DSA Application #02-123745

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Specifications

for

Solano Community College District

Solano Community College

Hydronic System Modernization

DSA Backcheck Submittal

SOBE No. 2510-00649-00

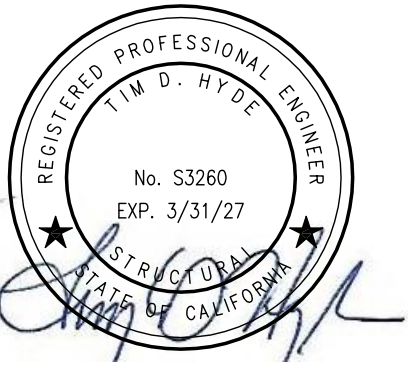
1/23/2026

SPECIFICATIONS

SOLANO COMMUNITY COLLEGE DISTRICT
Solano Community College
Hydronic System Modernization
Project #2510-00649-00

Fairfield, CA

Approval Stamps



ELECTRICAL ENGINEER	MECHANICAL ENGINEER	STRUCTURAL ENGINEER
Hugh King	Evan Sarver	Tim Hyde
Salas O'Brien	Salas O'Brien	AKH Structural Engineers, Inc
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San Jose, Ca. 95112	San Jose, Ca. 95112	San Jose, Ca. 95112

TABLE OF CONTENTS

SECTION 23 05 19
METERS AND GAUGES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Positive displacement meters.

B. Pressure gauges and pressure gauge taps.

C. Thermometers and thermometer wells.

1.02 REFERENCE STANDARDS

A. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2022.

B. AWWA C700 - Cold-Water Meters -- Displacement Type, Metal Alloy Main Case; 2024.

C. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Division 1 for Submittal requirements.

B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components. Indicate scale range, figure interval and minor graduation markings for all pressure and compound ranges.

C. Project Record Documents: Record actual locations of components and instrumentation.

1.04 FIELD CONDITIONS

A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 PRODUCTS

2.01 POSITIVE DISPLACEMENT METERS (LIQUID)

A. AWWA C700, positive displacement disc type suitable for fluid with metal alloy main case and cast iron bottom cap, hermetically sealed register.

B. Sized for load at temporary HHW and CHW buiilding connections.

2.02 PRESSURE GAUGES

A. Manufacturers:
   1. Ashcroft Model Duragage; Model 1279
   2. Substitutions: See Division 1

B. Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
   1. Case: Steel with brass bourdon tube.
   2. Size: 4-1/2 inch (115 mm) diameter.
   3. Mid-Scale Accuracy: 1/2 percent.
   4. Scale: Psi.

2.03 PRESSURE GAUGE TAPPINGS

A. Taps: Bonny Forge Thred-O-Let, min 1/2", sized for run pipe diameter. 1/4" minimum sched 40 steel piping from taps to gauge.

B. Gauge Valve: 150 lb Bronze ball valve, threaded, two piece body, stainless steel ball and stem. Nibco or equal.

2.04 DIGITAL THERMOMETERS

A. Manufacturers:
   1. Weiss Instruments, Inc. Digital Vari-Angle Thermometer,

2. Model DVU35 or DVU6, www.weissinstruments.com
3. Substitutions: See Division 1 - Product Requirements.

B. Thermometer: Hi-impact ABS case, glass passivated thermistor sensor, 1/2" LCD Digits.
1. Size:3-1/2 inch or 6 inch industrial stem.
2. Display: 1/2" LCD digits, wide ambient formula.Lens: Clear glass.
3. Accuracy: 1 percent.of reading or 1 degree F, whichever is greater/
4. Calibration: Degrees F.
5. Range: -50 to 300 degrees F
6. Resolution: 1/10 Degrees F between -19.9/199.9 Degrees F
7. Power: Integrated Photo Voltaic Cells
8. Sensor: Glass passivated thermistor.
9. Sensing Well: 3/4" NPT, length to suit application.

2.05 THERMOMETER SUPPORTS

A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.

2.06 CONTROL SUPPORTS

A. Pipe taps (branch connection): Forged ASTM A105 carbon steel, threaded branch connection suitable for sizes and schedules ro be connected for 150 psig working pressure. Bonney Forge Thred-o-let or approval equal. Coordinate with Controls Subcontractor for size, location and quantities.

2.07 TEST PLUGS

A. Manufacturers:
1. Peterson Equipment Co, Pete's Plug www.petesplug.com
2. Substitutions: See Division 1.

B. Test Plug: 1/4 inch (6 mm) brass fitting and cap for receiving 1/8 inch (3 mm) outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 degrees F (93 degrees C). Length to clear insulation.

C. Test Plug: 1/4 inch (6 mm) brass fitting and cap for receiving 1/8 inch (3 mm) outside diameter pressure or temperature probe with Nordel core for temperatures up to 350 degrees F (176 degrees C). Length to clear insulation.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide one pressure gauge per pump, installing taps and valves before strainers and on suction and discharge of pump. Pipe to gauge.

C. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch (60 mm) for installation of thermometer sockets. Ensure sockets allow clearance from insulation.

D. Provide instruments with scale ranges selected according to service with largest appropriate scale.

E. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

F. Pump and strainer pressure gauges: install taps, fittigs, valves to allow a single pressure gauge to make suction and discharge pressures on pump and inlet and outlet pressures on strainers. Provide a Petes Plug at every pressure gauge or control sensor and/or each thermometer.

G. Locate test plugs adjacent to thermometers and temperature sensors, at pressure gauges and sensors, and where indicated,

H. Provide new temperature wells for any relocated temperature sensors, as shown on dwgs.

END OF SECTION

SECTION 23 05 23
GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Ball valves.

B. Butterfly valves.

C. Check valves.

D. Chainwheels.

1.02 ABBREVIATIONS AND ACRONYMS

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. PTFE: Polytetrafluoroethylene.

G. RS: Rising stem.

H. TFE: Tetrafluoroethylene.

I. WOG: Water, oil, and gas.

1.03 REFERENCE STANDARDS

A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).

B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2020.

C. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard; 2025.

D. ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves; 2022, with Errata (2023).

E. ASME B16.34 - Valves — Flanged, Threaded, and Welding End; 2025.

F. ASME B31.9 - Building Services Piping; 2025.

G. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2023).

H. ASTM A216/A216M - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service; 2021.

I. ASTM A536 - Standard Specification for Ductile Iron Castings; 2024.

J. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings; 2017 (Reapproved 2025).

K. MSS SP-67 - Butterfly Valves; 2022.

L. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends; 2018.

M. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves; 2019.

N. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .

1.04 SUBMITTALS

A. See Division 1 for submirtral procedures.

B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

C. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

D. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.

1.05 QUALITY ASSURANCE

A. Manufacturer:
   1. Obtain valves for each valve type from single manufacturer.
   2. Company must specialize in manufacturing products specified in this section, with not less than three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect valve parts exposed to piped medium against rust and corrosion.
   2. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
   3. Adjust globe, gate, and angle valves to the closed position to avoid clattering.

B. Use the following precautions during storage:
   1. Maintain valve end protection and protect flanges and specialties from dirt.
      a. Provide temporary inlet and outlet caps.
      b. Maintain caps in place until installation.
   2. Store valves in shipping containers and maintain in place until installation.
      a. Store valves off the ground in watertight enclosures when indoor storage is not an option.

C. Exercise the following precautions for handling:
   1. Handle large valves with sling, modified to avoid damage to exposed parts.
   2. Avoid the use of operating handles or stems as rigging or lifting points.

PART 2 PRODUCTS

2.01 APPLICATIONS

A. See drawings for specific valve locations.

B. Listed pipe sizes shown using nominal pipe sizes (NPS) and nominal diameter (DN).

C. Provide the following valves for the applications if not indicated on drawings:
   1. Throttling (Hydronic): Butterfly and Ball.
   2. Isolation (Shutoff): Butterfly and Ball.
   3. Swing Check (Pump Outlet, if no Triple Duty):
      a. Size 2 inch (50 mm, DN) and Smaller: Bronze with bronze disc.
      b. Size 2-1/2 inch (65 mm, DN) and Larger: Iron with lever and spring, center-guided metal, or center-guided with resilient seat.
   4. Dead-End: Butterfly, single-flange (lug) type.

D. Required Valve End Connections for Non-Wafer Types:
   1. Steel Pipe:
      a. Size 2 inch (50 mm, DN) and Smaller: Threaded ends.
      b. Size 2-1/2 inch (65 mm, DN) and Larger: Flanged ends..

E. Chilled Water Valves:
   1. Size 2 inch (50 mm, DN) and Smaller, Brass and Bronze Valves:
      a. Threaded ends.
      b. Ball: Full port, two piece, bronze trim.
      c. Swing Check: Bronze disc, Class.
   2. Size 2-1/2 inch (65 mm, DN) and Larger, Iron Valves:
      a. 2-1/2 inch (65 mm, DN) to 4 inch (100 mm, DN): Flanged ends.
      b. Ball: 2-1/2 NPS (65 DN) to 10 inch (250 mm, DN), Class 150.

c. Single-Flange Butterfly: 2-1/2 inch (65 mm, DN) to 12 inch (300 mm, DN), aluminum-bronze disc, Chloramine resistant EPDM seat, 200 CWP.
d. Swing Check: Nonmetallic-to-metal seats, Class 125.
e. Swing Check with Closure Control: 2-1/2 inch (65 mm, DN) to 12 inch (300 mm, DN), lever and spring, Class 125.
f. Center-Guided Check: Globe, metal seat, Class 125.

F. Heating Hot Water Valves:
1. Size 2 inch (50 mm, DN) and Smaller, Brass and Bronze Valves:
a. Threaded ends.
b. Ball: Full port, two piece, bronze trim.
c. Swing Check: Bronze disc, Class 150.
2. Size 2-1/2 inch (65 mm, DN) and Larger, Iron Valves:
a. Ball: 2-1/2 inch (65 mm, DN) to 10 inch (250 mm, DN), Class 150.
b. Single-Flange Butterfly: 2-1/2 inch (65 mm, DN) to 12 inch (300 mm, DN), aluminum-bronze disc, Chloramine resistant EPDM seat, 200 CWP. Lug pattern.
c. Swing Check: 2-1/2 inch (65 mm, DN) to 12 inch (300 mm, DN), lever and spring closure control, Class 150.
d. Center-Guided Check: Globe, resilient seat, Class 150.

2.02 GENERAL REQUIREMENTS

A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.

B. Valve Sizes: Match upstream piping unless otherwise indicated.

C. Valve Actuator Types:
1. Gear Actuator: Quarter-turn valves 6 inch (200 mm, DN) and larger.
2. Hand Lever: Quarter-turn valves 5 inch (150 mm, DN) and smaller.
3. 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.

D. Valves in Insulated Piping: Provide 2 inch (50 mm, DN) stem extensions and the following features:
1. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
2. Butterfly Valves: Extended neck.
3. Memory Stops: Fully adjustable after insulation is installed.

E. Valve-End Connections:
1. Threaded End Valves: ASME B1.20.1.
2. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.
3. Pipe Flanges and Flanged Fittings 1/2 inch (15 mm, DN) through 24 inch (600 mm, DN): ASME B16.5.

F. General ASME Compliance:
1. Ferrous Valve Dimensions and Design Criteria: ASME B16.10 and ASME B16.34.
2. Building Services Piping Valves: ASME B31.9.

G. Bronze Valves:
1. Fabricate from dezincification resistant material.
2. Copper alloys containing more than 15 percent zinc are not permitted.

2.03 BRONZE, BALL VALVES

A. General:
1. Fabricate from dezincification resistant material.
2. Copper alloys containing more than 15 percent zinc are not permitted.

B. Two Piece, Full Port with Bronze or Brass Trim:

1. Comply with MSS SP-110.
2. WSP Rating: 150 psi (1,035 kPa).
3. WOG Rating: 400 psi (2,758 kPa).
4. Body: Forged bronze or dezincified-brass alloy.
5. End Connections: Pipe thread.
6. Seats: PTFE.
7. Stem: Stainless steel.
8. Ball: Stainless steel, vented.
9. Operator: Through 4" pipe size: Provide lockable handle and stem extension.5" and over
10. Manufacturers:
    a. Apollo Valves: www.apollovalves.com/#sle.
    b. NIBCO INC; T-580-70-66: www.nibco.com/#sle.
    c. Substitutions: See Division 1.

2.04 IRON, SINGLE FLANGE BUTTERFLY VALVES

A. Lug Style:
1. Comply with MSS SP-67, Type I.
2. Lug Style, CWP Ratings:
    a. Sizes 2 to 12 inches (50 to 300 mm, DN): 250 psi (1725 kPa).
    b. Sizes 14 to 24 inches (350 to 600 mm, DN): 150 psi (1034 kPa).
3. Body Material: ASTM A126 cast iron or ASTM A536 ductile iron.
4. Stem: One or two-piece stainless steel.
5. Seat: Chloramine resistant EPDM/.
6. Disc: Aluminum-bronze.
7. Removable Manual Actuator: Lockable handle or worm-gear-connected handwheel with open/close position indication for valves 4" and under.
8. Service Temperature Range: Minus 30 to 250 degrees F (Minus 34.4 to 121.1 degrees C).
9. Operator: Gear operator over direct-mount actuator base for sizes 5" and over.
10. Manufacturers:
    a. NIBCO INC; LD-2000: www.nibco.com/#sle.
    b. Substitutions: See Division 1.

2.05 BRONZE, SWING CHECK VALVES

A. Class 150:
1. Pressure and Temperature Rating: MSS SP-80, Type 3.
2. Design: Y-pattern, horizontal or vertical flow.
3. CWP Rating: 300 psi (2,068 kPa).
4. Body: Bronze, ASTM B62.
5. End Connections: Threaded.
6. Disc: Bronze.
7. Manufacturers:
    a. Apollo Valves: www.apollovalves.com/#sle.
    b. Nibco T-433 www.nibco.com

2.06 IRON, SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125:
1. Comply with MSS SP-71, Type I.
2. Sizes 2-1/2 to 12 inch (65 to 300 mm, DN): CWP Rating; 200 psi (1,380 kPa).
3. Body Design: Clear or full waterway.
4. Body Material: ASTM A126, gray iron with bolted bonnet.
5. Ends: Flanged.
6. Trim: Bronze.
7. Gasket: Asbestos free.

8. Closer Control: Factory installed, exterior lever, and spring or weight.
9. Manufacturers:
    a. Apollo Valves: www.apollovalves.com/#sle.
    b. Nibco; www.nibco.com.
    c. Substitutions: See Division 1 for substitution procedures.

2.07 CARBON STEEL, SWING CHECK VALVES

A. Class 150:
    1. Design: T-pattern, horizontal or vertical flow.
    2. Body and Disc: ASTM A216/A216M.
    3. CWP Rating: 150 psi (1,034 kPa).
    4. End Connections: Flanged.
    5. Pressure and Temperature Rating: ASME B16.34.

2.08 CHAINWHEELS

A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
    1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
    2. Attachment: For connection to ball, butterfly, and plug valve stems.
    3. Sprocket Rim with Chain Guides: Ductile iron include zinc coating.
    4. Chain: Hot-dip galvanized steel. Sized to fit sprocket rim.

