, chemical resistance, environmental stress crack resistance (ESCR), resistance to slow crack growth (SCG), toughness, and abrasion resistance. Crosslinking also makes PEX a “semi-thermoset” polymer, providing excellent long-term stability. This specification requires PEX to be designated as PEXa and be manufactured by the high-pressure peroxide method.

B. Manufacturers:

1. REHAU Construction LLC-Insulpex
2. Uponor- Ecoflex Pre-insulated PEX
3. Approved equal

A. Carrier Pipe: Crosslinked polyethylene (PEX) carrier pipe shall conform to the requirements of one or more of the following: ASTM F876, ISO 15875 or DIN 16892 and/or DIN 16893. PEX carrier pipe shall have a minimum degree of crosslinking of 70% when tested in accordance with ASTM D2765, Method B.

1. Deliver pipe cut to the length specified by the project, in banded coils. The coils shall be rolled or carried, but not dragged across the ground or concrete surfaces. Coils may be carried using flexible slings wrapped inside the coil. Coils may also be carried with forks covered by plastic sheaths to prevent damage to the pipe.
2. The coils shall be stored upright on a flat surface with no sharp edges, and chocked or braced to prevent rolling or tipping.
3. The coils shall remain strapped or banded while in storage and should not be uncoiled until time of installation.
4. Protect the exposed carrier pipe at the ends of coils from UV (ultraviolet) light with the supplied protective caps, until time of installation.
5. Maximum accumulated UV exposure to not exceed one year for outer jacket.

6. Pipe shall be protected from oil, grease, paint, and other elements as recommended by manufacturer.

C. Carrier Pipe Insulation:

1. Polyurethane Foam Pipe Insulation: Rigid, cellular, spray or multi-layer wrap applied to the carrier pipe. Minimum density to be 2.0 lb/ft3, measured in accordance with ASTM D1622. Closed cell structure to be minimum 90%, in accordance with ASTM D2856. Thermal insulation shall be bonded to carrier pipe. Closed cell foam insulation shall have a maximum water absorption of <10% (vol) in accordance to EN 15632.

D. Insulating Diffusion Barrier:

1. A diffusion barrier shall be applied on the outside of the insulation before application of the outer jacket. The barrier shall prevent the diffusion of the blowing agent out of the foam to prevent the foam from aging. Said diffusion barrier shall be applied to all joint closure kits as well to ensure continuity of the barrier.

E. Casing:

1. Seamless, extruded low density polyethylene (LDPE) or high density polyethylene (HDPE).

   a. Profile: Outer casing shall have corrugated profile. Outer casing shall be bonded to thermal insulation.
   b. Markings: The outer casing shall be marked with the following information, repeated no less than every 5 feet (1.5 meters):
      1) Manufacturer name or trade name.
      2) Carrier pipe nominal size and Standard Dimensional Ratio (SDR).
      3) Temperature and pressure ratings.
      4) Footage markings.

F. Fittings:

1. General: Mechanical fittings to be of compression-sleeve style, manufactured of metal suitable for the fluid application, in a size suitable for the PEX carrier pipe dimensions.
2. Fittings with Solder-joint Ends: Solder-joint end dimensions shall be in accordance with ASME B16.18, ASME B16.22 or MSS SP-104.
3. Tapered Threaded Ends: Fitting threads shall be right-hand, conforming to ASME B1.20.1, and shall be tapered threads (NPT).
4. Compression-Sleeve Fittings: Mechanical compression-sleeve cold-expansion fittings to consist of a metal ribbed insert and a metal compression-sleeve. Fittings must meet the temperature and pressure performance requirements of the PEX carrier pipe. The compression-sleeve fittin tool used to install fittings shall be provided to the campus for future repairs on the system.
5. Electrofusion Fittings: Electrofusion fittings used for joining PEXa pipes. Fittings must meet the temperature and pressure performance requirements of the project design. The electrofusion welder used to install fittings shall be provided to the campus for future repairs on the system.

G. Straight Run Joints: Shall be insulated to the same thickness as the pipe and jacketed with an electro-fusion welded split sleeve.

1. The manufacturer shall provide the fusion machine, straps, bands, pressure gauges and closure patches for the pressure testable joint cover.

2. Heat shrink materials will not be accepted for field joints or the repair of the field joints that do not pass the pressure tests
3. All field joints shall be pressure tested to ensure air tightness at 5psi for 5 minutes while being soap tested for leaks.

H. Fittings: Shall be factory pre-fabricated and field-insulated with manufacturer supplied insulation kits of polyurethane foam and jacketed with a mitered HDPE or LDPE jacket. Fittings include, elbows, tees, reducers, and anchors. Elbows, loops, or any other direction changes shall conform to the standards set by ASME B31.1, Code for Power Piping.

PART 3 - EXECUTION

3.1 EARTHWORK

A. See Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATION

A. Hot-Water Heating Piping:

1. NPS 2-1/2 and larger shall be the following:

   a. Underground Pre-insulated Steel Piping System.
   b. Where indicated on the Drawings in order to tie onto existing ductile iron piping systems Pre-Insulated Ductile Iron Piping Systems shall be used.
   c. Where indicated on the Drawings, at building connections of or smaller than 4-inch pipe Pre-Insulated PEX Piping Systems shall be used.
      1) Deliver pipe cut to the length specified by the project, in banded coils. The coils shall be rolled or carried, but not dragged across the ground or concrete surfaces. Coils may be carried using flexible slings wrapped inside the coil. Coils may also be carried with forks covered by plastic sheaths to prevent damage to the pipe.
      2) The coils shall be stored upright on a flat surface with no sharp edges, and chocked or braced to prevent rolling or tipping.
      3) The coils shall remain strapped or banded while in storage and should not be uncoiled until time of installation.
      4) Protect the exposed carrier pipe at the ends of coils from UV (ultraviolet) light with the supplied protective caps, until time of installation.
      5) Maximum accumulated UV exposure to not exceed one year for outer jacket.
      6) Pipe shall be protected from oil, grease, paint, and other elements as recommended by manufacturer.

2. Buried piping shall be factory pre-insulated with polyurethane carrier-pipe insulation.

   a. Piping Insulation Thickness: 2 inches.

B. Chilled-Water Piping:

1. NPS 2-1/2 and larger shall be the following:

a. Chilled water supply piping shall be HDPE SDR 13.5 factory pre-insulated with polyurethane carrier-pipe insulation. Where indicated on the Drawings in order to tie into existing PVC pipfing systems Pre-Insulated PVC Piping Systems shall be used, piping shall be C900.
   1) Piping Insulation Thickness: 1.5 inches.
b. Buried chilled water return piping shall be uninsulated HDPE SDR 13.5. Where indicated on the Drawings in order to tie into existing PVC piping systems PVC Piping shall be used, piping shall be C900.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such 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. Remove standing water in the bottom of trench.

C. Do not backfill piping trench until field quality-control testing has been completed and results approved.

D. Install piping at uniform grade of 0.2 percent. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points and elsewhere as required for system drainage. Install manual air vents at high points.

E. In conduits, install drain valves at low points and manual air vents at high points.

F. Install components with pressure rating equal to or greater than system operating pressure.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install tracer wire along the length of all underground PEX piping.

J. See Section 230517 "Sleeves and Sleeve Seals for HVAC Piping" for sleeves and mechanical sleeve seals through exterior building walls.

K. Secure anchors with concrete thrust blocks. Concrete is specified in Section 033000 "Cast-in-Place Concrete."

3.4 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs for HDPE and steel pipe. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe 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 unless dry seal threading is specified.
2. 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: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

F. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

G. Conduit and Cased Piping Joints: Assemble sections and finish joints with pourable insulation and exterior jacket sleeve, and apply fusion welded seals (shrink-wrap seals are allowable where dictated in Chapter 2).

H. Butt Fusion: The pipe shall be joined by the butt fusion process outlined in ASTM F2620 or PPI TR-33. All fusion joints shall be made in compliance with the pipe or fitting manufacturer’s recommendations. Fusion joints shall be made per qualified technicians per PPI TN-42.

I. Butt Fusion joint recording: The critical parameters of each fusion joint shall be recorded by an electronic data logging device. All fusion joint data shall be included in a Fusion Technician’s joint report.

3.5 IDENTIFICATION

A. Install continuous plastic underground warning tapes during back filling of trenches for underground hydronic piping. Locate tapes 6 to 8 inches below finished grade, directly over piping. See Section 312000 "Earth Moving" for warning-tape materials and devices and their installation.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. 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.

D. Tests and Inspections:

1. Prepare hydronic piping for testing according to ASME B31.9 and as follows:

a. Leave joints, including welds, uninsulated and exposed for examination during test.

b. Fill system with water. Where there is risk of freezing, air or a safe, compatible liquid may be used.
c. Use vents installed at high points to release trapped air while filling system.

2. Test hydronic piping as follows:

a. Subject hydronic piping to hydrostatic test pressure that is not less than 100 PSI for chilled water and 150 PSI for heating hot water.
b. After hydrostatic test pressure has been applied for 10 minutes, examine joints for leakage. Remake leaking joints using new materials and repeat hydrostatic test until no leaks exist.

3. Test conduit as follows:

a. Seal vents and drains and subject conduit to 15 psig for four hours with no loss of pressure. Repair leaks and retest as required.

E. Images and Videos:

F. Prepare test and inspection reports.

END OF SECTION 232113.13

SECTION 232116 - HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes special-duty valves and specialties for the following:

1. Chilled-water piping.
2. Heating hot-water piping.
3. Air-vent piping.
4. Safety-valve-inlet and -outlet piping.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Air-control devices.
2. Hydronic specialties.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:

Chilled-Water Piping: 125 psig at 150°F.
Heating Hot-Water Piping: 125 psig at 200°F.
Air-Vent Piping: 200°F.
Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Section 230523 “General Duty Valves for HVAC Piping”.

2.3 AIR-CONTROL DEVICES

A. Automatic Air Vents:

1. Manufacturers:

a. Spirotherm - VTP
b. Taco - 409
c. Hoffman - 78

2. Automatic Air Vents

a. Body: Bronze.
b. Internal Parts: Nonferrous.
c. Operator: Automatic
d. Inlet Connection: NPS ½ or ¾.
e. Discharge Connection: NPS minimum 1/8.
f. CWP Rating: 150 psig.
g. Maximum Operating Temperature: 240 deg F.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.

B. Install check valves at each pump discharge and elsewhere as required to control flow direction.

C. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.2 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping where shown on drawings. Provide insulated ball valve for isolation of automatic air vents.

END OF SECTION 232116

SECTION 232513 - WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 and Section 23 0000 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes the following water treatment for closed-loop hydronic systems:

1. Pre-treatment cleaning and passivation of the heating hot water piping.
2. Coordination of drain and refill locations complete with shut off valves of the system with the Mechanical Contractor locations
3. Coordination with the University's HVAC Water-Treatment Service Provider who will be responsible to provide the chemicals for the FINAL water treatment system fill.

1.3 DEFINITIONS

A. TSS: Total suspended solids are solid materials, including organic and inorganic, that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

B. MSDS: Material Safety Data Sheets.

1.4 REGULATORY REQUIREMENTS

A. Conform to all applicable codes for non-potable chemicals to be used for HVAC Water Treatment.

B. All chemicals shall be suitable to be drained to the public sanitary sewer system.

1.5 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:

1. Temporary injection and circulation pumps.
2. Chemical test kits and equipment.
3. Pre-treatment Cleaning and Passivation Chemical list with MSDS.

B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to hydronic systems.

1. Include plans with proposed locations for drain down and fill points.
2. Schematic diagrams indicating pump location to circulate (supply and return) chemical pre-treatment.

3. Include diagrams for power and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Water Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.

B. Field quality-control reports.

C. Other Informational Submittals:
1. Water Analysis: Illustrate water quality available at Project site.

1.7 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

B. HVAC Water-Treatment Service Provider shall be capable of providing 10 years of documented experience if requested.

1.8 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion and scale formation for hydronic piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion and shall include the following:

1. Initial HVAC water-treatment recommendations for cleaning and passivation.
2. Startup assistance for Contractor to flush, pre-treat and clean the pipe to prepare it for passivation.
3. Passivation of piping prior to initially fill and operation of the system with required water chemical treatment.
4. NOTE: Final fill water treatment chemical shall be provided by the University.
5. Customer report charts and log sheets.
6. Laboratory technical analysis.
7. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. World Laboratories (Basis of Design)

B. NALCO

C. AquaChem Engineering

D. Or Approved Equal

2.2 PERFORMANCE REQUIREMENTS

A. Water treatment to chemically flush and clean remove the loose rust, dislodging the burrs, welding slag and mill scales adhering to the internal surface of the pipe and left behind from the installation of the piping

2.3 CHEMICALS

A. Circulating Water Applications

1. Pre-treatment Clean and Flush

a. Ferroquest FQ7103
b. Or approved equal

2. Passivator

a. CWT-Metal Passivator
b. Or approved equal

B. Dry Hand Swab Method for Short Runs inside Mechanical Manholes

1. Pre-treatment Clean and Flush

a. Simple Green Extreme:
b. Or approved equal

2. Passivator

a. CWT-Metal Passivator:
b. Or approved equal

2.4 TEMPORARY CHEMICAL-FEED EQUIPMENT

A. Provide temporary chemical feed equipment temporary circuits, arrangement of pumps, piping, valves tanks etc as required to introduce cleaning, degreasing and inhibitors for passivation of the piping system.

2.5 CHEMICALS TEST EQUIPMENT AND REAGENTS

A. Chemicals test equipment and reagents shall be as recommended by HVAC Water-Treatment Service Provider that are compatible with piping system components and connected equipment and that can attain water quality specified in "Performance Requirements" Article..

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 PREPARATION

A. Hydronic piping test for leaks and defects shall be completed prior to the HVAC water treatment is to begin. If testing is performed in segments, submit separate pressure test report for each segment, complete with diagram of portion of piping tested.

B. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.

C. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.

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 test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.

E. Repair leaks and defects with new materials and retest piping until no leaks exist.

3.3 INSTALLATION

A. Install in accordance with the HVAC Water Treatment Providers recommendations.

B. Coordinate with the Mechanical Contractor the configuration of the temporary chemical feed equipment for the chemical cleaning and passivation.

C. All chemicals shall be introduced to the system through a temporary bypass feeder as required by testing.

D. Coordinate with the Mechanical Contractor any temporary power requirements.

E. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Provide general-duty butterfly or ball valves are specified in Section 230523. Provide threaded connection on the inlet and outlet with caps

F. The temporary system shall be operational, filled, started and vented prior to cleaning.

G. Mechanical Contractor shall coordinate with the University's representative and the University's existing HVAC Water-Treatment Service Provider to schedule the water treatment and final fill requirements.

3.4 CONNECTIONS

A. Where installing piping adjacent to piping equipment, allow space for access to safely operate the system during the initial clean and passivation.