PART 3 EXECUTION

3.01 EXAMINATION

A. Discard all packing materials and verify that valve interior, including threads and flanges, are completely clean without signs of damage or degradation that could result in leakage.

B. Verify valve parts to be fully operational in all positions from closed to fully open.

C. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.

D. Should valve is determined to be defective, replace with new valve.

3.02 INSTALLATION

A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.

B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.

C. Install check valves where necessary to maintain direction of flow as follows:
    1. Swing Check: Install horizontal maintaining hinge pin level.
    2. Orient center-guided into horizontal or vertical position, between flanges.

D. Provide chainwheels on operators for valves 4 NPS (100 DN) and larger where located 96 inches (2.4 m) or more above finished floor, terminating 60 inches (1.5 m) above finished floor.

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Testing, adjustment, and balancing of hydronic systems.

B. Measurement of final operating condition of HVAC systems.

1.02 REFERENCE STANDARDS

A. AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition; 2016.

B. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems; 2024, with Errata (2025).

C. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing; 2023.

1.03 SUBMITTALS

A. See Division 1 for submittal procedures.

B. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.

C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
   1. Submit six weeks prior to starting the testing, adjusting, and balancing work.
   2. Include at least the following in the plan:
      a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
      b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
      c. Identification and types of measurement instruments to be used and their most recent calibration date.
      d. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
      e. Final test report forms to be used.
      f. Expected problems and solutions, etc.
      g. Details of how TOTAL flow will be determined; for example:
         1) Water: Pump curves, circuit setter, flow station, ultrasonic, etc.
      h. Time schedule for TAB work to be done in phases (by floor, etc.).
      i. Time schedule for deferred or seasonal TAB work, if specified.
      j. False loading of systems to complete TAB work, if specified.
      k. Procedures for field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
      l. Procedures for formal deficiency reports, including scope, frequency and distribution.

D. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
   1. Submit to the Construction Manager within two weeks after completion of testing, adjusting, and balancing.
   2. Revise TAB plan to reflect actual procedures and submit as part of final report.
   3. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for architect and for inclusion in operating and maintenance manuals.
   4. Include actual instrument list, with manufacturer name, serial number, and date of calibration.

5. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
6. Units of Measure: Report data in both I-P (inch-pound) and SI (metric) units.
7. Include the following on the title page of each report:
   a. Name of Testing, Adjusting, and Balancing Agency.
   b. Address of Testing, Adjusting, and Balancing Agency.
   c. Project name.
   d. Project location.
   e. Project Engineer.
   f. Project Contractor.
   g. Project altitude.
   h. Report date.

E. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Perform total system balance in accordance with one of the following:
   1. AABC (NSTSB), AABC National Standards for Total System Balance.
   2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
   3. SMACNA (TAB).
   4. Maintain at least one copy of the standard to be used at project site at all times.

B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.

C. TAB Agency Qualifications:
   1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
   2. Having minimum of three years documented experience.
   3. Certified by one of the following:
      a. AABC, Associated Air Balance Council: www.aabc.com/#sle; upon completion submit AABC National Performance Guaranty.
      b. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: www.tabbcertified.org/#sle.

D. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.02 EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
   1. Systems are started and operating in a safe and normal condition.
   2. Temperature control systems are installed complete and operable.
   3. Proper thermal overload protection is in place for electrical equipment.
   4. Hydronic systems are flushed, filled, and vented.
   5. Pumps are rotating correctly.
   6. Proper strainer baskets are clean and in place.
   7. Service and balance valves are open.

B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.

C. Beginning of work means acceptance of existing conditions.

3.03 ADJUSTMENT TOLERANCES

A. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.04 RECORDING AND ADJUSTING

A. Field Logs: Maintain written logs including:
   1. Running log of events and issues.
   2. Discrepancies, deficient or uncompleted work by others.
   3. Contract interpretation requests.
   4. Lists of completed tests.

B. Ensure recorded data represents actual measured or observed conditions.

C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

D. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.05 WATER SYSTEM PROCEDURE

A. Adjust water systems to provide required or design quantities.

B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.

C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

D. Effect system balance with automatic control valves fully open to heat transfer elements.

E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.06 SCOPE

A. Test, adjust, and balance the following:
   1. HVAC Pumps.
   2. Rental boilers, chillers and pumps

3.07 MINIMUM DATA TO BE REPORTED

A. Electric Motors:
   1. Manufacturer.
   2. Model/Frame.
   3. HP/BHP.
   4. Phase, voltage, amperage; nameplate, actual, no load.
   5. RPM.
   6. Service factor.

B. Pumps:
   1. Identification/number.
   2. Manufacturer.
   3. Size/model.
   4. Impeller.
   5. Service.
   6. Design flow rate, pressure drop, BHP.
   7. Actual flow rate, pressure drop, BHP.
   8. Discharge pressure.

9. Suction pressure.
10. Total operating head pressure.
11. Shut off, discharge and suction pressures.
12. Shut off, total head pressure.

C. Combustion Equipment:
1. Boiler manufacturer.
2. Model number.
3. Firing rate.
4. Gas meter timing dial size.
5. Gas meter time per revolution.
6. Gas pressure at meter outlet.
7. Heat input.
8. Burner manifold gas pressure.
9. Heat output.

D. Chillers:
1. Identification/number.
2. Manufacturer.
3. Capacity.
4. Model number.
5. Evaporator entering water temperature, design and actual.
6. Evaporator leaving water temperature, design and actual.
7. Evaporator pressure drop, design and actual.
8. Evaporator water flow rate, design and actual.

E. Cooling Coils:
1. Identification/number.
2. Location.
3. Service.
4. Water flow, design and actual.
5. Water pressure drop, design and actual.

F. Heating Coils:
1. Identification/number.
2. Location.
3. Service.
4. Water flow, design and actual.
5. Water pressure drop, design and actual.

END OF SECTION

SECTION 23 07 19
HVAC PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Piping insulation and appurtenances for above grade piping..

B. Flexible removable and reusable blanket insulation.

C. Weather barrier coatings.

D. Jacketing and accessories.

1.02 REFERENCE STANDARDS

A. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.

B. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2019, with Editorial Revision (2023).

C. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.

D. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2025.

E. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2022a.

F. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2024.

G. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2023).

H. ASTM C1775 - Standard Specification for Laminate Protective Jacket and Tape for Use Over Thermal Insulation for Outdoor Applications; 2022.

I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2025.

J. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.

K. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Division 1 for submittal procedures.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.

B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum three years of experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.06 FIELD CONDITIONS

A. Maintain ambient conditions required by manufacturers of each product.

B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, FLEXIBLE

A. Manufacturers:
   1. Knauf Insulation: www.knaufinsulation.com/#sle.
   2. Substitutions: See Division 1

B. Insulation: ASTM C553; flexible, noncombustible blanket.
   1. K (Ksi) Value: 0.36 at 75 degrees F (0.052 at 24 degrees C), when tested in accordance with ASTM C518.
   2. Maximum Service Temperature: 1,200 degrees F (649 degrees C).
   3. Maximum Water Vapor Absorption: 5.0 percent by weight.

C. Vapor Barrier Jacket:
   1. Kraft paper with glass fiber yarn and bonded to aluminized film.
   2. Moisture Vapor Permeability: 0.02 perm inch (0.029 ng/(Pa s m)), when tested in accordance with ASTM E96/E96M.
   3. Secure with pressure-sensitive tape.

2.03 GLASS FIBER, RIGID

A. Manufacturers:
   1. Johns Manville Corporation; _____: www.jm.com/#sle.
   2. Knauf Insulation; Performance+ Earthwool 1000 Pipe Insulation: www.knaufinsulation.com/#sle.
   3. Owens Corning Corporation; Fiberglas Pipe Insulation ASJ: www.owenscorning.com/en-us/#sle.

B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
   1. K (Ksi) Value: ASTM C177, 0.24 at 75 degrees F (0.035 at 24 degrees C).
   2. Maximum Service Temperature: 850 degrees F (454 degrees C).
   3. Maximum Moisture Absorption: 0.2 percent by volume.

C. Aluminum-Foil Laminate Jacket:
   1. Factory-applied, pressure sensitive adhesive jacketing to comply with ASTM C1775.

D. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches (0.029 ng/(Pa s m)).

2.04 FLEXIBLE REMOVABLE AND REUSABLE BLANKET INSULATION

A. Description: Custom cut and fabricated, removable and reusable blanket insulation system, consisting of inner liner, insulation layer, outer protective jacket, and fastening system.

B. Provide insulation system based on surface temperature of piping, installed location of piping, and maximum safe-to-touch temperature of jacketing.

C. Performance Criteria:
   1. Safe-to-Touch Temperature of Jacketing: 140 degrees F (60 degrees C).

2.05 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturers:
   1. Armacell LLC; AP ArmaFlex: www.armacell.us/#sle.

2. Substitutions: See Division 1.

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.
   1. Minimum Service Temperature: Minus 40 degrees F (Minus 40 degrees C).
   2. Maximum Service Temperature: 180 degrees F (82 degrees C).
   3. Connection: Waterproof vapor barrier adhesive.

C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

D. Weather Barrier Coating: Air dried, contact adhesive, compatible with insulation and ASTM E84 compliant.

2.06 WEATHER BARRIER COATINGS

A. Weather-Resistive Barrier Coating: Fire-resistive, UV resistant, water-based mastic for use over closed cell polyethylene and polyurethane foam insulation; applied with glass fiber or synthetic reinforcing mesh.
   1. Surface Burning Characteristics: Flame spread index of 25 or less, smoke developed index of 450 or less, Class A, when tested in accordance with ASTM E84.
   2. Water Vapor Permeance: Greater than 1.0 perm (57 ng/(Pa s m)) in accordance with ASTM E96/E96M.

2.07 JACKETING AND ACCESSORIES

A. PVC Plastic.
   1. Manufacturers:
      a. Johns Manville Corporation; _____: www.jm.com/#sle.
   2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
      a. Minimum Service Temperature: 0 degrees F (minus 18 degrees C).
      b. Maximum Service Temperature: 150 degrees F (66 degrees C).
      c. Moisture Vapor Permeability: 0.002 perm inch (0.0029 ng/(Pa s m)), maximum, when tested in accordance with ASTM E96/E96M.
      d. Thickness: 10 mil, 0.010 inch (0.25 mm).
      e. Connections: Brush on welding adhesive.
   3. Covering Adhesive Mastic: Compatible with insulation.

B. Aluminum Jacket:
   1. Comply with ASTM B209/B209M, Temper H14, minimum thickness of 0.016 inch (0.41 mm) with factory-applied polyethylene and kraft paper moisture barrier on the inside surface.
   2. Thickness: 0.016 inch (0.40 mm) sheet.
   3. Type: Factory-applied, self-adhesive jacketing.
   4. Finish: Smooth.
   5. Joining: Longitudinal slip joints and 2 inch (50 mm) laps.
   6. Fittings: 0.016 inch (0.40 mm) thick die-shaped fitting covers with factory-attached protective liner.
   7. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.010 inch (0.25 mm) thick stainless steel.

PART 3 EXECUTION

3.01 EXAMINATION

A. Test piping for design pressure, liquid tightness, and continuity prior to applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NAIMA National Insulation Standards.

C. Exposed Piping: Locate insulation and cover seams in least visible locations.

D. Insulated Pipes Conveying Fluids Below Ambient Temperature:
   1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

E. Glass Fiber Insulated Pipes Conveying Fluids Below Ambient Temperature:
   1. Provide vapor barrier jackets, factory-applied or field-applied; secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
   2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.

F. For hot piping conveying fluids over 140 degrees F (60 degrees C), insulate flanges and unions at equipment.

G. Glass Fiber Insulated Pipes Conveying Fluids Above Ambient Temperature:
   1. Provide standard jackets, with or without vapor barrier, factory-applied, or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples.
   2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.

H. Inserts and Shields:
   1. Application: Piping 1-1/2 inches (40 mm) diameter or larger.
   2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
   3. Insert location: Between support shield and piping and under the finish jacket.
   4. Insert Configuration: Minimum 6 inches (150 mm) long, of same thickness and contour as adjoining insulation; may be factory fabricated.
   5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

I. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, see Section 07 84 00.

J. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Provide two coats of UV-resistant finish for flexible elastomeric cellular insulation without jacketing.

3.03 SCHEDULE

A. Heating Systems:
   1. Heating Water Supply and Return:

B. Cooling Systems:
   1. Chilled Water:

END OF SECTION

SECTION 23 09 34
VARIABLE-FREQUENCY MOTOR CONTROLLERS FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Variable-frequency motor controllers for low-voltage (600 V and less) AC motor applications.

B. Overcurrent protective devices for motor controllers, including overload relays.

1.02 REFERENCE STANDARDS

A. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code); 1989 (Corrigendum 2019).

B. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

C. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2008 (Reaffirmed 2020).

D. NEMA IA 10039 - Control Circuit and Pilot Devices; 2025.

E. NEMA IA 10030 - Industrial Control and Systems: Enclosures; 2024.

F. NEMA IS 10033 - Adjustable Speed Drives; 2020 (Reapproved 2025).

G. NEMA IS 10034 - Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems; 2022 (Reapproved 2025).

H. NEMA IS 10035 - Application Guide for AC Adjustable Speed Drive Systems; 2021 (Reaffirmed 2025).

I. NEMA ICS 61800-2 - Adjustable Speed Electrical Power Drive Systems, Part 2: General Requirements-Rating Specifications for Low Voltage Adjustable Frequency AC Power Drive Systems; 2005.

J. NEMA MG 00001 - Motors and Generators; 2024.

K. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.

L. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

M. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

N. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.

O. UL 61800-5-1 - Standard for Adjustable Speed Electrical Power Drive Systems - Part 5-1: Safety Requirements – Electrical, Thermal, and Energy (Ed. 2); Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate work to provide motor controllers suitable for use with actual motors to be installed.
   2. Coordinate work to provide controllers and associated wiring suitable for interface with control devices to be installed.
   3. Coordinate arrangement with dimensions and clearance requirements of actual equipment to be installed.
   4. Verify with manufacturer that conductor terminations are suitable for use with conductors to be installed.
   5. Notify architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. See Division 1 for submittal procedures.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets for motor controllers, enclosures, overcurrent protective devices, and other installed components and accessories.

D. Shop Drawings: Indicate dimensions, voltage, controller sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
   1. Include dimensioned plan and elevation views of controllers and adjacent equipment with required clearances indicated.
   2. Include wiring diagrams showing factory and field connections.
   3. Identify mounting conditions required for equipment seismic qualification.

E. Derating Calculations: Indicate ratings adjusted for applicable service conditions.

F. Specimen Warranty: Submit sample of manufacturer's warranty.

G. Manufacturer qualification statement.

H. Installer qualification statement.

I. Manufacturer's equipment seismic qualification certification.

J. Manufacturer's certification that products meet or exceed specified requirements.

K. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

L. Manufacturer’s detailed field testing procedures.

M. Field quality control test reports.

N. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
   1. Include contact information for entity providing contract maintenance and trouble call-back service.

O. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.

P. Project Record Documents: Record actual installed locations of controllers and final equipment settings.
   1. Include nameplate data of actual installed motors and associated overload relay selections and settings.

1.05 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain copy of each referenced document that prescribes execution requirements at project site.

C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
   1. Authorized service facilities located within 200 miles (320 km) of project site.

D. Installer Qualifications: Company with minimum three years documented experience with variable-frequency motor control systems of similar size, type, and complexity; manufacturer's authorized installer.

E. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to internal components, enclosure, and finish.

1.07 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

1.08 WARRANTY

A. See Division 1 for additional warranty requirements.

B. Provide minimum 18 month manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. ABB: www.abb.com/#sle.

B. Source Limitations: Furnish variable-frequency motor controllers and associated components produced by a single manufacturer and obtained from a single supplier.

2.02 VARIABLE-FREQUENCY MOTOR CONTROLLERS

A. Provide variable-frequency motor control system consisting of required controller assemblies, operator interfaces, control power transformers, instrumentation and control wiring, sensors, accessories, system programming, etc. as necessary for complete operating system.

B. Provide products listed, classified, and labeled as suitable for purpose intended.

C. Variable-Frequency Motor Controller:

D. Controller Assemblies: Comply with NEMA IS 10033, NEMA IS 10034, and NEMA ICS 61800-2; list and label as complying with UL 61800-5-1 or UL 508A as applicable.

E. Provide controllers selected for actual installed motors and coupled mechanical loads in accordance with NEMA IS 10035, NEMA MG 00001 Part 30, and recommendations of manufacturers of both controller and load, where not in conflict with specified requirements; considerations include, but are not limited to:
   1. Motor type (e.g., induction, reluctance, and permanent magnet); consider NEMA MG 00001 design letter or inverter duty rating for induction motors.
   2. Motor load type (e.g., constant torque, variable torque, and constant horsepower); consider duty cycle, impact loads, and high inertia loads.
   3. Motor nameplate data.
   4. Requirements for speed control range, speed regulation, and braking.
   5. Motor suitability for bypass starting method, where applicable.

F. Devices on Load Side of Controller: Suitable for application across full controller output frequency range.

G. Operating Requirements:
   1. Input Voltage Tolerance: Plus/minus 10 percent of nominal.
   2. Input Frequency Tolerance: Plus/minus 5 percent of nominal.
   3. Efficiency: Minimum of 96 percent at full speed and load.
   4. Input Displacement Power Factor: Minimum of 0.96 throughout speed and load range.
   5. Overload Rating:
      a. Variable Torque Loads: Minimum of 110 percent of nominal for 60 seconds.
      b. Constant Torque Loads: Minimum of 150 percent of nominal for 60 seconds.

H. Power Conversion System: Microprocessor-based, pulse width modulation type.

I. Control System:

1. Provide microprocessor-based control system for automatic control, monitoring, and protection of motors. Include sensors, wiring, and connections necessary for functions and status/alarm indications specified.
2. Provide integral operator interface for controller programming, display of status/alarm indications, fault reset, and local control functions including motor run/stop, motor forward/reverse selection, motor speed increase/decrease, and local/remote control selection.
3. Control Functions:
    a. Control Method: Selectable vector and scalar/volts per hertz unless otherwise indicated.
        1) Scalar/Volts per Hertz Control: Provide IR compensation for improved low-speed torque.
        2) Vector Control: Provide selectable autotuning function.
    b. Adjustable acceleration and deceleration time; linear and S-curve ramps; selectable coast to stop.
    c. Selectable braking control; DC injection or flux braking.
    d. Adjustable minimum/maximum speed limits.
    e. Adjustable pulse width modulation switching carrier frequency.
    f. Adjustable motor slip compensation.
    g. Selectable autorestart after noncritical fault; programmable number of time delay between restart attempts.
4. Status Indications:
    a. Motor run/stop status.
    b. Motor forward/reverse status.
    c. Local/remote control status.
    d. Output voltage.
    e. Output current.
    f. Output frequency.
    g. DC bus voltage.
    h. Motor speed.
5. Protective Functions/Alarm Indications:
    a. Overcurrent.
    b. Motor overload.
    c. Undervoltage.
    d. Overvoltage.
    e. Controller overtemperature.
    f. Input/output phase loss.
    g. Output short circuit protection.
    h. Output ground fault protection.
6. Inputs:
    a. Digital Input(s): Three.
    b. Analog Input(s): Two.
7. Outputs:
8. Features:
    a. Password-protected security access.
    b. Event log.

J. Power Conditioning/Filtering:
1. Provide DC link choke or input/line reactor for each controller unless otherwise indicated or required.
2. Reactor Impedance: 3 percent, unless otherwise indicated or required.

K. Packaged Controllers: Controllers factory-mounted in separate enclosure with externally operable disconnect and specified accessories.
1. Disconnects: Circuit breaker or disconnect switch type.

a. Disconnect Switches: Fusible type or nonfusible type with separate input fuses.
b. Provide externally operable handle with means for locking in OFF position. Provide safety interlock to prevent opening cover with disconnect in ON position with capability of overriding interlock for testing purposes.
c. Provide auxiliary interlock for disconnection of external control power sources where applicable.

2. Provide door-mounted remote operator interface.

L. Service Conditions:
1. Provide controllers and associated components suitable for operation under following service conditions without derating:
a. Altitude: Less than 3,300 feet (1,000 m).
b. Ambient Temperature: Between 32 degrees F (0 degrees C) and 104 degrees F (40 degrees C).
2. Provide controllers and associated components suitable for operation at indicated ratings under service conditions at installed location.

M. Short Circuit Current Rating:
1. Provide controllers with listed short circuit current rating not less than available fault current at installed location as indicated on drawings.
2. Provide line/input reactors where specified by manufacturer for required short circuit current rating.

N. Conductor Terminations: Suitable for use with conductors to be installed.

O. Enclosures:
1. Comply with NEMA IA 10030.
2. NEMA EN 10250 Environment Type or Equivalent IEC 60529 Rating: Unless otherwise indicated, as specified for following installation locations:
3. Finish: Manufacturer's standard unless otherwise indicated.
4. Cooling: Forced air or natural convection as determined by manufacturer.

P. Interface with Other Work:
1. Provide products compatible with other systems requiring interface with controllers.
2. Interface with building automation system.
a. Capable of remote monitoring and control of controllers.

Q. Products:
1. ABB; ACH580: www.abb.com/#sle.

2.03 OVERCURRENT PROTECTIVE DEVICES

A. Overload Relays:
1. Provide overload relays and, where applicable, associated current elements/heaters selected for actual installed motor nameplate data, in accordance with manufacturer's recommendations and NFPA 70; include consideration for motor service factor and ambient temperature correction, where applicable.
2. Comply with NEMA ICS 2.
3. Inverse-Time Trip Class Rating: Class 20 unless otherwise indicated or required.
4. Trip-free operation.
5. Visible trip indication.
6. Resettable:
a. Employ manual reset unless otherwise indicated.
b. Do not employ automatic reset with two-wire control.

B. Circuit Breakers:
1. Molded Case Circuit Breakers:
a. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers; listed and labeled as complying with UL 489; ratings, configurations, and features as indicated or as required.

b. Interrupting Capacity:
   1) Provide circuit breakers with interrupting capacity as required to provide short circuit current rating indicated, but not less than specified minimum requirements.
   2) Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than short circuit current rating indicated.
c. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
   1) Provide field-adjustable trip response settings:
d. Provide following features and accessories where indicated or where required to complete installation:
   1) Pad-Lock Provision: For locking circuit breaker handle in OFF position.
   2) Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.

2.04 ACCESSORIES

A. Auxiliary Contacts:
   1. Comply with NEMA IA 10039.
   2. Provide number and type of contacts indicated or required to perform necessary functions, including holding (seal-in) circuit and interlocking, plus one normally open (NO) and one normally closed (NC) spare contact for each bypass motor starter, minimum.

B. Pilot Devices:
   1. Comply with NEMA IA 10039; heavy-duty type.
   2. Pushbuttons: Unless otherwise indicated, provide momentary, nonilluminated type with flush button operator; normally open or normally closed as indicated or as required.
   3. Selector Switches: Unless otherwise indicated, provide maintained, nonilluminated type with knob operator; number of switch positions as indicated or as required.
   4. Indicating Lights: Push-to-test type unless otherwise indicated.
   5. Provide LED lamp source for indicating lights and illuminated devices.

C. Control and Timing Relays:
   1. Comply with NEMA IA 10039.
   2. Provide number and type of relays indicated or required to perform necessary functions.

D. Control Power Transformers:
   1. Size to accommodate burden of contactor coil(s) and connected auxiliary devices, plus _____ VA spare capacity.
   2. Include primary and secondary fuses.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that ratings of controllers are consistent with indicated requirements.

C. Verify that mounting surfaces are ready to accept controllers.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install in accordance with NEMA IS 10034 and manufacturer's instructions.

C. Do not exceed manufacturer's recommended maximum cable length between controller and motor.

D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

E. Provide required support and attachment in accordance with Section 23 05 29.

F. Install controllers plumb and level.

G. Provide grounding and bonding in accordance with Section 26 05 26.

H. Install field-installed devices, components, and accessories.

I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

J. Set field-adjustable settings of controllers and associated components according to installed motor requirements, in accordance with recommendations of manufacturers of controller and load.

3.03 FIELD QUALITY CONTROL

A. Provide services of manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's reports with submittals.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.17. Insulation-resistance test on control wiring listed as optional is not required.

D. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for circuit breakers larger than _____ amperes. Tests listed as optional are not required.

E. Packaged Controllers with Bypass: Test for proper operation in both drive and bypass modes.

F. Test for proper interface with other systems.

G. Correct deficiencies and replace damaged or defective controllers or associated components.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

A. Clean dirt and debris from controller enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

3.06 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate proper operation of controllers to Owner, and correct deficiencies or make adjustments as directed.

B. Training: Train Owner's personnel on operation, adjustment, and maintenance of controllers and associated devices.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Provide minimum of two hours of training.
   3. Instructor: Manufacturer's authorized representative.
   4. Location: At project site.

3.07 PROTECTION

A. Protect installed controllers from subsequent construction operations.

END OF SECTION

SECTION 23 21 13
HYDRONIC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Hydronic system requirements.

B. Heating water piping, above grade.

C. Chilled water piping, above grade.

D. Equipment drains and overflows.

E. Pipe hangers and supports.

F. Unions, flanges, mechanical couplings, and dielectric connections.

1.02 REFERENCE STANDARDS

A. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.

B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.

C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.

D. ASME B31.9 - Building Services Piping; 2025.

E. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.

F. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2025.

G. ASTM B32 - Standard Specification for Solder Metal; 2020.

H. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.

I. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.

J. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 2024.

K. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2019.

L. AWS D10.12M/D10.12 - Guide for Welding Mild Steel Pipe; 2000.

M. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2025.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting at least one week prior to the start of the work of this section; require attendance by all affected installers.

B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.04 SUBMITTALS

A. See Division 1 for Submittal requirements

B. Product Data:
   1. Include data on pipe materials, pipe fittings, valves, and accessories.
   2. Provide manufacturers catalog information.
   3. Indicate valve data and ratings.

C. Shop Drawings: Submit complete shop drawings for piping system showing all fittings, elevations, pipe accessories, hanger locations and all connected equipment. Submit shop drawings electronically in PDF or DWG format. Drawings shall be produced in AutoCad 2018, or Revit 2018 or later releases.

D. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

E. Project Record Documents: Record actual locations of valves.

F. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

G. Piping Pressure Test Reports: Provide piping pressure test reports indicating:
   1. Owner
   2. Project Address
   3. Project Name
   4. Testing Contractor
   5. Pipe Segment Tested
   6. Pipe Size, Service and material (including wall thickness information (schedule, SDR, etc.)
   7. Test Medium
   8. Date and Time of Test Start
   9. Starting Pressure and Temperature of Test Medium
   10. Starting Ambient Temperature
   11. Date and Time of Test End
   12. Ending Pressure and Temperature of Test Medium
   13. Ending Ambient Temperature
   14. Observations and Conclustions

H. As-Built Drawings: At project closeout, provide as-built drawings of the piping systems installed. Submit in same format as for Shop Drawings above.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified in this section, with minimum three years of experience.

C. Welder Qualifications: Certify in accordance with AWS D1.1/D1.1M.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.07 FIELD CONDITIONS

A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.01 HYDRONIC SYSTEM REQUIREMENTS

A. Comply with ASME B31.9 and applicable federal, state, and local regulations.

B. Piping: Provide piping, fittings, hangers, and supports as required, as indicated, and as follows:
   1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
   2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
   3. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.

C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.

D. Valves: Provide valves where indicated:

1. Provide drain valves where indicated, and if not indicated, provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch (20 mm) ball valves with cap; pipe to nearest floor drain.
2. Isolate equipment using butterfly valves with lug end flanges.
3. For throttling and isolation service in chilled and condenser water systems, use only butterfly valves.

2.02 HEATING WATER PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:
   1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
   2. Threaded Joints (through 2"): ASME B16.3, malleable iron fittings.

B. Copper Tube: ASTM B88 (ASTM B88M), Type L (Type B), drawn temper, using one of the following joint types:
   1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
      a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
      b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.

2.03 CHILLED WATER PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black; using one of the following joint types:
   1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D10.12M/D10.12 welded.
   2. Threaded Joints: ASME B16.3, malleable iron fittings,

B. Copper Tube: ASTM B88 (ASTM B88M), Type L (Type B), drawn temper.
   1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22, solder wrought copper fittings.
      a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
      b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.

2.04 EQUIPMENT DRAINS AND OVERFLOWS

A. Steel Pipe: ASTM A53/A53M, Schedule 40 galvanized; using one of the following joint types:
   1. Threaded Joints: Galvanized cast iron, or ASME B16.3 malleable iron fittings.

B. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), drawn; using one of the following joint types:
   1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.

2.05 ESCUTCHEON PLATES

A. Stainless steel, 16 Ga, one or two piece, sized for piping or insulation system outside diameter, outside diameter of escutcheon plate shall fully cover wall opening/sealant system, with a neat, finished appearance.

2.06 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.
   1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
   2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inches (13 to 38 mm): Malleable iron, adjustable swivel, split ring.
   3. Hangers for Cold Pipe Sizes 2 Inches (50 mm) and Greater: Carbon steel, adjustable, clevis. Sized for insulation
   4. Hangers for Hot Pipe Sizes 2 to 4 Inches (50 to 100 mm): Carbon steel, adjustable, clevis.
   5. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support. With insulated support foot.

6. Floor Support for Hot Pipe Sizes to 4 Inches (100 mm): Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
7. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

2.07 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

A. Unions for Pipe of 2 Inches (50 mm, DN) and Less:
   1. Ferrous Piping: 150 psi (1034 kPa) brass or malleable iron, threaded.
   2. Copper Pipe: Bronze, soldered joints.