B. Provide piping connections and shut-off valves between HVAC water-treatment equipment and the piping to allow for the circulation of the water treatment at minimum of 5 FPS velocities.

C. Provide backflow preventers as required for makeup-water connections to potable-water systems.

3.5 CLEANING SEQUENCE

A. Circulating Water Applications

1. Isolate existing piping from new piping so as to circulate solution in the newly installed pipe system ONLY.
2. Contractor shall provide valves and piping as necessary to bypass the existing heating hot water systems.
3. Circulate Ferroquest FQ7103 1% solution throughout the system for 72 hours and drain as quickly as possible.
4. Refill with Ferroquest FQ7103 1% solution recirculate for 24 hours and drain as quickly as possible.
5. Refill with clean water, circulate, drain and repeat until system cleaner is removed.
6. Fill with clean water and add CWT-Metal Passivator, one (1) quart to 1000 gallons of water and circulate for 2 to 4 hours hours.
7. Immediately add the Inhibitor provided by the University's HVAC Water Treatment Provider

B. Dry Hand Swab Method for Short Runs inside Mechanical Manholes

1. Contractor shall provide valves and piping as necessary to isolate the piping from the rest of the system.
2. Isolate new piping from the existing piping.
3. Pre-clean all surfaces by hand with Simple Green Extreme at a ratio of 1 gallon of Simple Green Extreme to 10 Gallons of water and a rag or mop. Thoroughly wipe down all surfaces.
4. Allow surfaces to dry completely.
5. Use a Hudson Sprayer and a rag or mop to thoroughly, completely and evenly cover all metal surfaces with fully concentrated CWT-Metal Passivator.
6. Allow surfaces to dry completely.
7. Install piping and connect (open) piping to the rest of the system and add inhibitor

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections

1. Inspect field-assembled components and equipment installation, including piping and electrical connections.

2. Inspect piping and equipment to determine that systems and equipment are fully operational before introducing chemicals for water-treatment system.

C. Equipment will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 232513

SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Remove surface debris.

B. Remove paving, curbs, foundations and surface improvements.

C. Clear site of plant life and grass.

D. Remove trees and shrubs.

E. Remove root system of trees and shrubs.

F. Temporary Erosion and Sedimentation Control

1.2 REGULATORY REQUIREMENTS

A. Conform to applicable codes for disposal of debris. Burning debris on site not permitted.

B. Coordinate clearing work with utility companies and Campus Facilities. Existing utility mark-out shall be performed by a utility locating service and Campus Dig Permit.

C. Prior to commencement, Contractor shall provide Campus Facilities and Fire Marshall access and construction phasing plan for approval. Access to buildings shall be maintained at all times.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify that existing plant life and features designated to remain are tagged or identified.

B. Contractor shall be responsible for the preparation, approval, and implementation of the project Erosion Control Measures. The Erosion Control Measures shall comply with the current requirements of the State and Regional Water Quality Control Boards and all laws and ordinances regarding site construction. Contractor shall comply with all best management practices (BMP) to control and eliminate discharge of contaminated stormwater from the site. Contractor shall be responsible for the implementation of the all Erosion Control.

3.2 PROTECTION

A. Protect utilities that are designated to remain from damage.

B. Protect trees, plant growth and features designated to remain as final landscaping.

C. Protect bench marks and designated existing structures from damage or displacement.

D. Erect barricades in accordance with Title 8, Subchapter 4, Construction Safety Orders, and California Code of Regulations.

E. Protect existing items not indicated to be altered.

3.3 CLEARING

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

B. Remove paving, curbs, foundations and surface improvements. Patch and repair surfaces not indicated to be removed.

C. Remove trees and shrubs indicated. Remove stumps, main root ball, root system to full depth.

D. Clear undergrowth, grass and deadwood. Protect plant material not scheduled for removal.

E. Keep site free of dust by sprinkling with water. Maintain adequate water trucks, hoses and water supply.

F. Construction site shall be kept clear and free of debris at all times.

3.4 REMOVAL

A. Remove debris, rock and extracted plant life from site as work progresses. Dispose legally.

B. Burial of removed materials not permitted.

C. Use of Owner's disposal system not permitted. Do not use disposal system belonging to any other property Owner. All disposals must be made in accordance with local governing agencies and in a legal manner.

D. Loose fill material, buried trash, abandoned underground structures or deleterious materials of any kind encountered shall be identified and removed to expose natural earth.

END OF SECTION 311000

SECTION 311723 – PAVEMENT MARKING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Parking-stall line and curb painting.

B. Traffic symbols, directional arrows, lettering and safety zones, loading zone.

C. Accessibility signage.

D. Fire lane markings.

E. Paint for Traffic Striping.

F. Raised Pavement Markers.

1.2 REFERENCES

A. AQMD - Air Quality Management District.

B. Fed. STD 595B - Colors Listed in Government Procurement.

C. CACRM - California Access Compliance Reference Manual, updated based on 2007 California Building Code.

D. MUTCD - Department of Transportation, Manual for Uniform Traffic Control Devices.

E. CSS - Caltrans Standard Specifications, Latest Edition.

F. [IR 11B-7 – Requirements for Accessible Parking Spaces.]

G. [California Fire Code 2007, Chapter 5 and Appendix D.]

H. CBC – California Building Code, Latest Edition – Sections 1129B.3 and 1129B.4

I. ADA – Americans with Disabilities Act

1.3 SUBMITTALS

A. Product data.

B. Shop drawing layout of complete parking lot, indicating stalls, dimensions, lettering, safety zones, directional arrows, widths of lines and colors.

1.4 QUALITY ASSURANCE

A. Product Manufacturer: Company specializing in manufacturing quality traffic line paint products with ten years experience.

B. Applicator: Company specializing in commercial pavement painting with five years experience.

C. Regulatory Requirements

1. Conform to Federal Regulations concerning lead content of paints.
2. Conform to AQMD, Local Regulations. Copy of regulation is on file at Engineer's office.

D. Field Samples

1. Provide field sample in form of one parking lot stall, illustrating coating color, width of stroke, thickness of application and dimensioning.
2. Locate where approved.
3. Accepted sample may remain as part of Work.
4. Do not proceed with pavement marking until sample markings has been approved.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver products to site in sealed and labeled containers.

B. Container labeling to include manufacturer's name, type of paint, brand name, brand code, coverage, surface preparation, drying time, cleanup, color designation and instructions for mixing and reducing.

C. Store paint materials at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, unless otherwise recommended by manufacturer.

1.6 REGULATORY REQUIREMENTS

A. Paint products shall produce a coated finish as slip resistant as surrounding pavement.

1.7 EXTRA STOCK

A. Provide one gallon unopened container of each color to Owner.

B. Label each container with color in addition to manufacturer's label.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products of following manufacturers form basis for design and quality intended.

1. Dunn-Edwards Corporation, Los Angeles, CA.
2. Frazee Paint and Wallcovering, Inc., Anaheim, CA.

B. Or equal as approved in accordance with Division 01, General Requirements for Substitutions.

2.2 MATERIALS

A. Traffic Line Paint: Waterbourne emulsion type, lead and chromate free, ready mixed, complying with Fed. Spec. TT-P-1952D drying time less than 45 minutes. Color as shown. Paint shall be in containers of at least 18 L (5 gallons). A certificate shall accompany each.

1. Dunn-Edwards: VIN-L-STRIPE TRAFFIC PAINT, VINYL EPOXY EMULSION, W801.
2. ICI Paints: Traffic Paint 4810, Fast Dry Acrylic.
3. Frazee: No. 506 TRAFFIC LINE PAINT.
4. Pervo Paint Company: Pervo Stripe 6000
5. Reflective Paint: rapid dry, per SSPWC Table 210-1.6.1(A) and 210-1.6.5. Reflective material: glass beads added to surface of final coat of paint prior to setting. Glass beads shall conform to Calif. State Specification 8010-004(type II), applied mechanically at 8 lbs of beads per gallon of paint, dispensed by device developed for the purpose. Option: for thermoplastic paint glass beads may be added to directly to the paint per 210-1.6.1 with additionally adding 1 pound of beads per gallon. Color: White, Yellow, or Black per Cal Trans. By Emedco Buffalo, NY, or equal.

B. Striping, pavement markings, and curb markings in accordance with Sections 210-1.6 and 310-5.6 SSPWC.

C. Raised Pavement Markers: In accordance with Caltrans Section 85, Type A-non-reflective white, Type AY-non-reflective yellow, Section 85-1.04A ceramic disks (Bott's Dots). Rectangular "Highway" Raised pavement markers, beveled edges, prismatic, dual reflective lenses, White and blue for fire hydrant location, 4" x 4" x 3/4". High-impact plastic, ASTM D788, Grade 8. Cal Trans Type D or G.

1. Hy-Viz, Lodi, NJ. Or equal.
2. Adhesive: Epoxy type, rapid set, CalTrans Sections 85-1.055, 95-2.04, ASTM C881, Type IV Grade, 3, Class B.

D. Substrate: Asphalt and/or Concrete.

2.3 COLORS

A. Accessible Stalls and Signage: Blue, conforming to No. 15090 Fed. Std 595C and California Building Code Section 11B-502.

B. Parking stalls, lettering, arrows, passenger loading zones and traffic signage: White.

1. Accessible Parking spaces: Border (perimeter) shall be blue, hatching shall be blue. Markings and lettering according to CBC Section 11B-502.

C. Stalls: Single line, 4 inches wide unless double lines are noted on drawings.

D. Fire Lanes: Red; paint curbs or paint 6 inch red strip if no curb. Paint 4-inch high stenciled white letters on curbs and strip indicating, "NO PARKING – FIRE LANE" at 30 feet on center.

E. Temporary Parking: Green painted curbs, with 4-inch high stenciled white letters, indicating, "Temporary Parking 20 Minutes", at designated stalls.

F. Loading and unloading access aisle shall be marked by a border painted blue. Within the blue border, hatched lines a maximum of 36" on center shall be painted a color contrasting with the parking surface, preferable blue or white. CBC Figures 11B-502.3.3 and 11B503.3.3.

PART 3 - EXECUTION

3.1 INSPECTION

A. Verify that surfaces are ready to receive Work as instructed by product manufacturer.

3.2 APPLICATION

A. Surfaces to be painted shall be clean and free of dust, dirt, grease, oil, water or other contaminates.

1. Existing lines to be removed shall be sandblasted clean.

B. Traffic paint shall not be applied until seal coat has been in place minimum of 10 days.

C. Apply material by machine spray, airless sprayer, roller or brush to provide a minimum thickness of 15 mils average. Precise edges required, no overspray allowed.

D. Perform Work in accordance with approved Shop Drawings. Conform to Section 310-5.6.8, SSPWC and CACRM [CAS/CAR.]

E. Mark parking spaces for disabled according to CBC Section 11B-502 and 11B-503.

F. Painted lines and markings on pavement shall be 4 inches minimum wide and blue in color equal to color No. 15090 per Federal Standard 595C.

G. Raised Pavement Markers: Install in accordance with Caltrans Section 85-1.06 with rapid set epoxy adhesive.

H. Paint Fire Lane lettering on curbs.

3.3 DEFECTIVE WORK

A. Remove any paint that demonstrates evidence of checking, cracking, peeling, and discoloration, lack of bonding or poor coverage. Misplaced lines shall be completely removed by paint remover or wet sandblasting per Section 310.5.6.3, SSPWC. Painting over misplaced lines will not be permitted.

END OF SECTION 311723

SECTION 312200 - EARTHWORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Earth preparation outside building areas.

1.2 REFERENCES

A. ASTM D 1557 Laboratory compaction characteristics of soil using modified effort.

B. Project Geotechnical report titled: “Geotechnical Engineering Investigation, Proposed Hot Water Distribution System, California State University, Northridge Campus, 18111 Nordhoff Street, Los Angeles, California”, prepared by Geotechnologies, Inc., dated January 5, 2015, File No. 20896.

1.3 SUBMITTALS

A. Compaction Report indicating requirements per ASTM D1556.

B. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earthwork operations. Submit to construction manager before earthwork begins.

1.4 GENERAL REQUIREMENTS

A. Existing Conditions: Contractor shall examine site of Work and verify existing conditions under which work will be performed, including subsurface conditions.

B. Drainage and Pumping: Maintain excavations and site free from water throughout work. Run surface water or seepage to sumps with float-switch controlled pumps. Pump to drainage system as approved by Engineer.

C. Protection: Provide and maintain protection to retain earthbanks and protect adjoining existing monuments, grades and structures from caving, sliding, erosions or other damage and suitable forms of protection against bodily injury or property damage.

D. Bulkheads and shoring shall conform to Occupational Safety and Health Act Construction Safety Orders, Title 8, Industrial Relations, California Code of Regulations.

E. Provide barricades and berms at top of slopes to prevent water from flowing over top.

F. Geotechnical Investigation Report has been prepared under direction of Owner. Geotechnical Investigation Report is hereby referenced as information for Work of this Section. Engineer assumes no responsibility for conclusions Contractor may draw from information provided. Contract Documents take precedence over recommendations that may be contained in the Investigation Report and Contractor must obtain approval for deviations from Contract Documents. Copy of Geotechnical Investigation Report is available at Engineer's office.

G. Borrow. Fill, backfill, aggregate base, and other soil materials obtained from off-site sources shall be sampled and tested in compliance with California EPA Department of Toxic Substances Control recommendations to prevent the importation of contaminated materials to the Site.

1. Testing Frequency

   a. For borrow up to 1,000-cu.yd, conduct 1 test for each 250-cu.yrds.
   b. For borrow between 1,001- and 5,000-cu.yd; conduct 4 tests for first 1,000-cu.yd, if material tests acceptable, conduct 1 test for each additional 500-cu.yrds.
   c. For borrow over 5,000-cu.yds, conduct 12 tests during import of first 5,000-cu.yd, if material tests acceptable, conduct 1 test for each additional 1,000-cu.yds.

2. Owner's Testing Laboratory shall take samples at source, conduct testing and evaluate test results prior to delivery.
3. Conduct tests for lead and other heavy metals, asbestos, PCB's, pesticides, herbicides, VOCs, and semi-VOCs.
4. When detectable quantities of hazardous materials are found, determine the risk to human health, the environment, or both using the DTSC Preliminary Endangerment Assessment Guidance Manual.
5. Do not import soils that exhibit a known risk to human health, the environment, or both.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Excavated material, Imported Fill and Backfill: As specified in Section 31 23 23 and as approved by Geotechnical Engineer prior to placement on site.

PART 3 - EXECUTION

3.1 PRE-CONSTRUCTION INSPECTION

A. Inspection of Site: Inspect entire site prior to commencing work and determine character of materials to be encountered and all conditions affecting Work.

B. Existing Site Conditions: Verify location of existing underground structures and facilities (if any) and take adequate precautions to avoid damage to any active service or structure. Contractor shall locate existing utilities with a utility locating service and Campus Dig Permit. Existing utilities shall be staked, flagged, and recorded.

C. Repair or replace property damaged by Work of this Section immediately.

D. Piping and conduit encountered shall be adequately supported and protected until permanent support is provided or removal of same is approved by Engineer.

E. Existing Utilities: After approval of Engineer, totally remove abandoned pipes and utilities found in excavations. Cap or plug at both ends all abandoned utility piping, conduit and lines encountered to provide a complete seal. Provide plugs or seals of concrete or threaded caps unless otherwise approved.

F. Support and protect existing pipes and conduits where required during construction.

G. Site Clearing: Conform to Section 31 10 00.

H. Loose fill and natural on-site soils that are approved by Geotechnical Engineer may be stock-piled and used as fill material.

I. After clearing and removal of loose fill, exposed surfaces shall be inspected and approved by Geotechnical Engineer prior to placing fill.

J. Backfilling: Conform to Section 31 23 23.

3.2 SITE PREPARATION

A. Not used.

B. Over-excavate and remove loose existing soils to depths required by the Geotechnical Investigation Report.

C. Scarify or blade mix exposed soil to depth of 6 inches below exposed grade.

D. Geotechnical Engineer shall inspect scarified areas.

E. After approval has been received from Geotechnical Engineer to proceed, bring soil mix to optimum moisture content and re-compact to 90 percent of maximum dry density per ASTM D 1557. Geotechnical Engineer shall test and approve results.

F. Bring grade to subgrades indicated or to accommodate conditions in 8 inches maximum loose lifts. Compact to 95 percent of maximum dry density per ASTM D1557.

G. No jetting or flooding permitted.

3.3 INSPECTION

A. Grading operations shall be inspected by Geotechnical Engineer. No fill shall be placed on any prepared surface until that surface has been inspected and approved by Geotechnical Engineer.

B. Completed earthwork including cuts, fills, and earth bank slopes (cut or fill) shall be inspected by Geotechnical Engineer to determine suitability of exposed soils.

3.4 SEASONAL LIMITS

A. No fill material shall be placed, spread or rolled while it is frozen or thawing or during unfavorable weather conditions. When Work is interrupted by heavy rain, fill operations shall not be resumed until field tests by Geotechnical Engineer indicate that moisture content and density of fill are as previously specified.

3.5 EXCAVATION FOR FOUNDATIONS

A. Conform to Section 31 23 15 and Geotechnical Report Recommendations.

3.6 EARTH BANK SLOPES

A. Earth banks shall be sloped to 2 (horizontal) to 1 (vertical). Tops of banks shall be bermed to prevent surfaces water from running off over cut banks. Tops of earth banks shall be level to distance of 5 feet minimum from existing structures and 5 feet minimum behind construction barricades adjacent to driveways.

3.7 TOLERANCES

A. Perform rough grading to grades indicated, plus or minus 0.1 foot. Where grades are not indicated, grade uniformly level or slope between points for which elevations are given or from such points to existing grades with due allowance for adequate drainage and subsequent materials.

B. Grading at Asphaltic Concrete Areas: Rough grade soil to elevation to conform to specified depth of base and pavement.

C. Place necessary fill to bring sub-grade to proper elevations. Fill shall be placed as Compacted Fill.

3.8 TRENCHING FOR UTILITIES

A. Conform to Section 31 23 17.

3.9 STOCKPILING OF FILL MATERIAL

A. Fill: Soil removed that is suitable for fill shall be stockpiled separately on site.

B. Stockpile Locations: Materials shall not be stockpiled unless approved by Campus Facilities.

3.10 FIELD QUALITY CONTROL

A. Testing and Inspection: Owner will engage a qualified independent Geotechnical Engineer Testing Laboratory to perform field quality-control testing and inspections. Do not proceed with concrete placement without approval of Geotechnical Engineer Testing Laboratory.

B. Testing agency will test compaction of soils in place according to ASTM D1556, and ASTM D2937 as applicable. Tests will be performed at the following locations and frequencies:

1. Paved Areas: At sub-grade and at each compacted fill and backfill layer, at least 1 test for every 2000 sq. ft. or less of paved area, but in no case fewer than 3 tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least 1 test for each 100 feet or less of wall length, but no fewer than 2 tests.

C. Frequency of Tests: Geotechnical Engineer Testing Laboratory may make as many tests as are necessary to ensure specified results.

D. When testing agency reports that sub-grades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; re-compact and retest until specified compaction is obtained.

3.11 DISPOSAL OF EXCESS MATERIAL

A. Legally dispose off excess materials. Disposal shall be in areas off Owner's property, unless otherwise approved by Engineer.

END OF SECTION 312200

SECTION 312317 - TRENCHING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Excavate trenches for utilities.

B. Compacted bedding.

C. Backfilling and compaction to required elevations.

D. Slurry concrete.

E. Thrust Blocks.

1.2 REFERENCES

A. ASTM C150 - Portland Cement.

B. ASTM C494 - Chemical Admixtures for Concrete.

C. ASTM D1557 - Laboratory compaction characteristics of soil using modified effort.

D. California Code of Regulations, Title 8, Industrial Relations, Construction Safety Orders, Division 01, Chapter 4, Sub-Chapter 4, Article 6 Excavations.

E. California Public Contract Code, Section 7104 - Public Works Contracts for Digging Trenches or Excavations; Notice on Discovery of Hazardous Waste or Other Unusual Conditions; Investigations; Change Orders; Effect on Contract.

F. California Labor Code, Section 6705 - Public Works Contracts requiring detailed plans for shoring, bracing, sloping, indicating protection from caving ground for trenching work in excess of 5’ deep and contract amounts stipulated therein.

G. City of Los Angeles Standards (Current Edition)

1.3 QUALITY ASSURANCE

A. Verify survey benchmark and intended elevations for Work.

B. Borrow, Fill, backfill, aggregate base, and other soil materials obtained from off-site sources shall be sampled and tested in compliance with CA EPA Department of Toxic Substances Control recommendations to prevent the importation of contaminated materials to the Site.

1. Testing Frequency

a. For borrow up to 1,000-cu.yd, conduct 1 test for each 250-cu.yrds.

b. For borrow between 1,001- and 5,000-cu.yrd; conduct 4 tests for first 1,000- cu.yrd, if material tests acceptable, conduct 1 test for each additional 500-cu.yrds.
c. For borrow over 5,000-cu.yrds, conduct 12 tests during import of first 5,000-cu.yrd, if material tests acceptable, conduct 1 test for each additional 1,000-cu.yrds.

2. Owner's Testing Laboratory shall take samples at source, conduct testing and evaluate test results prior to delivery.
3. Conduct tests for lead and other heavy metals, asbestos, PCB's, pesticides, herbicides, VOCs, and semi-VOCs.
4. When detectable quantities of hazardous materials are found, determine the risk to human health, the environment, or both using the DTSC Preliminary Endangerment Assessment Guidance Manual.
5. Do not import soils that exhibit a known risk to human health, the environment, or both.

1.4 SOILS INFORMATION

A. Geotechnical Investigation has been prepared under direction of Owner. Investigation is hereby referenced as information for Work of this Section. Architect assumes no responsibility for conclusions Contractor may draw from information provided. The Contract Documents take precedence over recommendations that may be contained in the Investigation and the contractor must obtain approval for any and all deviations from the Contract Documents. Copy of investigation is available at Architect's office.

PART 2 - PRODUCTS

2.1 FILL AND BEDDING MATERIALS

A. Sand: Sand shall consist of natural or manufactured granular material, or a combination thereof, free of deleterious amounts of organic material, mica, loam, clay and other substances not suitable for the purpose intended. Conform to Subsection 200-1.5.5, SSPWC, for gradation as required for Portland Cement Concrete, sand must achieve compaction of a minimum 90 percent.

B. Imported Fill: Granular, free of debris, no gravel larger than 3 inches in any dimension, non-expansive, approved by the Geotechnical Engineer prior to placement on the site.

C. Slurry Concrete:

1. Slump: Between 4 inches and 6 inches.
2. Aggregate: 40 percent sand by weight, 60 percent pea gravel, minimum 1/4 inch, maximum 5/8 inch.
3. Portland Cement: ASTM C150, 2-sack mix (2 sacks of cement per cubic yard).
4. Admixture: Calcium Chloride free, in proportions not to exceed the manufacturer's recommendations.
5. Artificial Coloring: ASTM C494. Mix in Mapico Red pigment, proportions as recommended by the manufacturer, L.M. Scofield or equal.
6. Sufficient water shall be added to produce a fluid, workable mix that will flow and can be pumped without segregation of aggregate. Material shall be mechanically mixed until the cement and water are thoroughly dispersed.

D. Stockpiled Fill: Onsite soils, stored separately on the site, approved for re-use by the Geotechnical Engineer.

E. Thrust Blocks: Concrete per Section 32 13 13.

2.2 ACCESSORIES

A. Underground Warning Tape: Metallic Detection Tape, aluminum core, 6 inches wide AASHTO specification colors, by Safety Sign Company, Cleveland, OH, or equal.

B. Color Coding and Lettering: as required for type of underground utility.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify fill material to be reused is acceptable to the Geotechnical Engineer.

3.2 PREPARATION

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

B. Backfill with approved fill and compact to density equal to or greater than requirements for subsequent backfill material.

C. Prior to commencement of trenching operations, notify Underground Service Alert of Southern California (800) 422-4133, Monday through Friday, 7:00 A.M. to 5:00 P.M.

D. Prior to commencement of trenching operations, locate existing utilities with a utility locating service and Campus Dig Permit. Stake, Flag, and record locations.

3.3 EXCAVATION

A. Conform to Construction Safety Orders, Title 8, CCR, For Sloping, Benching, Shoring, Bracing, Protective Systems, and Shafts.

B. Conform to Section 7104, Public Contract Code. Promptly notify Owner of any contact with hazardous materials or differing conditions.

C. Conform to Section 6705, Labor Code. Provide shoring and bracing plan or other provisions intended to prevent caving ground.

D. Excavate subsoil required for utilities. Trenches shall be level or parallel to finish grade unless designated on drawings to be installed to specific gradient.

E. Cut trenches sufficiently wide to enable installation of utilities and allow inspection.

F. Water, storm drainage piping located in the same trench shall be separated by 12 inches horizontally and vertically, and water line shall be placed on a solid shelf excavated on one side of the common trench. Cross-over water lines shall also be separated 12 inches vertically from storm drainage pipe. Unless otherwise indicated on Drawings.

G. Water and sewer piping shall not be located in the same trench and they shall be separated by 10 feet horizontally and 12 inches vertically. Unless otherwise indicated on Drawings.

H. Hydronic and Steam Piping separations shall be provided by mechanical engineer.

I. Excavation shall not interfere with normal 45 degree bearing splay of foundations. Parallel trenches, no closer than 18 inches from building foundations. Protect all existing structures.

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

K. Remove lumped subsoil, boulders and rock.

L. Correct unauthorized excavation.

M. Stockpile approved excavated material within approved and designated work area on-site and remove excess material not being used from site. Stockpiling of materials on-site is not permissible unless authorized by Campus.

3.4 BEDDING

A. Support pipe and conduit during placement and compaction of bedding fill. Provide uniform bearing along entire length. Conform to Section 306, SSPWC.

B. Bedding: Place and compact materials in continuous layers not exceeding 6 inches compacted depth, ASTM D1557.

3.5 BACKFILLING

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

B. Fill areas will be inspected, tested and approved by Geotechnical Engineer.

C. Soil Fill over Bedding: Place and compact material in continuous layers as scheduled, compacted to ASTM D1557.

D. Employ placement method that does not disturb or damage conduit, ducts or piping in trench.

E. Maintain optimum moisture content of backfill materials to attain required compaction density. When operations are interrupted by rain, do not resume Work until field tests indicate that moisture content and density of fill are as previously specified.

F. Remove surplus backfill materials from site and dispose legally.

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

H. Minimum Cover Over Piping, Conduits or Duct Banks: 36 inches unless otherwise noted.

I. Lay out and install or otherwise confirm invert elevations of all gravity flow systems to avoid conflict with other sub-surface structures or utilities of any kind. Adjust elevations or layout of pipes, conduits or duct banks to permit the required gravity flow.

J. Jetting for utility trenching compaction may be used outside building perimeter and only when recommended by Geotechnical Engineer, in accordance with Section 306 SSPWC.

K. Pressurized piping shall be installed level, or shall be installed parallel to finish grades unless designated on the Drawings to be installed to specific gradients.

L. All utilities shall be recorded on contractor as-built drawings and surveyed.

3.6 THRUST BLOCKS

A. Install at turns of water lines and as indicated in drawings and required by governing agencies.

3.7 TOLERANCES

A. Top Surface of Backfilling Under Paved Areas: 0.2 ft from required elevations.

B. Top Surface of General Backfilling: Plus or minus 0.2 ft from required elevations.

3.8 FIELD QUALITY CONTROL

A. Backfill materials and operations will be inspected and approved by Geotechnical Engineer including earth bank slopes (cut or fill).

B. Tests, analysis and compaction of fill material will be performed in accordance with ASTM D1557.

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

D. Frequency of Tests: Geotechnical Engineer may make as many tests as are necessary to ensure specified results.

3.9 PROTECTION OF FINISHED WORK

A. Protect finished Work.

B. Recompact fills subjected to vehicular traffic.

3.10 TEMPORARY PROTECTION OF UNFINISHED WORK

A. Trenching for placement of underground utilities shall be covered and protected with steel trench plates during non-work hours and during school session hours. Steel trench plate requirements shall meet current agency, state and local governmental regulations, OSHA requirements, and meet HS 20-44 loading. Adequate warnings and protection indication of open trenches during work hours must be provided for project safety. All trenching surfaces shall be “non-skid”. ADA access shall be maintained at all times. Work areas impacting ADA path of travel shall be coordinated with Campus staff and work plans approved including signage.

3.11 SCHEDULE

A. Storm and Sanitary Piping:

1. Bedding Fill: Sand, minimum thickness below piping 0.4 times outside diameter of pipe but no less than 4 inches. Minimum thickness above top of piping, 12 inches, compacted to 95 percent.
2. Cover with stockpiled fill in 8-inch lifts to specified subgrade elevations, compact to 90 percent or to 95 percent under vehicle traffic-supporting paved areas.
3. Fill: Slurry concrete, 6” cover at top, bottom and sides of pipes at exterior paved areas (at vehicle traffic) where minimum fill cover is less than 12” below finished elevation of paving.

4. Bury warning tape marked “Caution Sewer Line” or “Caution Storm Drain Line” 12 inches above all concrete-encased piping. Align tape parallel to and within 3 inches of the centerline of the piping.