B. Flanges for Pipe 2 Inches (50 mm, DN) and Greater:
   1. Ferrous Piping: 150 psig (1034 kPa) forged steel, slip-on.
   2. Copper Piping: Bronze.
   3. Gaskets: 1/16 inch (1.6 mm) thick, preformed neoprene.

C. Dielectric Connections:
   1. Waterways:
      a. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
      b. Dry insulation barrier able to withstand 600-volt breakdown test.
      c. Construct of galvanized steel with threaded end connections to match connecting piping.
      d. Suitable for the required operating pressures and temperatures.

2.08 BALANCING VALVES

A. Manufacturers:
   1. ITT Bell & Gossett: Model Circuit Setter: www.bellgossett.com.

B. Construction:
   1. 1/2" to 2" Pipe Size
      a. Bronze body, brass ball construction with glass and carbon filled TFE seat rings. Valves to have differential pressure read-out ports across valve seat area. Read-out ports shall have integral EPT insert and check valve. Valve bodies shall have 1/4" tapped drain/purge point. Valve to have memory stop feature and integral calibrated nameplate with position indication. 300 psig design pressure, NPT connections. 250 F operating termperature.
   2. 2-1/2" to 12" Pipe Size
      a. Cast iron, flanged construction with 125 psig flanged connections suitable up to 175 psig working pressure at 250 F. Valves 2-1/2" - 3" shall have a brass ball with glass and carbon filled TFE seat rings. Valves 4" - 12" shall be fitted with a bronze seat, replaceable bronze disc with EPDM seal insert, and stainless steel stem. Valves shall have memory stop feature and calibrated nameplate with position indication.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment using jointing system specified.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

E. After completion, fill, clean, and treat systems. See Section 23 25 00 for additional requirements.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install heating water, glycol, chilled water, condenser water, and engine exhaust piping to ASME B31.9 requirements.

C. Route piping in orderly manner, parallel to building structure, and maintain gradient.

D. Install piping to conserve building space and to avoid interference with use of space.

E. Group piping whenever practical at common elevations.

F. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified.

G. Slope piping and arrange to drain at low points.

H. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58.
   2. Support horizontal piping as scheduled.
   3. Install hangers to provide minimum 1/2-inch (13 mm) space between finished covering and adjacent work.
   4. Place hangers within 12 inches (300 mm) of each horizontal elbow.
   5. Use hangers with 1-1/2 inches (38 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   6. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

I. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

J. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.

K. Finish paint exposed piping prepped for painting per previous paragraph.

L. Install valves with stems upright or horizontal, not inverted.

3.03 TESTING

A. Unless otherwise noted, pressure test in accordance with California Mechanical Code, Chapter 12.

B. Provide necessary caps or blinds to protect equipment not rated for test pressure (safety valves, regulators, etc.).

C. Pneumatic Testing:
   1. Pneumatic testing is expressly prohibited on any non-metallic piping.
   2. Other than as excepted above, pneumatic testing will not be considered without written consent from Owner or architect, and substantiation as to why hydrotesting is inapplicable. Additional testing requirements and measures may be required for a pneumatic test and will be considered on a case-by-case basis.

D. Reports: Submit test reports for all pipeline sections tested per Submittals requirements in Part 1 of this specification.

3.04 SCHEDULES

A. Hanger Spacing for Steel Piping.
   1. 1/2 Inch (15 mm), 3/4 Inch (20 mm), and 1 Inch (25 mm): Maximum span, 7 feet (2100 mm); minimum rod size, 1/4 inch (6 mm).
   2. 1-1/4 Inches (32 mm): Maximum span, 8 feet (2400 mm); minimum rod size, 3/8 inch (9 mm).
   3. 1-1/2 Inches (40 mm): Maximum span, 9 feet (2700 mm); minimum rod size, 3/8 inch (9 mm).
   4. 2 Inches (50 mm): Maximum span, 10 feet (3.0 m); minimum rod size, 3/8 inch (9 mm).
   5. 2-1/2 Inches (65 mm): Maximum span, 11 feet (3.4 m); minimum rod size, 3/8 inch (9 mm).
   6. 3 Inches (80 mm): Maximum span, 12 feet (3.6 m); minimum rod size, 3/8 inch (9 mm).
   7. 4 Inches (100 mm): Maximum span, 14 feet (4.3 m); minimum rod size, 1/2 inch (13 mm).
   8. 6 Inches (150 mm): Maximum span, 17 feet (5.1 m); minimum rod size, 1/2 inch (13 mm).
   9. 8 Inches (200 mm): Maximum span, 19 feet (5.8 m); minimum rod size, 5/8 inch (16 mm).

END OF SECTION

SECTION 23 21 14
HYDRONIC SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Air vents.

B. Strainers.

C. Suction diffusers.

D. Combination pump discharge valves.

E. Pressure-temperature test plugs.

F. Balancing valves.

1.02 REFERENCE STANDARDS

A. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2020.

1.03 SUBMITTALS

A. See Divsion 1 for submittal procedures.

B. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description and model.

C. Manufacturer's qualification statement.

D. Project Record Documents: Record actual locations of flow controls.

E. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. Installer Qualifications: Company specializing in installation of the type of products specified in this section, with minimum three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept Specialities on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary end caps and closures on devices, piping and fittings. Maintain in place until installation.

C. Protect piping systems and equipment from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 AIR VENTS

A. Manufacturers:
   1. Armstrong International, Inc: www.armstronginternational.com/#sle.
   2. Bell & Gossett, a brand of Xylem, Inc: www.bellgossett.com/#sle.

B. Manual Air Vent: Short vertical sections of 2-inch (50 mm, DN) diameter pipe to form air chamber, with 1/8 inch (6 mm, DN) brass needle valve at top of chamber.

C. Float Air Vent:
   1. Standard Duty: Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve. With pipe away provisions.

D. Maximum Fluid Pressure: 150 psi (1,034 kPa).

E. Maximum Fluid Temperature: 250 degrees F (121.1 degrees C).

2.02 STRAINERS

A. Manufacturers:
   1. Mueller Steam Speciaties, a Watts Co: www.watts.com:

B. Size 2 inch (50 mm, DN) and Under:
   1. Provide threaded bronze or iron body for up to 175 psi (1,200 kPa) working pressure, Y-pattern strainer with 1/32 inch (0.8 mm) stainless steel perforated screen.
   2. Mueller Steam Specikalty: Model 351M
   3. Or approved equal.

C. Size 2-1/2 inch (65 mm, DN) to 4 inch (100 mm, DN):
   1. Provide flanged forged steel or iron body for up to 150 psi (1028 kPa) working pressure, up to 250 degrees F (121.1 degrees C) working temperature, Y-pattern strainer with 1/16 inch (1.6 mm) stainless steel perforated screen.
   2. Mueller Steam Specialties: Model 781
   3. Or approved equal

2.03 SUCTION DIFFUSERS

A. Manufacturers:
   1. Bell & Gossett, a brand of Xylem, Inc: www.bellgossett.com/#sle.
   2. Substitutions: See Section 01 60 00 - Product Requirements.

B. Fitting: Angle pattern, cast-iron body, threaded for 2 inch (50 mm) and smaller, flanged for 2-1/2 inch (65 mm, DN) and larger, rated for 175 psi (1200 kPa) working pressure, with inlet vanes, cylinder strainer with 3/16 inch (5 mm) diameter openings, disposable 5/32 inch (4 mm) mesh strainer to fit over cylinder strainer, 20 mesh startup screen, and permanent magnet located in flow stream and removable for cleaning.

2.04 PUMP CONNECTORS

A. Manufacturers:
   1. The Metraflex Company: www.metraflex.com/#sle.

B. Flexible Connectors: Flanged, braided type with wetted components of stainless steel, sized to match piping.
   1. Maximum Operating Service: 150 psi (1030 kPa) at 240 degrees F (115.6 degrees C).
   2. Accommodate the Following:
      a. Axial Deflection in Compression and Expansion: 1/2"
      b. Lateral Movement: 1".
      c. Angular Rotation: 15 degrees.
      d. Force developed by 1.5 times specified maximum allowable operating pressure.
   3. End Connections: Flanged ductile iron; complying with ASME B16.1 Class 125.or threaded to match pump/suction diffuser fittings.
   4. Provide necessary accessories including, but not limited to, swivel joints.

2.05 COMBINATION PUMP DISCHARGE VALVES

A. Manufacturers:
   1. Bell & Gossett, Xlyem: Triple Duty Valve, www.xylem.com
   2. Substitutions: See Division 1

B. Class 125:
   1. Maximum Service Operation: 175 psi (1,200 kPa) at 125 degrees F (51.7 degrees C).

C. Triple-Duty Globe Type: Flanged cast-iron straight pattern body with bolt-on bonnet, position indicator, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, metering connectors, flow shutoff mechanism, and adjustable flow handle.

2.06 PRESSURE-TEMPERATURE TEST PLUGS

A. Manufacturers:

1. Peterson Equipment Company Inc; Pete's Plug: www.petesplug.com/#sle.

B. Construction: Brass body designed to receive temperature or pressure probe with removable protective cap, and Nordel rated for minimum 200 degrees F (93 degrees C).

C. Application: Use extended length plugs to clear insulated piping.

2.07 BALANCING VALVES

A. Manufacturers:
1. ITT Bell & Gossett: Model Circuit Setter: www.bellgossett.com.

B. Construction:
1. 1/2" to 2" Pipe Size
a. Bronze body, brass ball construction with glass and carbon filled TFE seat rings. Valves to have differential pressure read-out ports across valve seat area. Read-out ports shall have integral EPT insert and check valve. Valve bodies shall have 1/4" tapped drain/purge point. Valve to have memory stop feature and integral calibrated nameplate with position indication. 300 psig design pressure, NPT connections. 250 F operating termperature.
2. 2-1/2" to 12" Pipe Size
a. Cast iron, flanged construction with 125 psig flanged connections suitable up to 175 psig working pressure at 250 F. Valves 2-1/2" - 3" shall have a brass ball with glass and carbon filled TFE seat rings. Valves 4" - 12" shall be fitted with a bronze seat, replaceable bronze disc with EPDM seal insert, and stainless steel stem. Valves shall have memory stop feature and calibrated nameplate with position indication.

2.08 LINK SEALS

A. The pipe to wall penetration closures shall be Link-Seal, as manufactured by Thunderline Corporation, or approved equal.

B. Seals shall be modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut.\

C. After the seal assembly is positioned in the opening, tightening of the bolts shall cause the rubber sealing elements to expand and effect a watertight seal between the pipe and opening.

D. Manufacturer shall be consulted for exact size of opening and model/construction of seal to be used for each application.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install specialties and equipment in accordance with manufacturer's instructions.

B. Provide manual air vents at system high points and as indicated.

C. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.

D. Provide valved drain and hose connection on strainer blowdown connection.

E. Provide pump suction fitting on suction side of base-mounted centrifugal pumps where indicated. Remove temporary strainers after cleaning systems.

F. Support pump fittings with floor-mounted pipe and flange supports.

END OF SECTION

SECTION 23 21 23
HYDRONIC PUMPS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. In-line pumps.(stacked verticl turbine)

B. End-suction pumps.

1.02 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. UL 778 - Standard for Motor-Operated Water Pumps; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Division 1 for submittal procedures.

B. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.

C. Millwright's Certificate: Certify that base mounted pumps have been aligned. Submit alignment report.

D. Submit proof that vertical turbine pumps were installed aligned, and started by authorized factory representatives.

E. Manufacturer's Installation Instructions: Indicate hanging and support requirements and recommendations.

F. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacture, assembly, and field performance of pumps, with minimum three years of documented experience.

B. Installers Qualifications: Company specializing in manufacture, assembly, field alignment and adjustment and performance of pumps, with minimum three years of documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Bell & Gossett, a Xylem Inc. brand; Series e-1510 and e-SV: www.bellgossett.com/#sle.

B. Substitutions: See Division 1 for substitution requirements and submittals.

2.02 GENERAL

A. Provide pumps that operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

B. Base Mounted Pumps: Aligned by qualified millwright.

C. Electrical Requirements:
   1. Listed and classified by UL or testing agency acceptable to authority having jurisdiction as suitable for the purpose specified and indicated.
   2. Variable Frequency Drives (VFDs): Provide in accordance with Section 23 09 34, except for integral-VFDs.

2.03 IN-LINE PUMPS

A. Split-Coupled, Multi-Stage: Vertical pump with radially-split casing, bottom mount suction, and discharge pipe connections with gauge ports rated for discharge pressures up to 580 psi (3999 kPa).

B. Casing: Cast iron with seal flush connection, flanged suction, and discharge ports with gauge port and drain plug.

C. Impeller: Bronze, fully enclosed, keyed directly to motor shaft or extension.

D. Shaft: Carbon steel with stainless steel impeller cap screw or nut and bronze sleeve.

E. Seal: Mechanical seal, 225 degrees F (107 degrees C) maximum continuous duty temperature.

F. Electrical:
   1. See Contract Drawings for details.
   2. Motor: 1,750 rpm, open drip-proof (ODP); see Section 23 05 13.
   3. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

2.04 END-SUCTION PUMPS

A. End Suction Pump:: Base-mounted, single-stage pump with horizontal shaft and radially- or horizontally-split casing rated for discharge pressures up to 175 psi (1200 kPa).

B. Casing: Cast iron or ductile iron with renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction, and discharge flanged connections with gauge ports.

C. Impeller: Stainless steel, balanced, fully enclosed, keyed to shaft.

D. Bearings: Grease lubricated roller or ball bearings.

E. Shaft: Alloy steel with copper, bronze, or stainless steel shaft sleeve.

F. Seal: Mechanical, 225 degrees F (107 degrees C) maximum continuous duty temperature.

G. Drive: Flexible coupling with coupling guard.

H. Baseplate: Cast iron or fabricated steel with integral drain rim.

I. Performance:
   1. See Contract Drawings for pump schedules.

J. Electrical:
   1. See Contract Drawings for pump schedules.
   2. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

2.05 VERTICAL TURBINE PUMPS

A. Base mounted, vertical multistage turbine pump coupled to a standard motor. The liquid end, located between the upper cover and the pump casing, is held in place by tie rods. Connection arrangment and fitting types as shown on drawings.
   1. 360 psig max operating pressure,
   2. 250 F max operating temperatiure.
   3. Motor: TEFC, premium efficiendy, VFD compatible, 3500 rpm motor and bearings. Voltage and phase per schedule.
   4. All wetted parts shall be stainless steel.
   5. ANSI flanges in line shall be AISI 316 stainless steel.
   6. Mechanical Seal

B. Capacities per schedule on Contract Drawiings

C. Goulds Water Technology e-SV Multistage pump

D.

PART 3 EXECUTION

3.01 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.

C. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For close-coupled or base-mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches (102 mm) and over.

D. Provide line sized shut-off valve and strainer on pump suction, and line sized check and shut off valve on pump discharge.

E. Provide air cock and drain connection on horizontal pump casings.

F. Provide drains for bases and seals, piped to and discharging into floor drains.

G. Check, align, and certify alignment of base-mounted pumps prior to start-up. Provide aligment report for each pump. Comply with alignment procedures on vertical turbine pumps per manufacturer's written instruction.