B. Power Ducts: Concrete Encased

1. Fill: Slurry concrete, 3 inches cover at top, bottom, between conduits and sides of duct bank.
2. Fill: Slurry concrete, 6 inches cover at top, bottom and sides of duct bank conduit at exterior paved areas where minimum fill cover is less than 24” below finished elevation of paving, less than 12” below finished elevations of interior floor slabs and at building footings where conduit is in the footing structural splay.
3. Install two No. 4 bars in slurry concrete at top of bank under paved areas, minimum 3 inch concrete cover.
4. Cover with stockpiled fill in 6-inch lifts to specified subgrade elevation, compact to 90 percent, or to 95 percent under traffic-supporting paved areas.
5. Bury warning tape marked “Caution Buried High Voltage Line” 12 inches above all concrete-encased duct banks. Align tape parallel to and within 3 inches of the centerline of the duct bank.

C. Water Piping and Gas Piping:

1. Bedding Fill: Sand, minimum thickness below piping 0.4 times outside diameter of pipe but not less than 4”. Minimum thickness above top of piping, 6 inches, compacted to 90 percent.
2. Fill: Slurry concrete, 6 inches cover at top, bottom and sides of pipes at exterior paved areas where minimum fill cover is less than 24” below finished elevation of paving, and less than 12” below finished elevations of interior floor slabs and at building footings where piping is in the footing structural splay.
3. Cover with stockpiled fill in 6-inch lifts to specified subgrade elevation, compact to 90 percent, or 95 percent under traffic-supporting paved areas.
4. Observe joints at pressure tests.
5. Bury warning tape marked “Caution Buried Gas (or “Pipeline”) Line” 12 inches above all trenching. Align tape parallel to and within 3 inches of the centerline of trench.

D. Fire Lines:

1. Bedding Fill: Manufactured Sand, minimum 6” thickness under piping, minimum thickness above top of piping and sides, 6”, compact to 90 percent.
2. Fill: Slurry concrete, 6” cover at top pipes at exterior paved areas where minimum fill cover is less than 24” below finished elevation of paving.
3. Cover with stockpiled fill in 6-inch lifts to specified subgrade elevation, compact to 90 percent, or 95 percent under traffic-supporting paved areas.
4. Bury warning tape marked “Caution Buried Pipeline” 12 inches above all trenching. Align tape parallel to and within 3 inches of the centerline of trench.

E. Low Voltage Conduits and Communications: Direct Burial Minimum trench depth 36 inches.

1. Bedding Fill: Sand, 6 inches at bottom, sides and 12 inches on top, compacted to 95 percent.
2. Cover with stockpiled fill in 6-inch lifts to specified subgrade elevation, compact to 90 percent, or 95 percent under traffic-supporting paved areas.
3. Bury warning tape marked “Caution Buried Communication Line Below” 12 inches above conduits. Align tape parallel to and within 3 inches of the centerline of conduits.

END OF SECTION 312317

SECTION 312323 - BACKFILLING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Authorized types of fill.

B. Building area backfilling to subgrade elevations.

1.2 REFERENCES

A. ASTM D1557 - Laboratory compaction characteristics of soil using modified effort.

B. Chapter 18A and 33, California Building Code.

C. CSS - Caltrans Standard Specifications, Latest Edition.

D. CA EPA Department of Toxic Substances Control.

E. DTSC Preliminary Endangerment Assessment Guidance Manual.

F. CBC - California Building Code

G. Standard Drawings for Public Works Construction – City of Los Angeles, Latest Edition.

1.3 SUBMITTALS

A. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:

1. Classification according to ASTM D 2487 of each on-site and borrow soil material proposed for fill and backfill.
2. Laboratory compaction curve according to ASTM D 1557 for each on-site and borrow soil material proposed for fill and backfill.

B. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins.

1.4 QUALITY ASSURANCE

A. Borrow, Fill, backfill, aggregate base, and other soil materials obtained from off-site sources shall be sampled and tested in compliance with CA EPA Department of Toxic Substances Control recommendations to prevent the importation of contaminated materials to the Site.

1. Testing Frequency

a. For borrow up to 1,000-cu.yrd, conduct 1 test for each 250-cu.yrds.
b. For borrow between 1,001- and 5,000-cu.yrd; conduct 4 tests for first 1,000- cu.yrd, if material tests acceptable, conduct 1 test for each additional 500-cu.yrds.
c. For borrow over 5,000-cu.yrds, conduct 12 tests during import of first 5,000-cu.yrd, if material tests acceptable, conduct 1 test for each additional 1,000-cu.yrds.

2. Owner's Testing Laboratory shall take samples at source, conduct testing and evaluate test results prior to delivery.
3. Conduct tests for lead and other heavy metals, asbestos, PCB's, pesticides, herbicides, VOCs, and semi-VOCs.
4. When detectable quantities of hazardous materials are found, determine the risk to human health, the environment, or both using the DTSC Preliminary Endangerment Assessment Guidance Manual.
5. Do not import soils that exhibit a known risk to human health, the environment, or both.

PART 2 - PRODUCTS

2.1 FILL MATERIALS

A. This Section establishes standards of quality for backfill materials to be used as approved by Geotechnical Engineer in accordance with Chapter 18A CBC, Section 1803A.2 and Appendix J Section J107, California Building Code, and as scheduled in other Sections of this specification.

B. Crushed Rock and Rock Dust: Crushed rock and rock dust shall be product of crushing rock or gravel. Portion of material that is retained on a 3/8 inch sieve shall contain at least 50 percent of particles having three or more fractured faces. Not over 5 percent shall be pieces that show no such faces resulting from crushing. Of that portion which passes 3/8 inch sieve but is retained on No. 4 sieve, not more than 10 percent shall be gravel particles. Crushed rock shall conform to 3/4 inch sieve size in accordance with Subsection 200-1.2, SSPWC, and Crushed Rock Gradation Table.

C. Pea Gravel: Natural stone; washed, free of clay, shale, organic matter; graded to the following:

1. Minimum Size: 1/4 inch.
2. Maximum Size: 5/8 inch.

D. Sand: Sand shall consist of manufactured granular material, or combination thereof, free of deleterious amounts of organic material, mica, loam, clay and other substances not suitable for purpose intended. Conform to Section 200-1.5.5, SSPWC, for gradation as required for Portland Cement Concrete, sand must achieve compaction of a minimum 90 percent.

E. Crushed Aggregate Base: As specified in Section 32 12 16. Crushed rock and rock dust conforming to requirements of Section 200-1.2, SSPWC, with 3/8 inch sieve requirement waived, or Class 2 aggregate base as defined in Section 26, CSS.

F. Imported Fill: Clean granular, free of debris, no rock larger than 3 inches in any dimension, non-expansive, approved by Geotechnical Engineer prior to placement on site.

G. Concrete: Structural, as specified in Section 32 13 13.

H. Concrete Slurry: as specified in Section 31 23 17.

I. Stockpiled Fill: On-site soils, stored separately on site, approved for re-use by Geotechnical Engineer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify fill materials to be reused or imported are acceptable to Geotechnical Engineer.

B. Verify foundation perimeter drainage installation has been inspected and approved.

3.2 BACKFILLING

A. Backfill and compact areas to contours and elevations with unfrozen materials. Remove debris from areas to receive backfills.

1. Compaction: ASTM D1557, Compact to 90 percent of maximum dry density.
2. Floor slabs shall be in place a minimum of 7 days before backfill is placed against walls.

B. Fill areas and types of fill shall be inspected, tested and approved by Testing Laboratory.

C. Employ placement method that does not disturb or damage foundation perimeter drainage, foundation waterproofing and protective cover or utilities in trenches. Do not commence backfill until such work is in place, inspected and approved.

D. Maintain optimum moisture content of backfill materials to attain required compaction density. When operations are interrupted by rain, do not resume work until field tests indicate that moisture content and density of the fill are as previously specified.

E. Slope grade away from building minimum 2 inches in 10 ft, unless noted otherwise.

F. Make grade changes gradual. Blend slope into level areas.

G. Remove surplus backfill materials from site.

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

I. Compaction Equipment: Wherever feasible, perform compaction with approved power-driven equipment such as rollers and sheeps-foot compactors. Compact areas inaccessible to rollers with pneumatic tampers or other approved compactors.

J. Flooding and jetting is not permitted.

3.3 TOLERANCES

A. Top Surface of Backfilling Subgrade: Within 0.05 feet from required elevations.

3.4 FIELD QUALITY CONTROL

A. No fill shall be placed on any prepared surface until that surface has been inspected and approved by Geotechnical Engineer.

B. If tests indicate work does not meet specified requirements, remove work, replace and retest. Cost of retests shall be paid by Owner and deducted from contract sum by Change Order.

C. Frequency of Tests: Construction Manager and Geotechnical consultant may require as many tests as are necessary to ensure specified results.

3.5 PROTECTION OF FINISHED WORK

A. Protect finished Work.

B. Recompact fills subjected to and damaged by vehicular traffic.

END OF SECTION 312323

SECTION 321216 - ASPHALTIC CONCRETE PAVING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Asphaltic concrete paving and surface sealer.

B. Sub-base preparation.

C. Aggregate base course.

D. Concrete parking bumpers.

E. Related Section

1. Section 32 17 23, Pavement Marking.

F. Slurry sealing.

G. Patching and Repair of asphaltic concrete paving.

1.2 REFERENCES

A. ASTM D1557 - Laboratory compaction characteristics of soil using modified effort.

B. AQMD Air Quality Management District, Local Regulations, Cutback Asphalt.

C. SCAQMD – South Coast Air Quality Management District

1. SCAQMD-1108 – SCAQMD Rule 1108, Cutback Asphalt

D. CSS - Caltrans Standard Specifications, Latest Edition.

E. ASTM D2026 - Standard Specification for Cutback Asphalt

F. ASTM D2397 - Standard Specification for Cationic Emulsified Asphalt.

G. ASTM D977 - Standard Specification for Emulsified Asphalt.

H. ISSA - International Slurry Seal Association – Recommended Performance Guidelines for Emulsified Asphalt Slurry Seal, A105.

I. ASTM D3910 - Design, Testing, and Construction of Slurry Seal.

J. AASHTO - American Association of State Highways and Transportation Officials, AASHTO MP 1 – Performance Graded Asphalt Binders.

1.3 QUALITY ASSURANCE

A. Perform Work in accordance with Sections 200, 203 and 302, SSPWC.

B. Obtain materials from same source throughout, using batch plant method for proportioning and mixing.

1.4 SUBMITTALS

A. Product Data: mix design per Section 01 33 00 Submittals Procedures.

1.5 ENVIRONMENTAL REQUIREMENTS

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

B. Conform to AQMD, Local Regulations.

1.6 SOILS INFORMATION

A. Geotechnical Investigation has been prepared under direction of Owner. Investigation is hereby referenced as information for Work of this Section. Engineer assumes no responsibility for conclusions Contractor may draw, from information provided. Contract Documents take precedence over recommendations that may be contained in investigation and Contractor must obtain approval for deviations from Contract Documents. Copy of investigation is available at Engineer's office.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Acceptance at site.

B. Deliver pavement marking materials to project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

C. Store pavement markings materials is a clean dry protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Asphalt Binder: SSPWC 203-1 or AASHTO MP1, Performance Grade 64-10 South and Central Coast, Inland Valleys regions Grade 70-10 Desert regions, and shall conform to the testing requirements of Table 203-1.2 (B), Section 203 SSPWC.

B. Asphalt Aggregate: Uniformly graded in accordance with Section 203-6.4, SSPWC.

C. Crushed Aggregate Base (CAB): 3/4 inch maximum grading, crushed rock and rock dust conforming to requirements of Section 200-1.2, SSPWC, with 3/8 inch sieve requirement waived, or Class 2 Aggregate Base as defined in Section 26, CSS.

2.2 ACCESSORIES

A. Primer: ASTM D2026, cutback type, slow curing, Grade SC 250. Grade SC-70 may be used when approved by Engineer.

B. Tack Coat: ASTM D977, slow setting emulsified asphalt SS-1h. ASTM D2397 for CQS-1H, slurry Seal.

C. Seal Coat: Conform to Section 203-9, SSPWC.

1. GUARDTOP by Industrial Asphalt/Vulcan Material Co,, Inc., Irwindale, CA.
2. SATIN SEAL by Blue Diamond Co., Long Beach, CA.
3. Or equal, as approved in accordance with Division 01, General Requirements for Substitutions.

D. Parking Bumpers:

1. Precast concrete type, 2500 psi, bars No. 3 minimum size. Bars shall extend to within 1-1/2 inches of ends of bumpers. Minimum bumper size: 6 inches high, 8 inches wide, 5 feet long unless otherwise indicated on drawings.

E. Soil Sterilizer: Spike 80DF. Non-selective weed and grass killer, by Dow-AgroSciences, Indianapolis, IN, EPA Reg. No. 62719-107, or equal, as approved in accordance with Division 01, General Requirements for Substitutions.

1. Active Ingredients:

a.	Tebuthiuron	80 percent
b.	Inert Ingredients	20 percent
	Total:	100 percent

F. Headers: Foundation grade redwood, minimum 2 x 4 inch. Stakes shall be minimum 2 x 3 inch in accordance with Section 302-5.5 SSPWC.

G. Raised Pavement Markers: per Section 32 17 23.

2.3 ASPHALT PAVING MIX

A. Use dry material to avoid foaming. Mix uniformly.

B. Mix: Section 203-6.4 SSPWC, 1/2 inch maximum aggregate size, medium gradation curve, as required by outside temperatures at time of laying.

1. Single Course: C2 Dense Medium or D2 Dense Fine aggregate, Performance Grade 64-10 asphalt.

a. Areas where hand spreading is required: Use 3/8 inch mix.

PART 3 - EXECUTION

3.1 SUB-GRADE

A. Bring areas to be surfaced to required subgrades by cutting and filling with suitable equipment.

B. Scarify subgrade to minimum depth of 6 inches. Bring to optimum moisture content and compact to minimum 90 percent density in accordance with ASTM D1557 by rolling with power roller. Provide hard, even surface to receive subsequent base and paving.

C. Finish subgrade to required grades with allowance for compression and for thickness of base course and finish paving thickness.

3.2 SOIL STERILIZATION

A. After subgrade has been compacted and approved by Geotechnical Engineer, treat areas to be paved with specified soil sterilizer. Conform to following:

1. Apply 7.5 lbs. of solution per acre for each 15 gallons of water, spray apply per manufacturer's instructions.

B. Exercise caution during storage of material and during application. Prevent injury to humans, animal life, adjacent plant life and property. Keep soil sterilization materials minimum three feet from tree wells or any plant life.

C. Legally dispose of containers.

3.3 BASE COURSE

A. Place and compact aggregate base upon finished subgrade in conformance with Section 301-2 SSPWC. Compaction: 95 percent.

B. Thickness of Base After Compaction: As indicated on Drawings but not less than 6 inches if not indicated.

3.4 PREPARATION - PRIMER AND TACK COATS

A. Apply primer coat on base course surfaces in conformance with Section 302-5.3, SSPWC, at rate of 0.10 to 0.25 gallons per sq. yd. Allow to cure prior to application of asphalt course.

B. Apply tack coat to contact surfaces of cold joints, curbs, gutters, manholes and adjacent materials, and over existing asphalt surfaces in conformance with Section 302-5.4, SSPWC.

C. Coat surfaces of catch basin frames with oil to prevent bond with asphalt pavement. Do not tack coat these surfaces.

3.5 PLACING ASPHALT PAVEMENT - SINGLE COURSE

A. Install redwood headers.

B. Place asphalt in conformance with Section 302-5, SSPWC. Conform to temperature maximums and minimums specified therein. Materials shall not be applied which have cooled below lower limit allowable.

1. Install 3/8” mix for single course asphalt payment.

C. Place to thickness as indicated on drawings but not less than 2 inches if not indicated.

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

E. Compact pavement by rolling with equipment specified in Section 302-5.6, SSPWC. Do not displace or extrude pavement from position.

F. Develop rolling with consecutive passes to achieve even and smooth finish, without roller marks, rock pockets, ridges or depressions.

3.6 SEAL COAT

A. Apply seal coat 30 days or more after surface course application, in accordance with manufacturer's recommendations.

B. Apply seal coat to surface course in accordance with Section 302-8.2, SSPWC.

C. Add water to specified seal coat material. When air temperatures of 90 degrees F or more are encountered during application, consult manufacturer for recommendations.

D. If pavement surface exhibits imperfections noted Placing Asphalt Pavement above, as determined by the Engineer, the addition of sand aggregate to seal coat, and amounts thereof, shall be as recommended by the manufacturer.

E. A second application shall be made after first coat has dried to the touch. When sand is added to the first seal coat, two additional coats without extra sand shall be applied.

F. Allow seal coat to dry before permitting traffic or striping.

3.7 SLURRY SEALING

A. Prior to slurry application, repair areas and major depressions, wide cracks filled, remove dust, dirt and other foreign material from the surface.

B. Apply a tack coat of diluted emulsified asphalt of same type and grade specified for the slurry.

C. Apply slurry in accordance with ASTM D-3910, the Asphalt Institute Standards and the International Slurry Seal Association. Minimum thickness of 1/4”.

3.8 PARKING BUMPERS

A. Securely attach precast concrete parking bumpers into pavement with two 5/8 inch diameter galvanized solid rod anchors. Extend anchors 24 inches into ground. Apply adhesive to underside of concrete bumpers, as recommended by the manufacturer.

3.9 SPOT PATCHING AND REPAIRS

A. Patching: Saw cut perimeter of patch and excavate existing pavement section to sound base. Scarify and recompact the upper 12 inches of subgrade to 95% of maximum density. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically.

1. Tack coat faces of excavation and allow to cure before paving.
2. Fill excavation with dense-graded, hot-mix asphalt base mix and, while still hot, compact flush with adjacent surface.
3. Partially fill excavation with dense-graded, hot-mix asphalt base mix and compact while still hot. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

B. Pavement Painting

1. Allow seal coats to cure for ten days before applying paint.
2. Cleaning: Sweep and clean surface to eliminate loose material and dust.
3. Apply paint with mechanical equipment to produce uniform straight edges. Using painting equipment and templates specifically designed for this purpose. Protect adjoining work from damage.
4. Make lines 4" wide unless otherwise indicated.
5. Layout markings to exact requirements of Owner. Verify layout line widths, and colors prior to painting.

C. Field Quality Control

1. Before seal coating, flood the paved areas with water to check drainage and surface irregularities. Replace, or overlay high and low spots in an acceptable manner and water test the paving again after corrections have been made.
2. Replace or repair deficient and damaged asphalt paving.
3. All paving shall drain properly before being accepted. There shall be no variation greater than 1/4 inch plus or minus from a 10 foot straight-edge, except at grade changes.

3.10 TOLERANCES

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

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

C. Variation From True Elevation: Within 1/2 inch.

3.11 PROTECTION

A. Protect asphalt paving against vehicular traffic before and for 48 hours following seal coating.

END OF SECTION 321216

SECTION 321313 - **SITEWORK CONCRETE**

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Cast-In-Place concrete pedestrian paving and sidewalks.
2. Curbs and gutters.
3. Utility concrete pads.
4. Perimeter concrete curbing, mow strips, concrete drainage structures, swales.
5. Thrust Blocks.
6. Slurry Concrete.
7. Detectable Warnings

B. Related Sections:

1. Section 31 23 15 Site Earthwork and Building.

1.2 REFERENCES

A. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials.

B. ACI 318 - Building Code Requirements for Structural Concrete and Commentary, Latest Edition.

C. ACI 301 - Structural Concrete for Buildings.

D. ASTM - American Society for Testing and Materials

1. ASTM A185 - Steel Welded Wire Reinforcement, Plain, for Concrete
2. ASTM A615 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
3. ASTM C33 - Concrete Aggregates
4. ASTM C94 - Ready-Mixed Concrete
5. ASTM C150 - Portland Cement
6. ASTM C171 - Sheet Materials for Curing Concrete
7. ASTM C309 - Liquid Membrane-Forming Compounds for Curing Concrete
8. ASTM C920 - Elastomeric Joint Sealants
9. ASTM C1107 - Packaged Dry, Hydraulic - Cement Grout (Non-Shrink)
10. ASTM D1751 - Preformed Expansion Joint Fillers for Concrete, Paving and Structural Construction

1.3 SUBMITTALS

A. Placement Schedule for approval: Provide details or sketches showing location of each placement of concrete Work. Do not deviate from location of expansion joints or scorelines.

B. Product data on joint filler, sealants, curing compounds and reinforcing.

C. Project Record Documents

1. Accurately record actual locations of embedded sleeves, utilities and components that are concealed from view.

1.4 REGULATORY REQUIREMENTS

A. Pedestrian walks, plazas and paving shall comply with CBC 11B-302.1 and 11B-303.

1.5 QUALITY ASSURANCE

A. Maintain one copy of all records on site.

B. Acquire cement and aggregate from same source for all Work.

C. Conform to Section 1905A.13, California Building Code, when placing concrete during hot weather.

D. Conform to Section 1905A.12, California Building Code, when placing concrete during cold weather. No placement of concrete permitted below 50 degrees Fahrenheit.

1.6 EXTENDED WARRANTY

A. Manufacturer shall warrant prefabricated detectable warning texture products against failure in materials or workmanship for at least the specified warranty periods. Upon written notice from Owner manufacturer shall promptly, without cost, and with least practicable inconvenience to Owner correct such defects.

1. Failures include, but are not limited to, significant degradation in color fastness, conformation, sound-on-cane acoustic quality, resilience, and attachment will not degrade significantly.

a. Significant degradation means that product loses 10 percent or more of its approved design characteristics, as determined by the authority having jurisdiction.

2. Minimum Warranty Period: 5 years from date of Certified Completion.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

A. Cement: ASTM C150 - Type I - Normal or Type II - Moderate, Portland Cement type, from one manufacturing plant only.

B. Aggregates: ASTM C33, single source for all materials. Maximum size aggregate: 1 inch.

C. Non-Shrink Grout: ASTM C1107, premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 4,000 psi in 24 hours and 7,500 psi in 7 days unless otherwise indicated on Drawings; of consistency suitable for application and a 30 minute working time.

D. Crushed Aggregate Base: As specified in Section 32 12 16. Crushed rock and rock dust conforming to requirements of Section 200-1.2, SSPWC, with 3/8 inch sieve requirement waived, or Class 2 aggregate base as defined in Section 26, CSS.

2.2 ACCESSORIES

A. Expansion Joints:

1. Expansion Joint Filler - ASTM D1751: Closed cell, 1/2 inch max. thick; FIBER EXPANSION JOINT by American Highway Technology, Kankakee, IL, DECK-O-FOAM by W. R. Meadows, or approved equal.
2. Joint Devices: Integral extruded polystyrene plastic; 1/2 inch max. thick, with removable top strip exposing sealant trough; JOINT CAPS.
3. Sealant: Polyurethane two-component type, self-leveling, for level surface application, UREXPAN NR-200 or DYNATRED for sloped surfaces, manufactured by Pecora Corp., Harleysville PA, or equal. Color shall be selected by Engineer from manufacturer's standard list of colors.
4. Primer: As recommended by sealant manufacturer.
5. Joint Backing: ASTM C1330, Cylindrical, Type C, closed cell, polyethylene backer rod; oversized 30 to 50 percent larger than joint width. Green Rod by Nomaco Inc. or equal.

2.3 CONCRETE MIX

A. Mix and deliver concrete in accordance with Section 1905A, California Building Code. Deliver concrete in transit mixers only. Mix concrete for 10 minutes minimum at a peripheral drum speed of approximately 200 feet per minute. Mix at jobsite minimum 3 minutes. Discharge loads in less than 1-1/2 hours or under 300 revolutions of the drum, whichever comes first, after water is first added.

1. Design Mix:

   a. Concrete shall be minimum Class 520-A-2500 per section 201-1 of the SSPWC.

2. Do not exceed 0.50 water-cement ratio by weight for floor slabs and for other concrete.
3. Quantities of Materials: Weighmaster's records not required for sitework concrete.
4. Required Strength: Minimum Class 520-A-2,500 psi for site work concrete. Cross gutters shall be Class 520-A-3,250 psi per standards.

B. Slurry Concrete:

1. Slump: Between 4 inches and 6 inches.
2. Aggregate: 40 percent sand by weight, 60 percent pea gravel, minimum 1/4 inch, maximum 5/8 inch.
3. Portland Cement: ASTM C150, 2-sack mix (2 sacks of cement per cubic yard).
4. Sufficient water shall be added to produce a fluid, workable mix that will flow and can be pumped without segregation of aggregate. Material shall be mechanically mixed until the cement and water are thoroughly dispersed.

2.4 REINFORCEMENT

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

B. Welded Wire Reinforcement shall not be used.

C. Tie Wire: Annealed steel, minimum 16 gage size.

D. Dowels: ASTM A615; 60 ksi yield grade, plain steel, uncoated finish.

2.5 FORMS

A. Conform to Section 1906A.1 and 1906A.2, California Building Code.

B. Plywood Forms: APA - Medium density overlay, Group 1, Exterior, PS-1, for exposed surfaces. APA Plyform B-B, Class 1, Exterior, PS-1 for unexposed surfaces.

1. Use flexible or curved forms for curves with a radius 100 feet or less.

C. Lumber: Douglas Fir species, construction grade, Surfaced Lumber, with grade stamp clearly visible for smooth and straight exposed surface.

D. Form Release Agent; commercially formulated form-release agent that will not bond with, stain or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.6 CURING MATERIALS

A. Absorptive cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.

B. Polyethylene Film ASTM C171; 10 mil thick, clear, manufactured from virgin resin with no scrap or additives, manufactured by Burke-Edoco, Long Beach, CA, or equal as approved in accordance with Division 01, General Requirements for Substitutions.

C. Water: Potable and not detrimental to concrete.

D. Curing Compound: ASTM C309, Type 2, Class B; wax resin base, Burke Wax Emulsion White curing compound, by Burke-Edoko, Euclid Chemical Co. or equal as approved in accordance with Division 01, General Requirements for Substitutions. Curing materials and procedures for colored concrete in accordance with coloring material manufacturer's recommendations.

E. Curing Compound for Colored Concrete: ASTM C309, Type1, Class B; Water-base all resin curing compound-clear, by Burke-Edoco, Euclid Chemical Co. or equal. Curing materials and procedures for colored concrete in accordance with coloring material manufacturer's recommendations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify site conditions.

B. Verify requirements for concrete cover over reinforcement.

C. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely and will not cause hardship in placing concrete.

3.2 PREPARATION

A. Prepare previously placed concrete by cleaning with steel brush and applying bonding agent in accordance with manufacturer's instructions.

B. In locations where new concrete is doweled to existing Work, drill holes in existing concrete, insert steel dowels and pack solid with non-shrink grout.

3.3 PLACING CONCRETE (GENERAL)

A. Convey and deposit concrete in accordance with Section 1905A.9 and 1905A.10, California Building Code. Remove loose dirt from excavations.

B. Notify Job Inspector minimum 24 hours prior to commencement of operations.

C. Ensure reinforcement, inserts, embedded parts, formed joint fillers, joint devices and accessories are not disturbed during concrete placement.

D. Ensure sub-base or base materials have been compacted or otherwise treated.

1. Sub-base and base preparation per Section 31 23 15 Excavation and Section 31 23 23 for Backfilling.
2. Remove unsuitable soil, backfill with clean compactable soil or approve granular material to required elevations.
3. Scarify exposed natural sub-base to depth of 6 inches. Bring to optimum moisture content and re-compact to 90 percent in accordance with ASTM D 1557.
4. Add approved aggregated base to required elevation in 6 inch maximum lifts. Bring to optimum moisture content and compact to 90 percent in accordance with ASTM D1557.

E. Install joint fillers, primer and sealant in accordance with manufacturer's instructions.

F. Place concrete continuously between predetermined expansion joints.

1. Install expansion joints at vertical concrete walls at 24 feet on center unless noted otherwise on drawings.

G. Do not interrupt successive placement; do not permit cold joints to occur. Avoid segregation of materials. Perform tamping and vibrating so as to produce a dense, smooth application free of rock pockets and voids. Do not use vibrators to move concrete horizontally.

H. Do not allow concrete to fall free from any height which will cause materials to segregate. Maximum height of free fall permitted in any case: 5 feet.

I. Defective Installation: Repair and clean at Contractor's expense all concrete damaged or discolored during construction. Where concrete requires repair before acceptance, the repair shall be made by removing and replacing entire section between joints and not by refinishing the damaged portion.

J. Proper curing of concrete surfaces is the responsibility of the Contractor. Concrete failing to meet specified strength shall be removed and replaced.

3.4 ON-SITE CONCRETE SIDEWALKS, PEDESTRIAN PAVED AREAS AND RAMPS

A. Forms, Wood: Free from warp, with smooth and straight upper edges, surfaced one side, minimum thickness 1-1/2 inches adequate to resist springing or deflection from placing concrete.

B. Forms, Metal: Gage sufficient to provide rigidity and strength equivalent to wood.

C. Reinforcing Steel: # 4 bars, place bars at 12 inches on center each way for sidewalks and paved areas and #4 bars for edges unless otherwise indicated on Drawings.

D. Reinforcement: Provide welded steel wire fabric, 6 inches by 6 inches, No. 10 gage at middle of slab for sidewalks and ramps unless otherwise indicated on Drawings. Interrupt reinforcement at expansion joints.

E. Concrete Placement: Dampen subgrade to retain moisture in concrete mix. Tamp and spade to consolidate concrete for entire length of pour. Strike off upper surface to specified grades.

F. Isolation Joints: Locate at slabs abutting vertical concrete surfaces and as patterned on drawings. Install vertically, full depth of concrete with preformed joint filler recessed for plastic cap at 1/2 inch depth at top for sealant application.

1. Doweled Isolation Joints at Heavy Vehicle Driveways and Parking: At abutting building foundations; provide 1/2-inch diameter smooth steel dowels 14 inches long, one end of dowel lubricated and set in capped sleeve to allow for longitudinal movement, spaced at 24 inches on center maximum, 6 inches from edges.
2. Monolithic Curb and Gutter: No expansion joints required between gutter and curb face.