H. Provide pump anchorge and inertia pads as required by manufacturer and as shown on drawings.

I. Fully grout all frame bases after pump alignment.

J. Lubricate pumps before start-up.

END OF SECTION

SECTION 23 25 00
HVAC WATER TREATMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Materials.
   1. Materials as required to replenish or re-concentrate affected systems during construction progress.

1.02 SUBMITTALS

A. See Dvision 1 for submittal procedures.

B. Product Data: Provide chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.

C. Manufacturer's Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience. Company shall have local representatives with water analysis laboratories and full time service personnel.

B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum _____ years of experience and approved by manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Utilize Trreatment company regularly employed by District to maintain temporary systems protected under the contract.

2.02 REGULATORY REQUIREMENTS

A. Comply with applicable codes for addition of non-potable chemicals to building mechanical systems and to public sewage systems.

B. Perform work in accordance with local health department regulations.

2.03 MATERIALS

A. Compatible with existing water treatment program.

B. Provide rental/temporary water treatment equipment such as feeders, test points, injection ports, contanment systems for all temporary heating and cooling plants used for the project.

PART 3 EXECUTION

3.01 PREPARATION

A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.

B. Place terminal control valves in open position during cleaning.

C. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.03 CLOSED SYSTEM TREATMENT

A. Replanish and continue chemical treatment of hydronic heating and cooling systems affected by this project.

END OF SECTION

SECTION 26 05 05
SELECTIVE DEMOLITION FOR ELECTRICAL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical demolition.

1.02 SUBMITTALS

A. See Division 1 - Administrative Requirements for submittal procedures.

B. Sustainable Design Documentation: Submit certification of removal and appropriate disposal of abandoned cables containing lead stabilizers.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify field measurements and circuiting arrangements are as indicated.

B. Verify that abandoned wiring and equipment serve only abandoned facilities.

C. Demolition drawings are based on casual field observation and existing record documents.

D. Report discrepancies to architect/engineer before disturbing existing installation.

E. Beginning of demolition means installer accepts existing conditions.

3.02 PREPARATION

A. Disconnect electrical systems in walls, floors, and ceilings to be removed.

B. Coordinate utility service outages with utility company.

C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
   1. Obtain permission from Owner at least 720 hours before partially or completely disabling system.
   2. Make temporary connections to maintain service in areas adjacent to work area.
   3. Provide temporary power as directed on contract documents.

E. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Minimize outage duration.
   1. Notify Owner before partially or completely disabling system.
   2. Notify local fire service.
   3. Make notifications at least 720 hours in advance.
   4. Provide fire watch as required at no additional cost to the project.

F. Existing Distribution System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
   1. Obtain permission from Owner at least 720 hours before partially or completely disabling system.
   2. Make temporary connections to maintain service in areas adjacent to work area.
   3. Provide temporary power as directed on contract documents.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Perform work for removal and disposal of equipment and materials containing toxic substances regulated under the Federal Toxic Substances Control Act (TSCA) in accordance with applicable federal, state, and local regulations. Applicable equipment and materials include, but are not limited to:
   1. PCB-containing electrical equipment, including transformers, capacitors, and switches.

B. Remove, relocate, and extend existing installations to accommodate new construction.

C. Remove abandoned wiring to source of supply.

D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.

F. Disconnect and remove abandoned panelboards and distribution equipment.

G. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.

H. Repair adjacent construction and finishes damaged during demolition and extension work.

I. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

J. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

3.04 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment that remain or that are to be reused.

B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

END OF SECTION

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Single conductor building wire.

B. Metal-clad cable.

C. Variable-frequency drive cable.

D. Wiring connectors.

E. Electrical tape.

F. Heat shrink tubing.

G. Wire pulling lubricant.

H. Firestop sleeves.

1.02 REFERENCE STANDARDS

A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013 (Reapproved 2024).

B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2023.

C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010, with Editorial Revision (2020).

D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2020).

E. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2024.

F. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

G. NECA 120 - Standard for Installing Armored Cable (AC) and Type Metal-Clad (MC) Cable; 2018.

H. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; 2021.

I. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.

J. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

K. NFPA 79 - Electrical Standard for Industrial Machinery; 2021.

L. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.

M. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.

N. UL 267 - Outline of Investigation for Wire-Pulling Compounds; Current Edition, Including All Revisions.

O. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.

P. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.

Q. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.

R. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.

S. UL 1569 - Metal-Clad Cables; Current Edition, Including All Revisions.

T. UL 2277 - Outline of Investigation for Flexible Motor Supply Cable and Wind Turbine Tray Cable; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Division 1-Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.

1.04 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 CONDUCTOR AND CABLE APPLICATIONS

A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.

B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.

C. Armored cable is not permitted.

D. Metal-clad cable is permitted only as follows:
   1. Where not otherwise restricted, may be used:
      a. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.
         1) Maximum Length: 6 feet (1.8 m).

2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

A. Provide products that comply with requirements of NFPA 70.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.

D. Comply with NEMA WC 70.

E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.

F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.

G. Conductor Material:
   1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
   2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
   3. Tinned Copper Conductors: Comply with ASTM B33.

H. Minimum Conductor Size:
   1. Branch Circuits: 10AWG.

I. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

J. Conductor Color Coding:
   1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.

2. Color Coding Method: Integrally colored insulation.
3. Color Code:
   a. 480Y/277 V, 3 Phase, 4 Wire System:
      1) Phase A: Brown.
      2) Phase B: Orange.
      3) Phase C: Yellow.
      4) Neutral/Grounded: Gray.
   b. 208Y/120 V, 3 Phase, 4 Wire System:
      1) Phase A: Black.
      2) Phase B: Red.
      3) Phase C: Blue.
      4) Neutral/Grounded: White.
   c. Equipment Ground, All Systems: Green.

2.03 SINGLE CONDUCTOR BUILDING WIRE

A. Description: Single conductor insulated wire.

B. Conductor Stranding:
   1. Feeders and Branch Circuits:
      a. Size 14 AWG and Smaller: Solid.
      b. Size 12 AWG and Larger: Stranded.

C. Insulation Voltage Rating: 600 V.

D. Insulation:
   1. Copper Building Wire: Type THHN/THWN-2 or XHHW-2.

2.04 METAL-CLAD CABLE

A. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.

B. Conductor Stranding:
   1. Size 14 AWG and Smaller: Solid.
   2. Size 12 AWG and Larger: Stranded.

C. Insulation Voltage Rating: 600 V.

D. Insulation: Type THHN/THWN-2 or XHHW-2.

E. Grounding: Full-size integral equipment grounding conductor.

F. Armor: Steel, interlocked tape.

2.05 VARIABLE-FREQUENCY DRIVE CABLE

A. Description: Flexible motor supply cable listed and labeled as complying with UL 2277 in accordance with NFPA 79; specifically designed for use with variable frequency drives and associated nonlinear power distortions.

B. Conductor Stranding: Stranded.

C. Insulation Voltage Rating: 1000 V.

D. Insulation: Use only thermoset insulation types; thermoplastic insulation types are not permitted.

E. Grounding: Full-size integral equipment grounding conductor or symmetrical arrangement of multiple conductors of equivalent size.

F. Provide metallic shielding.

G. Jacket: PVC, Chlorinated Polyethylene (CPE), or Cross-linked polyethylene (XLPE).

2.06 WIRING CONNECTORS

A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.

B. Mechanical Connectors: Provide bolted type.

C. Compression Connectors: Provide circumferential type, hex type, or indentor type crimp configuration.

2.07 ACCESSORIES

A. Electrical Tape:
   1. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil (0.18 mm); resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F (105 degrees C).
   2. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil (0.18 mm); resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F (-18 degrees C) and suitable for continuous temperature environment up to 221 degrees F (105 degrees C).

B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.

C. Wire Pulling Lubricant:
   1. Listed and labeled as complying with UL 267.
   2. Suitable for use with conductors/cables and associated insulation/jackets to be installed.
   3. Suitable for use at installation temperature.

D. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for cables and roofing system to be installed; designed to accommodate existing penetrations where applicable.

E. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that work likely to damage wire and cable has been completed.

C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.

D. Verify that field measurements are as indicated.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 INSTALLATION

A. Circuiting Requirements:
   1. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
   2. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
   3. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is permitted, under the following conditions:

a. Provide no more than three current-carrying conductors in a single raceway, unless de-rating is approved by engineer or shown on drawings. Dedicated neutral conductors are considered current-carrying conductors.
b. Increase size of conductors as required to account for ampacity derating.
c. Size raceways, boxes, etc. to accommodate conductors.

4. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
a. Branch circuits fed from ground fault circuit interrupter (GFCI) circuit breakers.
b. Branch circuits with isolated grounding conductor.

B. Install products in accordance with manufacturer's instructions.

C. Perform work in accordance with NECA 1 (general workmanship).

D. Install metal-clad cable (Type MC) in accordance with NECA 120.

E. Installation in Raceway:
1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
2. Pull all conductors and cables together into raceway at same time.
3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.

F. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.

G. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.

H. Terminate cables using suitable fittings.
1. Metal-Clad Cable (Type MC):
a. Use listed fittings.
b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.

I. Variable-Frequency Drive Cable: Terminate shielding at both variable-frequency motor controller and associated motor using glands or termination kits recommended by manufacturer.

J. Install conductors with a minimum of 12 inches (300 mm) of slack at each outlet.

K. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

L. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.

M. Make wiring connections using specified wiring connectors.
1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
3. Do not remove conductor strands to facilitate insertion into connector.
4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.

5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
6. Mechanical Connectors: only to be used for lug terminations at bus
7. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

N. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.

O. Insulate ends of spare conductors using vinyl insulating electrical tape.

P. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified by UL certified system.

Q. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.04 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. See Division 1, for additional requirements.

C. Inspect and test in accordance with NETA ATS, except Section 4.

D. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is only required for conductors larger than 3/0. The resistance test for parallel conductors listed as optional is not required.

E. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Grounding and bonding requirements.

B. Conductors for grounding and bonding.

C. Connectors for grounding and bonding.

1.02 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittals procedures.

B. See Division 1-Administrative Requirements for submittals procedures.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

A. Do not use products for applications other than as permitted by NFPA 70 and product listing.

B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.

C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

D. Grounding System Resistance:
   1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by architect. Precipitation within the previous 48 hours does not constitute normally dry conditions.

2.02 GROUNDING AND BONDING COMPONENTS

A. General Requirements:
   1. Provide products listed, classified, and labeled as suitable for the purpose intended.
   2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 05 26:
   1. Use insulated copper conductors unless otherwise indicated.
      a. Exceptions:
         1) Use bare copper conductors where installed underground in direct contact with earth.
         2) Use bare copper conductors where directly encased in concrete (not in raceway).

C. Connectors for Grounding and Bonding:
   1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
   2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
   3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.

END OF SECTION

SECTION 26 05 33.13
CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Galvanized steel rigid metal conduit (RMC).

B. PVC-coated galvanized steel rigid metal conduit (RMC).

C. Flexible metal conduit (FMC).

D. Liquidtight flexible metal conduit (LFMC).

E. Galvanized steel electrical metallic tubing (EMT).

F. Rigid polyvinyl chloride (PVC) conduit.

1.02 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2020.

B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S); 2020.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

D. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2020.

E. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); 2025.

F. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.

G. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Metal Conduit and Intermediate Metal Conduit; 2018.

H. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2020.

I. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2021.

J. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

K. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.

L. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.

M. UL 360 - Liquid-Tight Flexible Metal Conduit; Current Edition, Including All Revisions.

N. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

O. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.

P. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.

Q. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.

R. UL 2419 - Outline of Investigation for Electrically Conductive Corrosion Resistant Compounds; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate minimum sizes of conduits with actual type and quantity of conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
   2. Coordinate arrangement of conduits with structural members, ductwork, piping, equipment, and other potential conflicts.
   3. Verify exact conduit termination locations required for boxes, enclosures, and equipment.
   4. Coordinate work to provide roof penetrations that preserve integrity of roofing system and do not void roof warranty.

5. Notify engineer of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not begin installation of conductors and cables until installation of conduit between termination points is complete.

1.04 SUBMITTALS

A. See Division 1 for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.

C. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2-inch (53 mm) trade size and larger.

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70, manufacturer's instructions, and product listing.

B. Unless otherwise indicated and where not otherwise restricted, use conduit types indicated for specified applications. Where more than one listed application applies, comply with most restrictive requirements. Where conduit type for particular application is not specified, use galvanized steel rigid metal conduit.

C. Underground:
   1. Under Slab on Grade: Use galvanized steel rigid metal conduit (RMC), PVC-coated galvanized steel rigid metal conduit (RMC), or rigid PVC conduit.
   2. Exterior, Direct-Buried: Use PVC-coated galvanized steel rigid metal conduit or rigid PVC conduit.
   3. Exterior, Embedded Within Concrete: Use galvanized steel rigid metal conduit (RMC), PVC-coated galvanized steel rigid metal conduit (RMC), or rigid PVC conduit.
   4. Where rigid polyvinyl chloride (PVC) conduit is provided, transition to PVC-coated galvanized steel rigid metal conduit (RMC) where emerging from underground.
   5. Where rigid polyvinyl (PVC) conduit is provided, use PVC-coated galvanized steel rigid metal conduit (RMC) elbows for bends.

D. Embedded Within Concrete:
   1. Within Slab on Grade: Use galvanized steel rigid metal conduit (RMC), PVC-coated galvanized steel rigid metal conduit (RMC), or rigid PVC conduit. Embed within structural slabs only where approved by Structural Engineer.
   2. Within Slab Above Ground: Not permitted.

E. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit (RMC) or galvanized steel electrical metallic tubing (EMT).

F. Concealed Within Hollow Stud Walls: Use galvanized steel rigid metal conduit (RMC) or galvanized steel electrical metallic tubing (EMT).

G. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit (RMC) or galvanized steel electrical metallic tubing (EMT).

H. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit (RMC) or galvanized steel electrical metallic tubing (EMT).

I. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit (RMC) or galvanized steel electrical metallic tubing (EMT).

J. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit (RMC) .
   1. Locations subject to physical damage include, but are not limited to:

a. Where exposed below 8 feet (2.4 m), except within electrical and communication rooms or closets.

K. Exposed, Exterior, Not Subject to Severe Physical Damage: Use galvanized steel rigid metal conduit (RMC).

L. Exposed, Exterior, Subject to Severe Physical Damage: Use galvanized steel rigid metal conduit (RMC).

M. Corrosive Locations Above Ground: Use PVC-coated galvanized steel rigid metal conduit (RMC).

N. Flexible Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit (FMC).
1. Maximum Length: 6 feet (1.8 m).

O. Flexible Connections to Vibrating Equipment:
1. Dry Locations: Use flexible metal conduit (FMC).
2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit (LFMC).
3. Maximum Length: 6 feet (1.8 m) unless otherwise indicated.
4. Vibrating equipment includes, but is not limited to:
a. Transformers.
b. Motors.