G. Expansion Joints: Locate maximum 24 feet centers and as patterned on drawings. Install vertically, full depth of concrete, install preformed joint filler recessed for plastic cap at 1/2 inch depth at top for sealant application.

1. Monolithic Curb and Gutter: No expansion joints required between gutter and curb face.

H. Contraction/Crack Control Joints: At 8 feet each way at concrete paved areas, and 5 feet at sidewalks, tool joint with 1/2 inch radius, depth 1/4 the thickness of slab but not less than 1 inch deep. Refer to drawings for required design patterns.

I. Curb Ramps: Flush to finished surfaces, 12" wide border. Grooves at 1/4" deep, 1/4" wide and at 3/4" on centers at 3 sides on level surface of the sidewalk. Provide patterns as indicated in drawings. Detectable Warnings at Curb Ramps per CBC 11B-406.5.12 and 11B-705.

1. Detectable warning (Truncated Domes) required at curb ramps less than 1:15 (6.7% slope), DSA IR 11B-3
2. Detectable Warnings (Truncated Domes) required at all Curb Ramps, American with Disabilities Act Standards for Accessibility Design Section 4.7.7.

a. Paver Tiles: Cast in place concrete tiles per manufacturer’s instructions and in accordance with CBC.
b. Form bottom edge flush and free of abrupt changes DSA IR 11B-2.

J. Finish:

J 1. Screed concrete to required grade, float to a smooth, flat, uniform surface. Edge all headers to 1/2 inch radius. Edge expansion joints to 1/4 inch radius. Steel trowel to hard surface.

2. Grades less than 6 percent:
After final troweling, apply a medium broom finish transverse to centerline or direction of traffic. Finish shall be at least as slip resistant as that described as a medium salted finish.

3. Grades exceeding 6 percent:
After final troweling, apply a heavy broom finish transverse to centerline or direction of traffic

4. Curb Ramps, Blended Transitions and Islands: Curb ramps shall be perpendicular, parallel or a combination of the two, per 11B·406.1.12" grooved patterns are no longer required to mark the top edge of curb ramps. Provide flush transitions at top and bottom grade breaks per 11B-406.5.6. Typically, curb ramps are required to have truncated domes per 11B-406.5.12.

K. Curing: Cure surfaces utilizing one of the following methods:

1. Spraying: Spray water over slab areas and maintain wet for 7 days, use burlap mats.
2. Spread polyethylene film over slab areas, lapping edges and sides, minimum 6 inches and sealing with pressure sensitive tape; cover with plywood or otherwise protect film from damage; maintain in place for 7 days.
3. Apply liquid curing compound at rate of 200 sf per gallon, using power sprayer equipped with agitator. Do not apply liquid curing compound to surfaces scheduled to receive paving units of any kind.

L. Remove expansion joint plastic caps. Prime both sides of joint and apply self-leveling sealant per Section 07 92 00. Provide smooth concave surface.

3.5 CURB AND GUTTER, PERIMETER CONCRETE CURBING, CONCRETE DRAINAGE STRUCTURES, SWALES

A. Subgrade Preparation: Subgrade material, base material and compaction requirements as approved by the Geotechnical Engineer.

B. Forms: Single face type required, cut to conform exactly with face batter and radius, sufficiently rigid to resist springing or deflection from concrete placement. Clean forms of all loose dirt, mortar or similar materials and apply a light coating of oil or other suitable material prior to concrete placement.

1. Slip Forms: Contractor's option upon approval of the Engineer.

C. Reinforcement: Refer to drawings for size and spacing. Interrupt reinforcement at expansion joints.

D. Concrete Placement: Dampen subgrade to retain moisture in concrete mix. Tamp and spade to consolidate concrete to entire length of pour. Strike off upper surface to specified grades. Cut drain pipes to conform to curb batter.

E. Expansion Joints: Locate joint filler at maximum 20 foot centers. Trim off excess filler material flush to finish surface. No sealant application required.

F. Control Joints: at 8 feet on center, tooled joints, 1/2 inch radius.

G. Finish: Apply thin layer of mortar of 1 part portland cement to 1-1/2 parts sand to exposed faces. Trowel to a smooth and even finish with a fine hair broom applied parallel with the line of the work. Round all edges to 1/2 inch radius. No Contractor identification permitted.

H. Curing: Cure surfaces utilizing one of the following methods:

1. Spraying: Spray water over curb and gutter and maintain wet for 7 days.
2. Spread polyethylene film over areas, lapping edges and sides, minimum 6 inches and sealing with pressure sensitive tape; cover with plywood or otherwise protect film from damage; maintain in place for 7 days.
3. Apply liquid-curing compound at rate of 200 sf per gallon, using power sprayer equipped with agitator.

3.6 CONCRETE THRUST BLOCKS

A. Refer drawings for locations.

B. Installed where the water main changes direction as at ells and tees and where the irrigation main terminates. Pressure tests shall not be made for a period of 36 hours following the completion of pouring of the thrust blocks. Concrete thrust blocks for supply mains shall be sized and placed in strict accordance with the pipe manufacturer's specifications and shall be of an adequate size and so placed as to take all thrust created by the maximum internal water pressure.

3.7 TOLERANCES

A. Construction tolerances shall not violate dimensions, grades, slopes required by CBC for accessibility requirements. Adjust work accordingly to comply with requirements.

B. Comply with tolerances of ACI 117 and as follows (tolerances may not exceed CBC maximum or minimum):

1. Maximum deviation of 1/8 inch in 10 feet. In no case shall cross fall exceed 2.0%.
2. Elevation: 1/4 inch (6 mm).
3. Thickness: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
4. Surface: Gap below 10-foot- (3-m-) long, unleveled straightedge not to exceed 1/8 inch (3 mm).
5. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch (25 mm).
6. Vertical Alignment of Tie Bars and Dowels: 1/4 inch (6 mm).
7. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2 inch (13 mm).
8. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches (6 mm per 300 mm).
9. Joint Spacing: 3 inches (75 mm).
10. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.
11. Joint Width: Plus 1/8 inch (3 mm), no minus.

END OF SECTION 321313

SECTION 321726 - DETECTABLE/TACTILE WARNING SURFACES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Special Conditions and Division 1 Specifications Section, apply to this Section.

1.2 DESCRIPTION

A. This Section specifies furnishing and installing precast concrete Detectable/Tactile Warning Surface Tiles set on concrete, where indicated.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's literature describing products, installation procedures and routine maintenance.

B. Samples for Verification Purposes: Submit two (2) tile samples minimum 12" x 12" of the kind proposed for use.

C. Shop drawings are required for products specified showing fabrication details, composite structural system, tile surface profile, sound on cane contact amplification feature, plans of tile placement including joints, and material to be used as well as outlining installation materials and procedure.

1.4 QUALITY ASSURANCE

A. Provide Cast in place detectable/tactile warning surface tiles and accessories as produced by a single manufacturer with a minimum of five (5) years experience in the manufacturing of Cast In Place Detectable/Tactile Warning Surface Tiles.

B. Installer's Qualifications: Engage an experienced Installer certified in writing by Cast in place detectable/tactile warning surface tile manufacturer as qualified for installation, who has successfully completed installations similar in material, design, and extent to that indicated for Project.

C. Americans with Disabilities Act (ADA): Provide Surface Applied Detectable/Tactile Warning Surface Tiles which comply with the detectable warnings on walking surfaces section of the Americans with Disabilities Act (Title III Regulations, 28 CFR Part 36 ADA Standards For Accessible Design, Appendix A, Section 4.29.2 Detectable Warnings On Walking Surfaces).

D. California Code of Regulations (CCR): Provide only approved DSAAC detectable warning products as provided in the California Code of Regulations (CCR) Title 24, Part 2, Section 205 definition of "Detectable Warning". CBC Section 11B-405 for "Ramps" and Section 11B-705 for "Detectable warnings and detectable directional texture".

E. Detectable warning surfaces shall comply with CBC Section 11B-705.1.

F. Detectable warning surfaces at transit boarding platform edges, bus stops, hazardous vehicular areas, reflecting pools, and track crossings shall be yellow and approximate FS 33538 of Federal Standard 595C. Detectable warning surfaces at other locations shall be either the aforementioned yellow or a color providing a 70 percent minimum visual contrast with that of adjacent walking surfaces. The material used to provide visual contrast shall be an integral part of the surface. CBC Section 11B-705.1.1.3.

G. Detectable warning surfaces shall differ from adjoining surfaces in resiliency or sound-on-cane contact. Such constraint shall not be required for detectable warning surfaces at curb ramps, islands, or cut-through medians. CBC Section 11B-705.1.1.4.

1.5 DELIVERY, STORAGE AND HANDLING

A. Cast in place detectable/tactile warning surface tiles shall be suitably packaged or crated to prevent damage in shipment or handling. Finished surfaces shall be protected by sturdy plastic wrappings to protect tile from concrete residue during installation and tile type shall be identified by part number.

B. Cast in place detectable/tactile warning surface tiles shall be delivered to location at building site for storage prior to installation.

1.6 SITE CONDITIONS

A. Environmental conditions and protection: Maintain minimum temperature of 40°F in spaces to receive Cast in place detectable/tactile warning surface tiles for at least 24 hours prior to installation, during installation, and for not less than 24 hours after installation.

B. The use of water for work, cleaning or dust control, etc. shall be contained and controlled and shall not be allowed to come into contact with the general public. Provide barricades or screens to protect the general public.

1.7 GUARANTEE

A. Cast in place detectable/tactile warning surface tiles shall be guaranteed in writing for a period of five (5) years from date of final completion. The guarantee includes defective work, breakage, deformation, fading and loosening of tiles, per DSA Bulletin 10/1/02, revised 04/9/08.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Precast concrete detectable/tactile warning surface tile shall be by Stepstone, Inc. or equal.

B. Pavers/tiles shall be precast concrete, consisting of Portland cement, aggregate, and color admixtures.

1. Portland Cement: ASTM C 150, Type III, high early strength.
2. Aggregate: ASTM C 33.

3. Color Admixture. By Davis Colors, or equal, as required to achieve color as selected.
4. Mortar that meets or exceeds ANSI A118.4 requirements when mixed with water or a latex admixture, and is designed for installation of large format tile.
5. Grout that meets or exceeds ANSI A118.7 when mixed with water or latex admixture.

C. Color: Yellow conforming to Federal Color No. 33538 per Federal Standard No. 595C, CBC Section 11B-705.1.1.3 and 11B-705.1.2, Item 8(a). Color shall be homogeneous. Unless otherwise indicated on Drawings, color shall match existing adjacent products.

D. Finishes: Walking surfaces of precast concrete paving units shall have minimum coefficient of friction of 0.60, wet and dry.

E. Weight: 22 pounds per square foot.

F. Precast concrete paving units shall have a minimum compressive strength of 5,000 psi.

G. Water absorption: Not more than 8.8 percent average, not more than 9.8 percent for any individual unit.

H. Resistance to Freeze-Thaw: Pavers shall resist 50 freeze thaw cycles in accordance with ASTM C1645 Standard test Method for Freeze-thaw and De-icing Salt Durability of Solid Concrete Interlocking Paving Units.

2.2 FABRICATION

A. Pavers shall be fabricated of cement conforming to ASTM C 150, Type III, aggregates conforming to ASTM C 33, and pigments for integrally colored concrete conforming to ASTM C979.

2.3 SOURCE QUALITY CONTROL

A. Concrete for precast concrete surface tile shall be tested frequently to assure that mixes provide units having not less than 5,000 psi compressive strength. At 28 days (average test strength not less than 4,500 psi).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine all surfaces.

B. Verify all dimensions of in-place and subsequent construction.

C. Notify the Owner in writing of conditions detrimental to the proper and timely completion of work.

D. Do not proceed with the work until unsatisfactory conditions have been corrected.

E. Installation of precast concrete pavers and associated construction constitutes acceptance of the adjacent and underlying construction.

3.2 INSTALLATION-GENERAL

A. Installation shall comply with requirements of applicable building codes and state and local jurisdictions.

B. Install precast concrete tiles in a thin-set mortar bed in accordance with the specifications defined in the CTMA Handbook for Concrete Tiles, available at www.concretile.org

1. Follow manufacturer's instructions for thin-set use.
2. 100% paver bonding coverage is recommended, with a minimum acceptable coverage of 95% for exterior installations or 80% for interior installations. Backbuttering is mandatory to obtain a minimum of 95% coverage.
3. Clean any mortar off the face of the pavers immediately. Never leave a 'cement haze' on the concrete paver's surface.

C. Provide for expansion and control joints as specified per TCA detail EJ-171-current year. Follow expansion and control joint materials manufacturer's instructions.

3.3 CLEANING

A. Clean exposed surfaces of precast concrete paving units. Use cleaners appropriate for precast concrete finishes and colors. Acid based cleaners will permanently alter finish and color.

3.4 SEALING

A. If precast concrete paving units are factory sealed, generally do not apply additional sealer. Verify with precast manufacturer and sealer manufacturer if it is desired to apply additional sealer. If precast concrete paving units are not sealed in the factory, sealer shall be applied.

3.5 COMPLETION

A. Protect precast concrete paving units from damage due to subsequent building operations.

B. After installation and before completion, inspect precast concrete paving units for construction damage and obtain new precast concrete paving units if required.

C. Immediately prior to final acceptance of project, clean precast concrete paving units.

END OF SECTION 321726

SECTION 329312 -TREE PRESERVATION AND PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1, of these specifications, apply to the work of this Section.

B. Related Sections include the following:

1. 31 10 00 Site Clearing
2. 32 13 13 Site Concrete Paving
3. 32 84 23 Lawns and Grasses
4. 32 93 16 Exterior Plants

1.2 SUMMARY OF WORK

A. The work of this section includes, but is not limited to the following:

1. Protection of existing trees.
2. Installation of protective fencing.

1.3 GENERAL REQUIREMENTS

A. Protection of existing trees shall be coordinated with all trades. Trees to be transplanted shall be removed and either stored on site or transplanted to their new locations prior to performing other work within that location.

B. Notify the landscape architect immediately in writing of conditions that delay or hinder the protection of trees prior to commencing work. Do not proceed with work until such conditions are corrected.

C. Upon award of contract, the Contractor shall submit the itemized bid cost of all work and materials specified herein.

1.4 SITE CONDITIONS

A. Utilities: Locate all underground utilities still in use and take proper precautions to avoid damage to such improvements. In the event of a conflict between such lines and plant locations, notify the University's Representative who shall arrange for appropriate action.

B. Verifications: Review on site grading conditions, including subgrade rubble conditions, verify the elevations, observe the conditions under which work is to be performed, and notify the University's Representative of unsatisfactory conditions. Proceeding with the work constitutes acceptance of existing or corrected conditions.