2.02 CONDUIT - GENERAL REQUIREMENTS

A. Comply with NFPA 70.

B. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling mandrel through them.
1. Where permitted, existing conduits to be reused may be used as sole equipment grounding conductor only when continuity of conduit pathway, including associated boxes and fittings, is verified; see Section 26 05 26.

C. Provide conduit, fittings, supports, and accessories required for complete raceway system.

D. Provide products listed, classified, and labeled as suitable for purpose intended.

E. Minimum Conduit Size, Unless Otherwise Indicated:
1. Branch Circuits: 3/4-inch (21 mm) trade size.
2. Underground, Interior: 3/4-inch (21 mm) trade size.
3. Underground, Exterior: 1-inch (27 mm) trade size.

F. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

B. Fittings:
1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6.
2. Material: Use steel.
3. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.04 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.

B. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil, 0.040 inch (1.02 mm).

C. PVC-Coated Boxes and Fittings:
   1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
   2. Nonhazardous Locations: Use boxes and fittings listed and labeled as complying with UL 514A, UL 514B, or UL 6.
   3. Material: Use steel.
   4. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil, 0.040 inch (1.02 mm).

D. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil, 0.015 inch (0.38 mm).

2.05 FLEXIBLE METAL CONDUIT (FMC)

A. Description: NFPA 70, Type FMC standard-wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems.

B. Fittings:
   1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Material: Use steel.

2.06 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

B. Fittings:
   1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Material: Use steel.

2.07 GALVANIZED STEEL ELECTRICAL METALLIC TUBING (EMT)

A. Description: NFPA 70, Type EMT galvanized steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

B. Fittings:
   1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Material: Use steel.
   3. Connectors and Couplings: Use compression/gland type.
      a. Do not use indenter type connectors and couplings.
      b. Do not use set-screw type connectors and couplings.

2.08 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

A. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.

B. Fittings:
   1. Manufacturer: Same as manufacturer of conduit to be connected.
   2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.09 ACCESSORIES

A. Conduit Joint Compound: Corrosion-resistant, electrically conductive compound listed as complying with UL 2419; suitable for use with conduit to be installed.

B. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.

C. Pull Strings: Use nylon or polyester tape with average breaking strength of not less than 1,250 lbf (5.6 kN).

D. Sealing Compound for Hazardous/Classified Location Sealing Fittings: Listed for use with particular fittings to be installed.

E. Sealing Systems for Concrete Penetrations:
   1. Sleeves: Provide water stop ring or cement coating that bonds to concrete to prevent water infiltration.
   2. Rate for minimum of 40 psig; suitable for sealing around conduits to be installed.

F. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for conduits and facade materials to be installed.

G. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.

H. Duct Bank Spacers: Nonmetallic; designed for maintaining conduit/duct spacing for concrete encasement in open trench installation; suitable for conduit/duct arrangement to be installed.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive conduits.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install conduit in accordance with NECA 1.

C. Galvanized Steel Rigid Metal Conduit (RMC): Install in accordance with NECA 101.

D. PVC-Coated Galvanized Steel Rigid Metal Conduit (RMC): Install using only tools approved by manufacturer.

E. Rigid Polyvinyl Chloride (PVC) Conduit: Install in accordance with NECA 111.

F. Conduit Routing:
   1. Unless dimensioned, conduit routing indicated is diagrammatic.
   2. When conduit destination is indicated without specific routing, determine exact routing required.
   3. Conceal conduits unless specifically indicated to be exposed.
   4. Conduits in the following areas may be exposed, unless otherwise indicated:
      a. Electrical rooms.
      b. Mechanical equipment rooms.
      c. Within joists in areas with no ceiling.
   5. Unless otherwise approved, do not route exposed conduits:
      a. Across floors.
      b. Across roofs.
      c. Across top of parapet walls.
      d. Across building exterior surfaces.
   6. Conduits installed underground or embedded in concrete may be routed in shortest possible manner unless otherwise indicated. Route other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
   7. Arrange conduit to provide no more than equivalent of four 90-degree bends between pull points.
   8. Maintain minimum clearance of 6 inches (150 mm) between conduits and piping for other systems.

G. Conduit Support:

1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction.
2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
4. Use conduit strap to support single surface-mounted conduit.
   a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
   b. Single hole straps are not acceptable without back spacer.
5. Use metal channel/strut with accessory conduit clamps to support multiple parallel surface-mounted conduits.
6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
7. Use trapeze hangers assembled from threaded rods and metal channel/strut with accessory conduit clamps to support multiple parallel suspended conduits.
8. Use nonpenetrating rooftop supports to support conduits routed across rooftops, where approved.

H. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
6. Where spare conduits stub up through concrete floors and are not terminated in box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor.
7. Provide insulating bushings, insulated throats, or listed metal fittings with smooth, rounded edges at conduit terminations to protect conductors.
8. Secure joints and connections to provide mechanical strength and electrical continuity.

I. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
4. Conceal bends for conduit risers emerging above ground.
5. Provide suitable sealing system where conduits penetrate exterior wall below grade.
6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
8. Install firestopping to preserve fire resistance rating of partitions and other elements.

J. Underground Installation:
1. Minimum Cover, Unless Otherwise Indicated or Required:
   a. Underground, Exterior: 30 inches.
   b. Under Slab on Grade: 12 inches (300 mm) to bottom of slab.
2. Provide underground warning tape along entire conduit length; see Section 26 05 53.

K. Embedment Within Structural Concrete Slabs (only where approved by Structural Engineer):
   1. Secure conduits to prevent floating or movement during pouring of concrete.

L. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
   1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
   2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
   3. Where conduits are subject to earth movement by settlement or frost.

M. Conduit Sealing:
   1. Use foam conduit sealant to prevent entry of moisture and gases. This includes, but is not limited to:
      a. Where conduits enter building from outside.
      b. Where service conduits enter building from underground distribution system.
      c. Where conduits enter building from underground.
      d. Where conduits may transport moisture to contact live parts.
   2. Where conduits cross barriers between areas of potential substantial temperature differential, use foam conduit sealant at accessible point near penetration to prevent condensation. This includes, but is not limited to:
      a. Where conduits pass from outdoors into conditioned interior spaces.
      b. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
      c. Where conduits penetrate coolers or freezers.
   3. Where conduits cross boundaries of hazardous/classified locations, provide identified/listed sealing fittings or conduit mechanical seals as approved by authorities having jurisdiction; locate as indicated or in accordance with NFPA 70.

N. Provide pull string in each empty conduit and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches (300 mm) at each end.

O. Provide grounding and bonding.

P. Identify conduits and label.

3.03 FIELD QUALITY CONTROL

A. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

B. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.

C. Correct deficiencies and replace damaged or defective conduits.

3.04 CLEANING

A. Clean interior of conduits to remove moisture and foreign matter.

3.05 PROTECTION

A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION

SECTION 31 00 00
EARTHWORK AND GRADING

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ASTM D448 - Standard Classification for Sizes of Aggregate for Road and Bridge Construction; 2012 (Reapproved 2022).

B. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)); 2012 (Reapproved 2021).

C. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils; 2017, with Editorial Revision (2018).

1.02 SUMMARY

A. This section describes general requirements, products, and methods of execution relating to onsite earthwork. Any work within the public right-of-way shall be constructed to the standards of Solano County, and the State of California Department of Transportation. Earthwork includes, but is not limited to, the following:
   1. Grading.
   2. Material.
   3. Excavation.
   4. Filling and backfilling.
   5. Soil Sterilant.
   6. Termiticide.

B. Provide labor, material and equipment and services necessary to complete the excavations, recompaction and finish grading as specified and indicated on Plans.
   1. Obtain permit from local authorities.
   2. Provide surveying for grading operations.
   3. Provide shoring design.
   4. Provide dewatering operations.
   5. Provide Site grading, cut, fill and finish.
   6. Provide excavation and backfill for filling construction, including trenches withing building lines.
   7. Preparation for subgrade for building slabs, walks, pavements, and landscaping.
   8. Provide distribution of stockpiled topsoil.
   9. Provide sub-base course for walks and pavements.
   10. Provide sand and gravel for capillary break/moisture barrier under building slabs.
   11. Provide slab-surface drainage backfill for walls and trenches.
   12. Provide Engineered fills for building slab and foundations.

C. The work includes removal and legal disposal off the site of debris, rubbish and other materials resulting from clearing and grubbing operations.

1.03 DEFINITIONS

A. Engineered Fill:

B. On-site Material: Soil or earth material obtained from required on-site excavation.

C. Excavation: Consists of the removal of material encountered to subgrade elevations and the reuse or disposal of materials removed.

D. Subgrade: The uppermost surface of an excavation or the top surface of a fill or backfill immediately below sub-base, drainage fill, or topsoil materials.

E. Borrow: Soil material obtained off-site when sufficient approved soil material is not available from excavations.

F. Base Course: The layer placed between the sub-base and surface pavement is a paving system.

G. Relative Compaction: In-place dry density of soil expressed as percentage of maximum dry density of same materials, as determined by laboratory test procedure American Society for Testing Materials (ASTM) D1557.

H. Subgrade: The uppermost surface of a excavation or the top surface of a fill or backfill immediately below top soil, rock base course, or drainage fill.

1.04 SYSTEM DESCRIPTION

A. Requirements:

B. Criteria:

C. Shoring Design: Where shoring is required by State Law or determined by the Contractor to be necessary, provide proposed excavation shoring method for review prior to commencement of excavation requiring shoring. Include the following information:

D. Dewatering Plan: Based upon site surface and subsurface conditions, including available geotechnical and hydrological data, provide a system to perform the following:

E. Safety:

1.05 1SUBMITTALS

A. Comply with provisions of Section SUBMITTAL PROCEDURES.

B. Product Data: Manufacturer's literature and data, including, where applicable, capacity, labels, or other markings on equipment made to the specified standards for materials, for the following:
   1. Imported materials.
   2. Class II aggregate base (CDT Section 26).
      a. Storm Wate Pollution Prevention / Erosion Control Plans.
   3. Permit/Notice of Intent (N.O.I.) for discharge of storm run-off from the construction site.
      a. Soil Sterilant.
   4. Termiticide.

C. Test Reports: Submit following reports for import material directly to Project Manager from the Contractor's testing services:
   1. Test reports on borrow material.
      a. Density test reports.
   2. One optimum moisture-maximum density curve for each type of soil encountered.
   3. Report of actual unconfined compressive strength and/or results of bearing test of each strata tested.
   4. At least one laboratory optimum moisture - maximum dry density curve for each type of soil encountered.

D. Shoring Design: Submit 4 copies of shoring design and shop plans; none will be returned unless a concern is observed.

E. Submit description of dewatering methods proposed for use.

F. Submit description of vibratory compactors proposed for use when requesting placement of backfill and fill materials in layers greater than 6 inche thick.

G. Samples:
   1. 20-lb. Samples, sealed in air-tight containers, of each proposed fill and backfill soil material from on-site or borrow sources.
   2. 12-by-12 inch sample of filter fabric.

1.06 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:
   1. Comply with State of California Business and Transportation Agency, Department of Transportation (Caltrans) "Standard Specifications."

2. Comply with State of California Code of Regulations (CCR).
3. Comply with State of California Construction Safety Orders, Latest Edition (CAL/OSHA).
    a. San Mateo Department of Public Works, Standards and Specifications and Plans.

B. Soil Testing:
1. District will engage a geotechnical testing agency, to include testing soil materials proposed for use in the work and for quality control testing during excavation and fill operations.
2. Test results will be distributed in compliance with Section TESTING AND INSPECTION.

C. Codes and Standards:
1. Perform excavation work in compliance with applicable requirements of authorities having jurisdiction.
2. Storm Water Pollution Prevention and Monitoring Plan to be prepared by others.
3. Statewide General Permit to Discharge Storm Water associated with construction activity.

D. Comply with the latest editions of the following Standards and Regulations:
1. American Society for Testing and Materials (ASTM):
    a. C33: Concrete Aggregates.
    b. C125: Standard Terminology Relating to Concrete and Concrete Aggregates.
    c. C136: Sieve Analysis of Fine and Coarse Aggregates.
    d. C566: Total Evaporable Moisture Content of Aggregate by Drying.
    e. D421: Dry Preparation of Soil Samples for Particle-Size and Determination of Soil Constants.
    f. D422: Particle Size Analysis of Soil
    g. D854: Specific Gravity of Soils.
    h. D1556: Density of Soil by the Sand Cone Method.
    i. D1557: Laboratory Compaction Characteristics of Soil Using Modified Effort
    j. D2216: Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures.
    k. D2487: Classification of Soils for Engineering Purposes.
    l. D2922: Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
    m. D2937: Density of Soil in Place by Drive Cylinder Method.
    n. D3017: Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
    o. D4318: Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
2. California Code of Regulations, Title 24, Part 2 - Basic Building Regulations, Chapter 24 Excavations, Foundations, and Retaining Walls.
3. California Department of Transportation (CDT) Standard Specifications:
    a. Section 17:
    b. Section 18:
    c. Section 19: Earthwork.
4. CAL/OSHA, Title 8.
5. Other authorities having jurisdiction

E. Geotechnical Engineering Services:
1. Geotechnical Engineer will observe grading observations during preparation offsite, excavation, and compaction of fill materials.
2. Make visits to site to familiarize himself generally with progress and quality of work.
3. Make field observations and tests to enable him to form opinions regarding adequacy of site preparation, acceptability of fill materials and extent to which earthwork construction and relative compaction comply with specifications requirements.
4. Examine conditions exposed in foundation excavations.

F. Site Information:

1. Soil borings and other exploratory operations may be made by Contractor at no cost to District. Submit proposed boring locations for review prior to performing the work.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect materials of this section before, during and after installation; objects designated to be retained; and the installed work of other trades.

B. In the event of damage to any these items, immediately make repairs or replacements necessary to the acceptance of the Project Manager and at no additional cost to the District.

C. Comply with provisions of Section 01500 - TEMPORARY FACILITIES AND CONTROLS where necessary to control dust and noise on and near the work caused by operations during performance of the Work.

1.08 PROJECT CONDITIONS

A. Environmental Requirements:
   1. When unfavorable weather conditions necessitate interrupting filling and grading operations, prepare areas by compaction of surface and grading to avoid collection of water.
      a. Provide adequate temporary drainage to prevent erosion.
   2. After interruption, reestablish compaction specified in last layer before resuming work.
      a. Protect existing storm drainage system from slit and debris resulting from construction activities. If contamination occurs, remove contamination at no cost to District.
   3. Protect existing streams, ditches and storm drain inlets from water-borne soil by means of straw bale dikes, filter fiber dams, or other methods of approved by the Project Manager.

B. Barricade open excavations and post with warning lights.
   1. Comply with requirements of Section TEMPORARY FACILITIES AND CONTROLS.
      a. Operate warning lights as recommended by authorities having jurisdiction.
   2. Protect structures, utilities, sidewalks, pavements, and other facilities immediately adjacent to excavations, from damages caused by settlement, lateral movement, undermining, washout and other hazards.

C. Protection of Subgrade: Do not allow equipment to pump or rut subgrade, stripped areas, footing excavations, or other areas prepared for project.

D. At Contractor's option, a working pad of granular material may be laid to protect footing and floor subgrade soils from disruption by traffic during wet conditions.