1.5 PROTECTION OF EXISTING PLANT MATERIALS

A. Prior to the start of work, the Contractor shall make himself familiar with all existing plant material which are to be preserved within the project limits and to take measures as described in the drawings and specifications.

B. Excavations close to existing trees and shrubs shall be done by hand. Exposed roots shall be protected with damp burlap. Roots one (1) inch and larger shall be painted with two (2) coats of Tree Seal, or equal (no known equal). All tree damage by the Contractor shall be repaired by a certified consulting arborist or other approved personnel, at no cost to the client.

C. Damage, death or permanent disfiguration to plant material resulting from Contractor's work, shall require the complete removal, including the roots. The Contractor shall replace the plant material with one of equal value at his own expense, or shall reimburse the district, the cost of said replacement. The Landscape Architect or certified consulting arborist shall be the sole judge of the condition of any plant material.

D. All plants to remain on-site shall be watered and irrigated as necessary during the entire construction contract.

E. All paving, headers, walls, utilities, fences, irrigation and mow edges shall be in place prior to the commencement of the planting operations.

F. Contractor shall review with the University's Representative all existing trees to be preserved and determine protection methods for each tree. Grading methods and extents of grading in and around tree(s) shall be reviewed per individual tree location.

1.6 SUBMITTALS

A. Submit samples and product literature, in accordance with Division 1 or the specification, for approval by University's Representative for the following:

1. Photographs of existing trees to be removed/ demolished and retained in place. See section 3.01.A, below.
2. Tree protection fencing and signs.
3. Plan at one-inch equals sixteen feet scale of tree protection fencing, with tree number, tree species, tree drip-line and trunk diameter; the protection areas shall dimensioned from hardscape edges and tree trunk.

1.7 GUARANTEES

A. Existing trees to remain shall be guaranteed to remain healthy and in a vigorous growing condition for a period of one (1) year after substantial completion.

PART 2 - PRODUCTS

2.1 PROTECTIVE FENCING

A. Fencing shall be of galvanized chain link fence with metallic-coated steel chain-link fence fabric of 0.120-inch- diameter wire, a minimum of 6' high, with 1.9-inch- diameter line posts; 2-3/8-inch-

diameter terminal and corner posts; 1-5/8-inch- diameter top rail; and 0.177-inch- diameter bottom tension wire; with tie wires, hog ring ties, and other accessories for a complete fence system. Fence enclosure shall not permit easy passage below fence.

B. Fencing shall be clearly marked or identified to remain and shall not be moved during construction.

2.2 TREE IDENTIFICATION

A. All trees to remain shall be clearly tagged to remain, by number, with water based paint or yellow tape.

PART 3 - EXECUTION

3.1 OBSERVATION BY CONTRACTOR

A. Prior to commencement of tree preservation work, contractor shall review trees. Contractor shall photograph existing conditions of trees which could be misconstrued as damaged resulting from work. File with the University's Representative prior to commencement of work.

B. Contractor shall walk through site with the University's Representative to discuss and clarify existing conditions, site limitations and concerns prior to construction. Contractor shall submit recommendations to University's Representative.

3.2 TREE PROTECTION

A. Tree Preservation Zone shall be from trunk out to drip line of the tree crown or as indicated in drawings. The tree preservation zone shall be protected by fencing as specified. Prohibit traffic from crossing over root zones of trees within tree preservation zones. Do not store any materials or allow any traffic, parking or people at any time within tree preservation zones other than for monitoring or maintaining the tree itself. Installation of protective fencing: Prior to the commencement of any other work at the site, specified protective fencing shall be installed by the Contractor in the staked location of construction limits as approved by the University's Representative. Signs prohibiting access within the fenced area shall be prominently displayed and affixed to the fencing. Signs shall clearly read "Tree Preservation Zone - NO ACCESS." Fencing shall be minimally at, preferably beyond the drip line of the tree. Fencing shall indicate the limit of construction activity, restricting the operation and movement of all equipment and vehicles, trampling, and other operations. Construction activities and operations shall be prohibited within fenced areas.

B. Excavation:

1. When excavation near a tree to be preserved must be carried out, damage shall be limited by root pruning. Roots shall be cleanly severed at the limit of excavation. The root pruning shall be completed before the installation of improvements, structures and grading is started.
2. No excavation shall take place within the tree preservation limits except under the supervision of the University's Representative.

C. Utilities: Buried utility locations shall be located out of root zones. In cases where utilities must cross root zones, tunnels shall be utilized in lieu of trenches. Tunneling within the preservation limit of a preserved tree shall be done under the supervision of a University's Representative.

D. Silt: Siltation control around trees to be preserved shall be accomplished through the installation of silt fencing or straw bales.

E. Physical damage:

1. Provide adequate barriers and undertake work in a manner that protects trees from damage by operations and equipment.
2. Do not operate equipment which generates toxic fumes or heat within 20' feet of the preservation limit of a protected tree.

F. Chemical Damage: Do not store materials and chemicals in tree protection zones.

G. Over- or Under-watering: Preserved trees shall be examined at regular intervals during site work and construction for water excess and deficiency.

H. Promptly repair trees damaged by construction operation in a manner acceptable to the University's Representative. Replace trees damaged beyond repair with the same species and of similar size or value, as determined by the University's Representative. Repair and replacement of trees damaged by the construction operations shall be at the Contractor's expense.

I. Construction limits: The Contractor shall clearly and accurately stake in the field the limits of demolition, clearing, grading, and site structures and features that affect tree preservation. After this procedure is completed, the University's Representative shall mark individual and groups of trees to be preserved. No other work at the site shall commence until tree preservation zones and measures are in place and approved by the University's Representative.

J. Silt Control within tree preservation zone. Silt fencing is the preferred method of siltation control.

1. Accumulations of silt greater than one (1) inch deep shall not be permitted. Silt accumulations shall be removed periodically by hand if allowed to accumulate.
2. Silt control measures shall be maintained and cleaned regularly of accumulated silt
3. Changes in work creating a need for additional silt fencing shall be identified by Contractor. The Contractor shall notify the University's Representative of the need for additional measures. The University's Representative shall approve all siltation control measures prior to installation.

3.3 DAMAGES AND PENALTIES

A. Damages to trees and loss of trees to be preserved by the Contractor resulting from the Contractor's negligence or any violation of the contract documents shall be assessed by the University's Representative on a case-by-case basis. Contractor penalties and required remedial actions are as follows:

1. Damages to tree(s): The University's Representative shall determine the damage to tree(s) and shall recommend remedial action. This action shall be undertaken at the Contractor's expense.
2. Loss of tree(s) and damages that result in loss of tree(s): The University's Representative shall determine whether damage to tree(s) will result in loss of tree(s). The Contractor shall

pay a penalty equal to the value of the tree(s) as determined in the tree appraisal undertaken by a qualified independent Certified Arborist.

3. Violation of contract documents: In the event that the Contractor violates the provision of the contract documents regarding tree preservation measures, the Contractor shall pay a fine in the amount of five hundred dollars ($500) for each violation.

3.4 CLEAN-UP, REPAIR AND MAINTENANCE

A. Upon completion of all work, remove tools, equipment and tree preservation materials and measures from site.

B. Repair all areas, structures, and surfaces damaged and requiring repair resulting from tree preservation measures. Repair adjacent construction or surfaces soiled or damaged by tree preservation measures at no expense to the University.

C. Provide post-construction tree maintenance measures for trees to remain for a period of 90 days from substantial completion.

END OF SECTION 329312

SECTION 329313- LAWNS AND GRASSES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Section Includes: Turf installation, seeding, turf establishment and minimum 90-days maintenance.

B. Related Sections

1. 01 56 39 Tree and Plant Protection
2. 31 10 00 Site Clearing
3. 31 22 00 Earthwork
4. 31 23 17 Trenching
5. 32 23 13 Sitework Concrete

1.2 GENERAL REQUIREMENTS/DEFINITIONS

A. Notice of Completion: The date at the close of the Maintenance Period when the work has been completed, checked, accepted, and written approval of the work has been given by the University's Representative.

B. Date of Acceptance: The date at the end of the warranty periods as specified herein, and written acceptance has been given by the University's Representative.

C. Finish Grade: Elevation of finished surface of planting soil within 1/10th of an inch.

D. Native Soil: Soil found in place in the designated landscape area, including soil compacted in place as part of the earthwork specified for the project.

E. Planting Area: Areas to be planted with trees, shrubs, groundcovers, lawn, or seed, or areas to be covered with various gravel or stone mulches not intended for pedestrian or vehicular circulation.

F. Planting Soil: Native soil modified to become planting soil; mixed with soil amendments.

G. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath planting soil.

H. To Remain: Protect and maintain at all times the existing plant material as identified on the Drawings.

1.3 SUBMITTALS

A. Soil Analysis:

1. Soil Analysis: Soil analysis test reports shall be completed after rough grading to determine actual recommended soil amendments. Refer to Part 1: Soil Testing.

B. Product Data and Samples:

1. Product Data: For each type of product specified.
2. Soil amendments and fertilizers: Submit supplier/manufacturer's product data on amendments and fertilizers as noted. Include brand names, estimated quantities, and supplier.

C. Certification of Grass Sod: From sod vendor for each sod type. Refer to drawings for sod species and vendor.

D. Seed mix: Submit a seeds list with quantities, purity, germination rate, additives and supplier

E. Product Certificates: For each type of manufactured product, signed by product manufacturer, and complying with the following:

1. Manufacturer's certified analysis for standard products.
2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

F. Qualification Data: For landscape Installer. Refer to Part 1, Section "Quality Assurance".

G. Material Test Reports: For existing surface soil and imported topsoil.

H. Planting Schedule: Indicating anticipated planting dates for each type of planting.

I. Maintenance Instructions: Prepare instructions for maintenance in cooperation with the Owner for maintenance of lawns during a calendar year. Submit before expiration of required maintenance periods. Instructions shall include but not be limited to the following tasks:

1. Fertilizing
2. Irrigation schedule
3. Over-seeding to insure 100% coverage.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: All of the work required to be provided as described in this Section of the Specifications shall be provided by a single entity sub-contractor skilled in this specialty, holding a valid C-27 California contractor's license.

B. The qualified landscape installer shall exhibit work that has resulted in successful lawn and hydroseed establishment. Submitted qualifications shall include a client list with contact names, phone numbers and date lawn was installed.

C. All work shall be performed by a trained crew company in accordance with the standards and practices related to the trade.

D. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.

E. Reference Standards: Reference Standards apply to this Sections and shall be the latest edition of the following:

1. "Seed Laws" State of California Department of Food and Agriculture

2. "Seed Laws" U.S. Department of Agriculture
3. Hortus Third
4. Sunset Western Garden Book, Sunset Publishing Corporation
5. The Jepson Manual, Owner of California Press, Berkeley

1.5 SOIL TESTING

A. Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

1. Supply Soil Testing Laboratory with complete copy of 32 93 13 specification sections at time of soil tests.

B. Soil Testing After Rough Grading

1. At the conclusion of rough grading, collect soil samples per plan (minimum 5), and submit the samples to an agricultural soils laboratory for testing. Submit the test results to the University's Representative for review. No amendments shall be applied prior to receipt of test results. The University's Representative shall recommend changes to the amendments and/or procedure listed herein, after review of the test results. Costs for testing shall be included in the contract. Changes in amendments and/or procedures shall be authorized by the Owner in accordance with the provisions of the General Conditions Article "Changes in the Work".
2. A soil analysis shall be made after rough grading operations are complete to determine actual recommended soil amendments.
3. Soil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter, textural classification, textural tests, silt sand clay content, sodium absorption rate (SAR), electrical conductivity (ECe), cation exchange capacity, boron content, deleterious material, pH, mineral and plant-nutrient content of topsoil and elemental data, corrective recommendations and soil amendment recommendations.
4. Report suitability of topsoil for plant growth. State recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil.

1.6 OBSERVATION

A. University's Representative may observe lawn and seed mixes on site before planting for compliance with requirements for genus, species, variety, size, and quality. University's Representative retains right to observe lawn further for size and condition of root systems, insects, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove lawn immediately from Project site.

1. Notify University's Representative of sources of sod fourteen days in advance of delivery to site.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Sod: Deliver sod to be planted at time of delivery.

B. Seed: Deliver seed in original sealed, labeled and undamaged containers.

1.8 COORDINATION

A. Planting Restrictions: Plant during one spring or fall. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

B. Weather Limitations: Proceed with planting and seeding only when existing and forecasted weather conditions permit.

C. Coordination with Exterior Plants: Plant trees and shrubs after finish grades are established and before planting lawns, from sod or seed, unless otherwise acceptable to University's Representative.

1. When planting trees and shrubs after lawns, protect lawn areas and promptly repair damage caused by planting operations.

1.9 LAWN MAINTENANCE

A. Begin maintenance immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:

1. Sodded Lawns: 90 days minimum from date of Final Completion.

a. When full maintenance period has not elapsed before end of planting season, or if lawn is not fully established, continue maintenance during next planting season.

2. Seeded areas: 90 days minimum from date of Final Completion.

a. Begin maintenance immediately after each area is planted and continue until acceptable seeding is established (100% coverage with no weeds), but not less than 90 days from date of substantial completion.
b. Maintain seeding by watering, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and re-mulch as needed to provide 100% coverage.

B. Within one week following authorization to start maintenance period, submit a Maintenance Schedule to the University's Representative listing the days when maintenance crews will be on site. In the schedule provide a contact person and emergency phone number.

C. The Maintenance Period shall be extended, when in the opinion of the University's Representative, dead or dying plant materials, poor or unhealthy growing conditions, or improper maintenance practices are evident within the maintenance period. The extended period shall be provided at no additional cost to the Owner, and shall be extended until the work is complete and acceptable to the University's Representative.

D. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas

E. Watering: Keep lawn uniformly moist to a depth of 4 inches. If a permanent irrigation source/system is not established, provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water lawn at a minimum rate of 1 inch per week.
3. Watering: Keep hydroseeding uniformly moist. If a permanent irrigation of ½" per week for 8 weeks after planting or per the seed supplier's recommendations.

F. Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 40 percent of grass height. Remove no more than 40 percent of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

1. Retain applicable mowing heights below. For sod type.
2. Mow grass (Paspalum) 1/2 to 1 inch high.

G. Lawn Postfertilization: Apply fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. to lawn area.

1.10 REJECTION AND SUBSTITUTION

A. Products or materials, whether installed or not, not conforming to the requirements herein specified shall be considered defective, and be marked as rejected. Materials shall be removed and replaced with approved materials at no additional cost to the Owner.

B. Submit written request for each proposed substitution. Provide data substantiating request as well as a "Certificate of Suitability" certifying that the proposed substitution is equal or better in all respects to that specified and that it will, in all respects perform the function for which it is intended. Include with request all required samples. Submit 3 copies of all written requests and data for proposed substitution.

1.11 SITE OBSERVATIONS

A. Schedule and coordinate site observation visits for the following construction activities. Reviews shall be performed by the University's Representative and notification shall be given in advance as noted:

Item		Advance Notice
1.	Protection of existing plant materials	48 hours
2.	Rough grade and soil tests	48 hours
3.	Soil preparation and finish grade	8 hours
4.	Percolation tests	48 hours
5.	Plant material review	48 hours
6.	Plant layout and installation	48 hours
7.	Substantial Completion Punch List	7 days
8.	Punch List Completion	7 days
	(Authorized start of Maintenance Period)	
9.	Maintenance Completion	7 days

1.12 TEMPORARY UTILITIES

A. Provide all temporary piping, wiring, meters, panels and other related appurtenances required between the source of supply and the point of use of utilities, or as required for medical center and/or renovation projects.

1. Permission to shut off in-use utilities must be obtained 48 hours in advance or as required for Medical Center and/or renovation projects, in writing from the University's Representative. The University's Representative shall determine the length of time for each shut-off.

PART 2 - PRODUCTS

2.1 GENERAL

A. Plants shall be in accordance with the California State Regulations for Nursery Inspection of Rules and Grading. All plants shall have a normal habit of growth and shall be sound, healthy and vigorous.

B. Soil Amendments: An assumed median level of amendments, including Gypsum, Soil Sulfur, Iron Sulfate and Organic Soil Amendment, must be specified for bidding purposes and adjusted as a result of final soil analysis during construction.

C. Fertilizing: All planting areas shall be fertilized. Incorporate fertilizer with soil amendments based on soil analysis.

2.2 TURFGRASS SOD

A. Sod shall be as indicated on the drawings. Contractor shall verify with the supplier, that the sod type and quantity will be available at time of installation. Substitution will not be considered after acceptance of submittals.

B. Sod shall be machine cut at a uniform soil thickness of 5/8 inch plus or minus 1/4 inch. Measurements for thickness shall exclude top growth and thatch. Individual pieces of sod shall be cut to the supplier's standard width and length. Maximum allowable deviation from standard width and lengths shall be 2 percent. Broken rolls or slabs and torn or uneven ends will not be acceptable. Standard size sections of sod shall be strong enough to support their own weight and retain their size and shape when suspended vertically from a firm grasp on the upper 10 percent of the section.

C. Sod shall be harvested, delivered and installed within a period of 24 hours, unless a suitable preservation method is approved prior to delivery. Sod not installed within this period shall be reviewed prior to installation and accepted by the Architect. Sod shall not be harvested or transplanted when moisture content may adversely affect handling and installation.

2.3 SEED

A. Seed: Fresh clean, dry, new seed, species as follows:

1. Seed Species: Match existing –confirm with University Landscape Maintenance.

B. Seed Carrier (as recommended by the seed supplier): Inert material, sharp clean sand or perlite, mixed with seed at a ratio of not less than two parts seed carrier to one part seed.

2.4 INORGANIC SOIL AMENDMENTS

A. Soil Sulfur: A commercially processed and packaged product in elemental form (S) Sulfur 90%, capable of oxidizing over time and providing nutrient sulfur. Pelletized.

B. Iron Sulfate: A non-staining iron with micronutrients, pelletized, slow release, environmentally safe, 40% Iron, 1% Manganese, 1% Zinc, 1% Magnesium, 6% Sulfur, 2% Humic Acids..

C. Agricultural Gypsum: Finely ground, containing a minimum of 90 percent calcium sulfate. Ninety percent shall pass a 50 mesh screen.

2.5 ORGANIC SOIL AMENDMENTS

A. Organic Soil Amendment:

1. A blend of organic fractions with several degrees of breakdown rate, a long-lasting form of iron, trace elements, pH of 5.5 to 7.5, maximum salinity of 2.50 ECe, organic matter (dry weight basis) more than 90%, non-ionic wetting agent and total nitrogen content of 0.4 – 0.8% (“Numex Lif” by John Deere (800) 347-4272, or “A-1 Nutri-Gro” by Hanson Aggregates/A-1 Soils or as indicated on the Drawings.

2.6 FERTILIZER

A. Pre-plant Fertilizer:

1. Gro-Power Plus 5-3-1,or equal, Soil Penetrant Added (1.00% Alkyl Naphthalene Sodium Sulfonate.) Fertilizer and soil conditioner from organic materials, higher plant form life, composted below the fibrous stage to support bacterial cultures. Shall not contain poultry, animal or human waste. As manufactured by Gro-Power®, Inc. (800) 473-1307, to match existing. This is a necessary item, that is only available from the listed source, or it is required , and no other product shall be furnished.
2. Physical properties: A uniform "Beaded" homogenous mixture - 100.00% passing through a #4 mesh screen - a water soluble bio-degradable binder is used to ensure fast breakdown.
3. Chemical Analysis: 5-3-1, nitrogen (available) 5.00%, phosphate 3.00%, potash 1.00% humus 70.00%, humic acids 15.00% soil penetrant 1.00%. Gro-Power bacterial "stimulator" included -bacteria (common soil and airborne organisms - aerobic, anaerobic,) yeast and mold, minimum 60,000 per 100 gram.

a.	Nitrogen 5%	minimum
b.	Phosphoric Acid	3% minimum
c.	Soluble Potash	1% minimum

B. Lawn Post-plant Fertilizer:

1. Gro-Power Premium High Nitrogen 18-3-7 NPK analysis, with 40% of the nitrogen a slow release SCU. 20% humus, 4% humic Acids, 4% sulfur, 1% iron, 0.50% soil penetrant, and soil enhancers. Nitrogen source: 5.94% Ammoniacal Nitrogen, 4.86% Nitrate Nitrogen,

5.40% Sulphur Coated Slow-Release Nitrogen, 1.08% Urea Nitrogen. Gro-Power bacterial "stimulator" included -bacteria (common soil and airborne organisms - aerobic, anaerobic,) yeast and mold, minimum 60,000 per 100 gram. As manufactured by Gro-Power®, Inc. (800) 473-1307, to match existing. This is a necessary item, that is only available from the listed source, , and no other product shall be furnished.

a.	Nitrogen 18% minimum	
b.	Phosphoric Acid	3% minimum
c.	Soluble Potash	7% minimum

C. Soil Conditioner: Mycorrhizal Inoculum / Soil Conditioner: Inculum shall be both Endo and Ecto (granular), with consititing of propagules (spores, fragments of fungal mycelium, and pieces of mycorrhizal roots capable of colonizing host plant roots) of the vesicular arbuscular mycorrhizal species Glomus intraradices, Glomus aggregatum, Glomus mosseae, combined with other species and/or additional genera including, Sclerocyctis, Gigaspora, Scutellospora, Entrophospora, and Acaulospora. Ectomycorrhiza include Pisolithus and 4 species of Rhizopogon. Soil Conditioner portion shall consist of organic materials consisting of higher plant form life, composted beyond the fiberous stage, to humus. Also shall have humic acids and beneficial soil bacteria strains. It shall NOT contain poultry, animal or human waste (i.e., sewage sludge), pathogenic viruses, fly larvae, insecticides, herbicides, fungicide or poisonous chemicals that would inhibit plant growth. Shall be “GroLife” (800) 473-1307, to match existing. This is a necessary item, that is only available from the listed source, , and no other product shall be furnished.

Ingredients		percentage (minimum)
1.	Mycorrhizal Inoculum	6,500/55,00 progagules per lb.*
2.	Humus 65%	
3.	Humic Acids	25%

2.7 BARRICADE MATERIALS

A. Protective Enclosure: “Temporary” construction fence 6’ tall chain link fence with a minimum 1½” dia. posts and 1” top and bottom rails.

B. 36" high orange snow fence w/ metal stakes or approved equal.

C. Caution tape, or twine and flags are not acceptable.

2.8 MISCELLANEOUS PRODUCTS

A. Prior to using herbicides, contractor shall review procedures with the University’s Representative and obtain written approval. A contractor licensed by the County shall perform herbicide applications requiring government or agency approvals.

B. Selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application.

C. Pre-emergent herbicide shall be Treflan, Surfland, Eptan, or equal.

PART 3 - EXECUTION

3.1 GENERAL

A. Finish Grading: All grades shall be finished graded. Finish grades shall be coordinated with adjacent finish paving and finish surfaces.

B. Rototilling: Rototill subgrade to a depth of 6 inches prior to placement of topsoil and/or amendments. Remove all rocks in the top 6 inches. Mitigate compaction in planting areas due to staging or construction.

3.2 EXAMINATION

A. Examine areas to receive sod and hydroseeding for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Examine areas to be planted before start of work, locate utilities, improvements, and easements, verify dimensions and areas shown on the Drawings with actual conditions identify and tag existing plant material to remain. Document conditions, which are in, direct conflict with the Drawings and notify the University's Representative. Do not start work until conditions that would adversely affect performance, installation, or quality of the work have been corrected. Start of work of this Section constitutes acceptance of the conditions.

3.3 WEED CONTROL

A. Prior to commencement of the planting operations, remove all weeds including the roots, remove existing plant material including stumps designated not to remain, dispose of cleared and grubbed material at a legal refuse site. Prior to using herbicides, review procedures with the Owner are Representative, and obtain written approval. An operator licensed by the County shall perform herbicide applications requiring government or agency approvals. Protect existing plant material on site and on adjacent properties from exposure to herbicides and equipment. Erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.4 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.5 SOIL PREPARATION

A. Limit lawn and hydroseeding preparation to areas to be planted.

B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 8 inches without adding soil conditioner. Remove stones, clods and debris larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off University's property.

1. Spread soil conditioner, gypsum and other amendments over all planting areas indicated on the Drawings, and mechanically till and blend to a depth of 6 inches.
2. Prepare areas within the dripline of existing trees by hand, do not use mechanical tillers. Rake smooth, lightly water, and compact to the finish grades shown on the Drawings. Use the amendments listed below for bidding purposes only. Materials and application rates may be modified after receipt of soils tests.
3. Use the amendments listed below for bidding purposes only. Modify materials and application rates after receipt of soils tests.

    a. Soil Conditioner 6 cubic yards / 1000sq.ft
    b. Gypsum 100 lbs/ 1000 sq.ft
    c. Pre-Plant Fertilizer 5-3-1/ 150 lbs. / 1000 sq.ft
    d. Soil Sulfur 10 lbs. / 1000 sq.ft
    e. Mycorrhizal Inoculum / Soil Conditioner 20 lbs. / 1000 sq.ft

4. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
5. Thoroughly blend planting soil mix off-site before spreading, apply soil amendments on surface, and thoroughly blend planting soil mix.
6. Spread planting soil mix to a depth of 8 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is, muddy, or excessively wet.

    a. Spread approximately one-half the thickness of planting soil mix over loosened subgrade. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil mix.
    b. Rake smooth and roll the area to compact and expose soil depressions or surface irregularities. Re-grade as necessary to achieve the finish grades indicated on the Drawings less the depth of the sod.

C. For Turfgrass only: Irrigate the area to thoroughly moisten soil and evenly broadcast the turf fertilizer (16-20-0) at the rate of one pound per 100 square feet, rake in lightly to a depth of 1".

1. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
2. Remove stones larger than 1-inch in any dimension and sticks, roots, trash, and other extraneous matter.
3. Legally dispose of waste material, including grass, vegetation, and turf, off University's property.
4. Rake smooth and roll the area to compact and expose soil depressions or surface irregularities. Re-grade as necessary to achieve the finish grades indicated on the Drawings less the depth of the sod.
5. Irrigate the area to thoroughly moisten soil and evenly broadcast the turf fertilizer (16-20-0) at the rate of one pound per 100 square feet, rake in lightly to a depth of 1".

D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Float smooth and compact all soil preparation areas to 85% relative dry density, maintain positive drainage, flow lines, and swells to area drains, fine grade to within plus or minus 0.10 foot of the grades shown on the Drawings. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas that can be planted in the immediate future.

E. Moisten prepared lawn and hydroseeding areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

F. Restore areas if eroded or otherwise disturbed after finish grading and before planting.

3.6 TURFGRASS SOD INSTALLATION

A. Soil Preparation -Rake smooth and roll the area to compact and expose soil depressions or surface irregularities. Re-grade as necessary to achieve the finish grades indicated on the Drawings less the depth of the sod. Irrigate the area to thoroughly moisten soil and evenly broadcast the turf fertilizer (16-20-0) at the rate of one pound per 100 square feet, rake in lightly to a depth of 1".

B. Installation: Place the first row of sod along a straight line. Butt joints tightly, do not overlap edges, and stagger the joints of succeeding rows. Use a sharp knife to cut the sod to fit curves, edges, around sprinkler heads, and other appurtenances. Water-in large areas to prevent drying, and continue to lay sod until installation is complete. After laying all sod, roll lightly to eliminate irregularities, and to form good contact between the sod and soil.

3.7 SEEDING

A. Seeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for seed application.

B. Application: Irrigate areas for three (3) consecutive days to thoroughly moisten the top 6" of soil prior to seeding operation.

C. Ammend soil per soil test as described above.

D. Irrigation: Irrigate areas throughout the construction and maintenance period as per University's representative approval.

E. Weeding: At 30 day intervals of the maintenance period, physically remove weeds and dispose of off-site. Take precautions to minimize walking on new growth or undisturbed mulch areas.

F. Coverage: Acceptance will be given at the end of the maintenance period when coverage is uniform over the entire area with minimal bare or non germinated areas, and the areas not exceeding 2 feet in its greatest dimension.

G. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.

1. Do not use wet seed or seed that is moldy or otherwise damaged.

3.8 IRRIGATION

A. Irrigate areas throughout the construction and maintenance period, or until the planting is sufficiently well established as per University's Representative's approval.

3.9 SATISFACTORY LAWNS

A. Satisfactory Sodded Lawn: At end of maintenance period, a healthy, well-rooted, even-colored, viable lawn has been established, free of weeds, open joints, bare areas, and surface irregularities.

3.10 CLEANUP AND PROTECTION

A. As the work progresses, maintain areas in a neat, clean, orderly manner, and remove unsightly debris as necessary. At the completion of the work, sweep and clean all walks, parking and other paved areas adjacent to plantings.

B. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Promptly remove soil and debris created by lawn work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

C. Protect plants, lawns from damage due to landscape operations, operations by other contractors and trades, and others. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged exterior planting.

D. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout maintenance period and remove after lawn is established.

E. Remove erosion-control measures after grass establishment period.

3.11 DISPOSAL

A. Disposal: All grubbed material, rock, surplus soil and waste material, including excess subsoil, unsuitable soil, trash and other debris shall be removed from the University's property and disposed of in a legal disposal site.

3.12 MAINTENANCE

A. Maintenance of turf areas includes proper watering and soil moisture content, fertilizing, mulching, cutting, rolling, pest and disease control, reseeding and other functions necessary to maintain a healthy, vigorous growing lawn. Maintenance will continue until all lawn areas have a complete established close stand of grass.

B. Maintenance Schedules: Provide complete maintenance specifications including general design maintenance intent of plant material and fertilizing schedule based on planting design.

END OF SECTION 329313