E. Transport all excess soils materials by legally approved methods to disposal areas.
   1. Coordinate with the Project Manager.
   2. Sufficient topsoil and fill material shall be retained from the site to complete project requirements.
      a. Any additional topsoil and fill requirements shall be the responsibility of the Contractor.

F. Use of explosives will not be permitted.

G. Dust Control Requirements: At all times during earthwork operations and until final completion and acceptance of earthwork, the Contractor shall prevent the formation of an airborne dust and dirt nuisance from interfering with the surrounding normal operations. The Contractor shall effectively stabilize the site of work in such a manner that it will confine dust particles to the immediate surface of the work and to obtain a minimum of 40 percent emissions reduction by applying a dust palliative. The dust palliative shall be non-petroleum based. Water alone is not considered to be a dust palliative. The dust palliative shall be applied at the rate and method in conformance with Section 18, "Dust Palliative," of the CDT Standard Specifications and as recommended and/or specified by the manufacturer. Contractor shall assume liability for all claims related to dust and dirt nuisances.

1.09 EXISTING UTILITIES

A. The Contractor shall contract local utility agencies prior to construction and arrange for the shut-off of all utilities serving the buildings to be demolished. Coordinate work required to abandon active lines with the Project Manager and the District.

B. Locate existing underground utilities in the areas of work. If utilities are to remain in place, provide adequate means of protection during excavation operation.

C. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, consult utility Project Manager immediately for directions.
   1. Cooperate with the District and public and private utility companies in keeping their respective services and facilities in operation.
   2. Repair damaged utilities to the satisfaction of the utility District.

D. Do not interrupt existing utilities serving facilities occupied and used by the District or others, except when permitted in writing by Project Manager and then only after acceptable temporary utility services have been provided.

1.10 SEQUENCING AND SCHEDULING

A. The sequence of operations shall be reviewed by the Project Manager prior to commencement of any work.

B. Coordinate operations with relocation of existing utilities.

PART 2 PRODUCTS

2.01 2MATERIALS

A. General:
   1. Fill material will be subject to approval of the Geotechnical Engineer.
   2. For approval of imported fill material, notify the Project Manager at least 7 days in advance of intention to import material, designated proposed borrow area, and permit the Geotechnical Engineer to sample as necessary from borrow area for purpose of making acceptance tests to prove quality of material.
   3. The Geotechnical Engineer's report on acceptability shall be final and binding.
   4. During grading operations, soil types other than those analyzed in the geotechnical report for the project, may be encountered.
   5. Consult the Geotechnical Engineer to determine the suitability of these soils.

B. Engineered Fill Material: Soil excavated from site or imported conforming to requirements for fill material.
   1. Imported materials should have a plasticity index not less than 5 nor greater than 15, as determined by ASTM D4318; and expansion index not exceeding 20, as determined by UBC Specification 29-2; and a particle size not exceeding 3 inches as determined by ASTM D422.

C. Topsoil: Friable clay loam surface soil found in a depth of not less than 10 inches. Satisfactory topsoil is reasonably free of subsoil, clay lumps, stones, and other objects over 2 inches in diameter, and without weeds, roots and other objectionable material.
   1. Use topsoil for top 2 feet of fill against exterior walls, except at paving, sidewalks, and slabs.
   2. Topsoil may also be used beyond the area within 5 feet of building, except under paving and sidewalks.
   3. Confirm suitability of stockpiled materials.

D. Sand: Clen, well-graded fine to coarse sand with not more than 2 percent passing the #200 sieve base on wet sieve analysis.
   1. Provide 2-inch layer under building slabs on grade or as specified by the geotechnical report for this project.
   2. Provide all other locations indicated.
   3. Where coarse sand is required, provide sand no finer than No. 40 sieve.

E. Graded Rock Base:

1. Bedding for utility piping: Washed, uniformly graded mineral aggregate ASTM D448 with percentage composition of dry weight conforming with following limits:
   a. Passing 1-inch Sieve: 100 percent.
   b. Passing 3/4-inch Sieve: 90-100 percent.
   c. Passing No. 4 Sieve: 0-10 percent.
2. Base at Slab-on-Grade: As specified in the geotechnical report for this project.
3. Absorption of water to saturated-surface dry condition shall not exceed 3 percent of oven-dry weight of a sample.

F. Backfill material for use behind retaining walls shall be a granular material consisting of sand, broken rock, or a mixture of sand and gravel containing no size larger than 2 1/2 inches and not more than 15 percent passing the No. 200 sieve.

G. Imported Fill Requirements: Imported fill, where required, shall be non expansive granular soil, free of organic matter and deleterious substances. Imported fill material shall conform to the following requirements:
1. Grading:

U.S. Sieve Size	Percentage Passing Sieve
2 1/2 inch	100
No. 8	25-45
No. 200	0-10

2. Be thoroughly compactable without excessive voids.
3. Meet the following plasticity requirements:
   a. Maximum Plasticity Index of 12, as determined by ASTM D4318.
   b. Maximum Liquid Limit of 35, as determined by ASTM D4318.

H. Imported Fill for Planting Areas: Imported fill for use in planting areas shall be sandy loam weed free soil. Submit analysis from certified Soil and Plant Lab. Coordinate with Landscape Engineer.

I. Pea Gravel: 3/8 inch to 1/2 inch washed, uncrushed gravel. Use at drainage pipe and at other locations indicated.

J. Filter Fabric: Provide filter fabrics that meet or exceed the listed minimum physical properties determined according to ASTM D4759 and the referenced standard test method in parentheses.
1. Grab Tensile Strength (ASTM D4632): 100 lb.
2. Appraent Opening Size (ASTM D4751): #100 U.S. Standard sieve.
3. Permeability (ASTM D4491): 150 gallons per minute per square foot.

K. Drainage Pipe:
1. Perforated corrugated plastic drainage tubing meeting ASTM F405, with continuous integral nylon filter screen.
2. Acceptable Manufacturer's and Products: Advanced Drainage Systems "DrainGuard," Hancor "Agri-Flow."
3. Provide couplings, elbows and other fittings as recommended by pipe manufacturer.

L. Water: Clean and free from deleterious amounts of acids, alkalis, salts and organic manner.

2.02 SOIL STERILANT

A. Soil Sterilant shall be Treflan E.C. or approved equivalent.

2.03 TERMITICIDE

A. Termiticide shall be Permethrin, Denon, or approved equivalent.

PART 3 EXECUTION

3.01 GENERAL

A. Prior to commencement of earthwork, become thoroughly familiar with site conditions.

B. In the event discrepancies are found, immediately notify the Project Manager in writing, indicating the nature and extent of differing conditions.

C. No earthwork shall be performed without physical presence or acceptance of the Geotechnical Engineer.

D. The Geotechnical Engineer's acceptance is required by these specifications; notify the Project Manager at least 48 hours prior to commencing any phase of earthwork.
   1. Where impractical to use rollers in close proximity to walls, stairs, etc., compact by mechanical tamping.
   2. Scarify and recompact any layer not attaining compaction until required density is obtained.

E. Compacting:
   1. Compact by power tampering, rolling or combinations thereof as accepted by the
      a. Where impractical to use rollers in close proximity to walls, stairs, etc., compact by mechanical tamping.
      b. Scarify and recompact any layer not attaining compaction until required density is obtained.
   2. Compaction by flooding, ponding or jetting will not be permitted, unless specifically accepted by the Geotechnical Engineer.

F. Hazardous Materials:
   1. If any materials are encountered that may be hazardous (as defined in Section 5117 of the California Health and Safety Code), inform the Project Manager verbally within 24 hours an in writing within 2 business days. Upon discovery, material is to remain undisturbed until investigation by Project Manager is complete. The removal and disposal of hazardous materials, if discovered, is not part of the scope of work of this Division of this project.

3.02 3.02 SITE PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities which are to remain from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations. Set up tree protection measures prior to commencing grading or demolition operations.

B. Clearing and Grubbing:
   1. Remove from area of designated project earthwork all improvements and obstructions, including designated concrete curbs or slabs, asphaltic concrete, all tree and shrub roots, any buried utility and irrigation lines, and other matter determined by the Geotechnical Engineer to be deleterious.
      a. In all new planting areas, remove existing base material.
      b. Use only hand methods for grubbing inside the drip line of trees indicated to be left standing.
   2. Retain on the site all trees and shrubs, unless otherwise indicated on the plans as existing trees to be removed.
   3. Remove of fill existing basements left from removed structures as appropriate to areas. Compact in accordance with requirements of these specifications.
   4. Removed material shall become property of the Contractor and shall be removed from site, unless otherwise indicated on the plans or specified herein.
   5. Holes resulting from removal of underground obstructions that extend below finish grades shall be cleared and backfilled with Engineered fill.
      a. Existing Trees to remain:
      b. Verify the locations of existing trees to be preserved.
      c. Replace existing trees to remain that are damaged during construction at no additional cost to the District and provide replacement specimens of species per coordination with the Project Manager.

d. Carefully make clean cuts at roots and branches of trees indicated to be left standing, where such roots and branches obstruct new construction. Paint cuts over 1/2 inch in size with tree pruning compound.

6. Contact District Arborist 48 hours prior to cutting any trees.

3.03 TOPSOIL:

1. Strip topsoil to whatever depths encountered in manner to prevent intermingling with the underlying subsoil or other objectionable material.
2. Remove heavy growths of grass from areas before stripping. Where trees are indicated to be left standing, stop topsoil stripping in a sufficient distance to prevent damage to the main root system.
   a. Stockpile topsoil in storage piles to freely drain surface water.
3. Cover storage piles if required to prevent windblown dust.

3.04 EXISTING UTILITIES

A. Protect existing utilities that are to remain in operation as specified.

B. Demolish and completely remove from the site existing underground utilities indicated and/or required to be removed in order to complete the work. See Section 02200 - SITE PREPARATION.

C. Movement of construction machinery and equipment over existing pipes and utilities during construction shall be at contractor's risk.

D. Excavation made with power-driven equipment is not permitted within 2 feet (60.96 cm) of any known utility or subsurface structure.
   1. Use hand or light equipment for excavating immediately adjacent to or from excavations exposing a utility or buried structure.
   2. Start hand or light equipment excavation on each side of the indicated obstruction and continue until the obstruction is uncovered or until clearance for the new garde is assured.
   3. Preserve and irrigate removed sections of existing turf for salvage and/or replacement and restoration.
      a. Support uncovered lines or other existing work affected by excavation until approval for backfill is obtained.
   4. Report damage of utility line or subsurface structures immediately to Project Manager.

3.05 PREPARATION OF SUBGRADE

A. Expansive soils are anticipated to basement depth.
   1. Review the necessity for over excavation of expansive soils.

3.06 SCARIFY BUILDING PAD, EXTERIOR FLATWORK AND PAVEMENT SUBGRADE TO A DEPTH OF AT LEAST 8 INCHES AND WORK UNIFORM AND FREE FROM LARGE CLODS.

1. Bring expansive subgrades to 2 to 5 percentage points above the optimum moisture content and compact to 90 percent of the maximum laboratory dry density, in accordance with ASTM D1557.
2. Bring nonexpansive subgrades to or slightly above the optimum moisture content and compact to 90 percent of the maximum laboratory dry density in accordance with ASTM D1557.
3. Increase compaction of the upper 12 - 18 inches of pavement subgrades to 95 percent of the maximum laboratory dry density per ASTM D1557 for nonexpansive subgrades.

3.07 DEWATERING

A. Do not allow water from surface drainage or underground sources to accumulate in excavations, unfinished fills, or other low areas.

B. Provide and maintain ample means and devices to remove water promptly and dispose properly of water entering excavations or other parts of the work to prevent softening of exposed surfaces.

C. Dewater by methods which will ensure dry excavation and preservation of finish and grades of excavation bottoms.

D. Prior to excavating below ground water level, place dewatering system in operation.
   1. Lower the ground water level a minimum of 2 feet (60.96 cm) below the bottom of the excavation.
   2. Relieve the hydrostatic pressure in pervious zones below the subgrade elevation to prevent uplift.
      a. Use screens and gravel packs a necessary to prevent removal of fines from the soil.

E. Operate the dewatering system continuously, 24 hours a day, 7 days a week until construction work below existing ground water lever is completed.
   1. Measure and record the performance of the dewatering system.
      a. Perform at the same time each day.
      b. Use piezometers and observation wells.
      c. After placement of initial slabs and backfill, the ground water level may be allowed to rise.
   2. At no time allow ground water to rise higher than 1 foot below the prevailing level of excavation or backfill.
   3. Have a back-up pump and system available for immediate use.

F. Dispose of water away from the work in suitable manner without damage to adjacent property or menace to public health.

G. Do not drain water into work being built or under construction without prior acceptance of the Project Manager.

H. Protect existing storm drainage system from silt and debris resulting from construction activities. If contamination occurs, remove contamination at no cost to the District.

3.08 SITE EXCAVATION

A. General:
   1. All supports, shoring, and sheet piling required for the sides of excavations or for protection of adjacent existing improvements shall be provided and maintained by the Contractor. The adequacy of such systems shall be the complete responsibility of the Contractor.
      a. Earth and rock, regardless of character and subsurface conditions, shall be excavated to depths shown on plans and to the neat dimensions of the footings wherever practicable, to permit pouring of footings and grade beams without use of side forms, except at slab perimeters.
   2. Large rocks, pieces of concrete or other obstructions, if encountered during the excavation/ scarifying operations, shall be removed and disposed of by the Contractor off the site in a legal manner.
   3. Where footing excavation is too deep, backfill shall be concrete. Where footings are overdug laterally, side forms shall be employed for backfill with rock fill or concrete backfill shall be used (Contractor's option).
   4. Where forming is required, only that excavation necessary to permit placing and removal of forms shall be done.
   5. Bottoms of all footings and foundations trenches shall be subject to testing by the Geotechnical Engineer. Corrective measures as directed by the Project Manager shall be executed promptly.

B. Excavate subgrade as required to allow for finish grades shown on plans, as required for structural fill or otherwise required for proper completion of the work

C. Remove and replace subgrade materials designated by Geotechnical Engineer as unsuitable.

3.09 FILL AND COMPACTING

A. See Section 31 23 33 - TRENCHING, BACKFILLING & COMPACTING for fill and compacting requirements.

3.10 MOISTURE CONTROL

A. Do not place, spread or roll fill material during unfavorable weather conditions or when fill material is excessively wet.

B. Do not resume operations until moisture content and fill density are satisfactory to the Geotechnical Engineer.

C. Provide beams or channels to prevent surface water from flooding excavations. Promptly remove water collecting in depressions.

D. Where soil has been softened or eroded by flooding or by placement during unfavorable weather, remove damaged areas and recompact as described for fill and compaction.
   1. Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade, or layer of soil material.
   2. Prevent free water appearing on surface during or subsequent to compaction operation.
   3. Remove and replace, or scarify and air dry, soil material too wet to permit compaction to specified density.
   4. Soil material removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing until moisture content is reduced to a satisfactory value.

3.11 GRADING

A. General: Uniformly grade areas of work including adjacent transition areas. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.
   1. All areas covered by the project, including excavated and filled areas and adjacent transition areas, shall be uniformly graded so that finished surfaces are at the elevations established by the plans. Planter areas to receive future topsoil shall be graded below finished grade to allow for such material.
   2. Finished surfaces and surfaces to receive paving and aggregate base shall be smooth, compacted, and free from irregular surface drainage.
   3. Ditches, gutters, and swales shall be finished to permit proper surface drainage.
   4. All surface areas, except paved and sloped embankments exceeding 8:1, shall be hydroseeded.

B. Grading Tolerances:
   1. Excavations shall not exceed 0.10-foot variation from dimensions and elevations shown or noted, unless otherwise approved by Project Manager.
   2. Fill and backfill shall be placed with tolerance of plus or minus 0.10 foot if placed in layers.
   3. Grading shall be done within plus or minus 0.10 foot typically; areas under slabs, walks, or pavements shall be graded within tolerance of 0 to 0.10 foot.
   4. Lawn or Unpaved Areas: Finish areas to received topsoil to within not more than 0.10 foot above or below required subgrade elevations.
   5. Walks: Shape surface of areas under walks to line, grade and cross-section, with finish surface not more than 0.10 foot above or below required subgrade elevation.
   6. Pavements: Shape surface of areas under pavement to line, grade and cross-section, with finish surface not more than 1/2 inch above or below required subgrade elevation.

C. Compaction: After grading, compact subgrade surfaces to the depth and percentage of maximum density for each area classification.

3.12 SOIL STERILIZATION

A. General: Soil sterilant shall be applied to prepared subgrade or after installation of rock or aggregate base as recommended by the manufacturer. Sterilant shall be applied uniformly at the rate recommended by the manufacturer to all areas beneath asphalt concrete pavement, brick pavement, concrete pavement, or on-grade concrete slabs including sidewalks, curbs, and gutters and areas between the inner and outer security fences. In addition to ground areas

treated, sterilant shall be applied below expansion or control joints, and at all areas where pipe, ducts, or other features penetrate slabs.

3.13 TERMITICIDE

A. Termiticide shall be applied to soils as recommended by the manufacturer. Termiticide shall be applied uniformly at the rate recommended by the manufacturer to all areas beneath and around wood frame structures.

3.14 DISPOSAL OF EXCESS AND WASTE MATERIALS

A. Removal of Excess Excavated Material: Excess material shall be removed by the Contractor off the site in a legal manner.

B. Testing Agency Services: Allow testing agency to inspect and test each subgrade and each fill or backfill layer. Do not proceed until test results for previously completed work verify compliance with requirements.
   1. Perform field in-place density tests according to ASTM D1556 (sand cone method), ASTM D2167 (Rubber Ballon Method), or ASTM D2937 (Drive Cylinder Method), as applicable.
      a. Field in-place density tests may also be performed by the nuclear method according to ASTM D2922, provided that calibration curves are periodically checked and adjusted to correlate to tests performed using ASTM D1556. With each density calibration check, check the calibration curves furnished with the moisture gauges according to ASTM D3017.
      b. When field in-place density tests are performed using nuclear methods, make calibration checks of both density and moisture gauges at beginning to work on each different type of material encountered, and at intervals as directed by the Project Manager.
   2. Footing Subgrade: At footing subgrades, perform at least one test of each soil stratum to v verify design bearing capacities. Subsequent verifications and approval of other footing subgrades may be based on a visual comparison of each subgrade with related tested strata when acceptable to the Project Manager.
   3. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, perform at least one filed in-place density test for every 2,000 square feet or less of paved area or building slab, but in no case fewer than three tests.
   4. Foundation Wall Backfill: In each compacted backfill layer, perform at least one field in place density test for each 100 feet or less of wall length, but no fewer than two tests along a wall face.
   5. Trench Backfill: In each compacted initial and final backfill layer, perform at least one filed in-place density test for each 150 feet or less of trench, but not fewer than two tests.

C. Number and location of test shall be at option of the Geotechnical Engineer

D. When testing agency reports that subgrades, fills, or backfills are below specified density, scarify and moisten or aerate, or remove and replace soil to the depth required, recompact and retest until required density is obtained.
   1. After grading is completed and the testing agency has completed observation of the work, permit no further excavation or filling, except as approved by Project Manager.

3.15 PROTECTION

A. Protect newly graded areas from traffic and erosion. Install erosion control mat and straw wattles as directed by the Project Manager.

B. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.

C. Where completed compacted areas are disturbed by subsequent construction operation or adverse weather, scarify surface, reshape, compact to required density and provide other corrective work, including retesting, prior to further construction.

3.16 CLEAN-UP

A. Comply with requirements of Section CLEANING.

END OF SECTION

SECTION 31 10 00
SITE PREPARATION

PART 1 GENERAL

1.01 SUMMARY

A. AThis section describes general requirements, products, and methods of execution relating to site preparation, unless otherwise noted. This section applies to:
   1. Surface and subsurface demolition.
   2. Backfilling of excavations and depressions.
   3. Coordination, demolition and/or relocation of existing utilities.
   4. Prior to start of demolition of facilities, shut-off, disconnect, cut and cap where required, underground utility services to facilities.
   5. Removal of A.C. pavement driveway and concrete pavement, concrete pads, and A.C. cur
   6. Removal of cyclone wire, wood fences and barricades.
   7. Removal of storm drainage piping, catch basins, and manholes.
   8. Removal of vegetation and trees as specified herein.

B. Contractor shall provide labor, material and equipment required for demolishing, cutting, removing and disposing of existing construction as designated and shown on the Plans for the following as required, unless otherwise noted.

1.02 SUBMITTALS

A. Comply with requirements of Section SUBMITTAL PROCEDURES.

B. Submit all permits and certificates required for the project, for record purposes.

C. Demolition schedule and proposed methods and operations.

D. Pemits and notices authorizing demolition.

E. Letter or certificates of severance of utilities services from the affected agencies or utilities.

F. Proposed haul route(s) from the demoiltion worksite to an authorized disposal site.

G. Permit for transport and disposal of debris.

H. Make arrangements of disposing of waste and excess materials at a legally licensed landfill/disposal facility outside worksite and pay cost thereof.

I. Photograph existing conditions of existing structure surfaces, equipments, and adjacent improvements that might be misconstrued as damage related to removal operations. File photographs with Project Manager prior to start of work.

J. Submit Proposed dust control measures.

K. Submit Proposed noise control measures

L. Work Schedule: Submit a proposed schedule of work items to be performed, and a description of how the work is to be accomplished, for the Project Manager's review.

M. Report of inspection conducted with the Project Manager before and after performing work.

1.03 QUALITY ASSURANCE

A. Comply with the following Standards: American National Standards Institute, Inc. "American National Standard Safety Requirements for Demoiltion" (ANSI A1.06 and A10.8).

B. Regulatory Agencies:
   1. Comply with rules and regulations of State of Californa, California Code of Regulations, Title 8, Industrial Relations, Chapter 4, Subchapter 4, "Construction Safety Order."
   2. Comply with applicable local and state agencies havng jurisdiction.
   3. Comply with governing EPA notification regulations.

C. Secure all required Permits or Certificates for demolition or discontinuance of utilities, prior to beginning the work.

1.04 PROJECT CONDITIONS

A. Disposition of Existing Improvements:
   1. All materials indicated to be removed shall become the property of the Contractor; dispose of these outside the project site.
      a. Do not dispose of removed materials to the general public by sale, gift or in any other manner at the project site.
      b. These provisions shall not be construed as limiting or prohibiting sale or disposal of such materials at the Site to dul licensed Contractors or material suppliers, provided materials are removed from the construction site by the Contractor.
   2. All removal of debris from the site, including removal of inventory to site of storage, is part of this Contract and shall be done by Contractor's employees and no others.

B. Sal
   1. Where units or items of existing work are desginated to be removed and reused in the new work or are to become salvage, remove such units or items carefully.
      a. Use tools and methods that will not damage such units or items.
      b. Protect underlyng or adjoining work from damage.
      c. Salvaged items shall be cleaned by the Contractor.

C. Protection:
   1. Erect and maintain temporary bracing, shoring, lights, barricades, except construction barricades for subsequent new construction, warning signs, and guards necessary to protect public, the District's employees, finishes, improvements to remain and adjoining property from damage, all in accordance with applicable regulations.

D. Scheduling:
   1. Coordinate with the District in scheduling noisy or dirty wo
   2. Schedule work at the District's convenience to cause minimal interference wit the District's normal operations.
   3. Jackhammering shall be coordinated with the District and College to minimize disturbance of classes.

E. Traffic Circulations: Ensure minimum interference with roads, streets, driveways, sidewalks, and adjacent facilities.
   1. Do not close or obstruct public thoroughfares without first obtaining the required permit or permission of the responsible jurisdiction.
   2. Where closing of a vehicular or pedestrian traffic circulation route is necessary, provide adequate directional signs to minimize the potential for confusion.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas affected by work of this Section and verify following:
   1. Disconnection of utilities as required.
   2. That utilities serving occupied portions of buildings on and off the site will not be distrubed or that temporary utility services have been provided.
   3. Removal by the District of the District's personal property, movable furniture and equipment items not designated for relocation.

B. Where existing conditions conflict with representations of the Construction Documents, notify the Project Manager and obtain clarifications. Do not perform work affecting the conflicting conditions until clarification of the conflict is received.

3.02 PREPARATION

A. Verify that the area to be demolished or removed has been vacated, or adequate space made available to perform the work.

B. Arrange for, and verify termination of utility services to include removing meters and capping of lines.

C. Lay out cutting work at Job Site and coordinate with related work for which cutting is required.

3.03 DEMOLITION

A. If confirmed or suspected hazardous materials are encountered during operations, stop operations immediately and notify the Project Manager.

B. Perform work in accordance with ANSI A10.6-1969 unless otherwise noted.

C. Provide noise and dust abatement as required to prevent contamination of adjacent areas.
   1. Remove all materials not designated as salvage, in their entirety.
   2. Remove building foundations in the entirety, unless otherwise indicated on the plans.

D. Fill voids in the land left by the removal

3.04 CUTTING

A. Make new opening neat.

B. Do not cut or alter structural members and any utilities including appurtenances unless indicated to do so in the Construction Documents, or written approval is received from the Project Manager.

C. Take care not to damage reinforcing or structural steel scheduled to remain in place.

D. Concrete: Cut new opening in concrete by coring and saw cutting. Saw run-bys will not be permitted.

3.05 PREPARATION FOR NEW FINISH WORK

A. Where demolished surfaces are scheduled to receive new finishes, Contractor shall restore such substrate to a condition ready to receive the scheduled new finishes, including grinding or leveling.

3.06 DISPOSAL OF DEMOLISHED MATERIALS

A. Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.

B. Burning of demolished materials off District's property in a legal manner.

3.07 FIELD QUALITY CONTROL

A. The Project Manager will accompany the Contractor before and after performance of work to observe physical condition of existing structures or improvements involved.

END OF SECTION

SECTION 31 23 33
TRENCHING, BACKFILLING AND COMPACTING

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)); 2012 (Reapproved 2021).

1.02 SUMMARY

A. Provide labor, material, equipment, and services necessary to complete the backfilling and compacting as necessary for this project. Section includes, but is not limited to:
   1. Select Backfill Material.
   2. Aggregate Base.
   3. Detectable Tape.
   4. Trench Excavation.
   5. Pipe Bedding.
   6. Trench Backfill
   7. Trench Surfacing.

1.03 DEFINITIONS

A. Engineered Fill:
   1. Soil or soil-rock material approved by the Project Manager and transported to the site by the Contractor in order to raise grades or to backfill excavations.
   2. Contractor shall provide sufficient tests, and a written statement that all materials brought onto the project site comply with specification requirements.

B. Excavation: Consists of the removal of material encountered to subgrade elevations.

C. Subgrade: The uppermost surface of an excavation or the top surface of a fill or backfill immediately below base.

D. Base: The layer placed between the subgrade and surface pavement in a paving system.

E. Relative: Compaction: In-place dry density of soil expressed as percentage of maximum dry density of same materials, as determined by laboratory test procedure American Society for Testing and Materials (ASTM) D1557.

1.04 SYSTEM DESCRIPTION

A. Requirements:
   1. Comply with the recommendations of the Geotechnical Engineer.
   2. Protect existing trees to remain. No grading is permitted under the drip line of protected trees.
   3. Excavations for appurtenant structures, such as, but not limited to, manholes, transition structures, junction structure, vaults, valve boxes, catch basin, thrust blocks, and boring pits, shall be deemed to be in the category of trench excavation.
   4. Unless otherwise indicated in the Plans, all excavation for pipelines shall be open cut.

1.05 SUBMITTALS

A. Comply with provisions of Section 01 32 19

B. Test Reports: Submit the following report for import material directly to the Project Manager from the Contractor's testing services:

C. Compaction test reports for aggregate base.
   1. Submit description of compactors proposed for use when requesting placement of base material.

1.06 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies

1. Comply with State of California Business and Transportation Agency, Department of Transportation (Caltrans) latest edition of "Standard Specifications." (CSS).
2. Comply with State of California Code of Regulations (CCR).
3. Comply with State of California Construction Safety Orders, Latest Edition (CAL/OSHA).

B. Soil Testing:
1. District to engage a geotechnical testing agency, to include compaction testing and for quality control testing during fill operations.
2. Test results will be submitted to the Project Manager.

1.07 CODES AND STANDARDS:

1. Perform excavation work in compliance with applicable requirements of authorities having jurisdiction.
2. California Department of Transportation (CDT):
   a. Section 19: Earthwork
   b. Standard Test Methods: No. 202
3. American Society for Testing and Materials (ASTM):
   a. D1556: Density of Soil by the San Cone Method.
   b. D1557: Moisture Density Relations of Soils and Soil-Aggregate Mixtures

1.08 DELIVERY, STORAGE AND HANDLING

A. Protect materials before, during and after installation.

B. Comply with provisions of Section 01 51 00 - TEMPORARY FACILITIES AND CONTROLS where necessary to control dust and noise on and near the work caused by operations during construction activities.

1.09 PROJECT CONDITIONS:

A. Environmental Requirements:
1. Protect existing storm drainage system from silt and debris resulting from construction activities. If contamination occurs, remove contamination at no cost to the District.
2. Protect existing streams, ditches and storm drain inlets during work on this project.

B. Barricade open excavations and post with warning lights.
1. Comply with requirements of Section 01 51 00 - TEMPORARY FACILITIES AND CONTROLS.
2. Operate warning lights and barricades as required.
3. Protect structures, utilities, sidewalks, pavements, and other facilities immediately adjacent to excavations, from damages caused by settlement, lateral movement, undermining, washout, and other hazards.

C. Protection of Subgrade: Do not allow equipment to pump or rut subgrade, stripped areas, footing, excavations, or other areas prepared for project.

D. Transport all excess soils materials by legally approved methods to disposal areas.
1. Coordinate with the Project Manager.
2. Any additional fill requirements shall be the responsibility of the Contractor.

1.10 EXISTING UTILITIES

A. Locate existing underground utilities in the areas of work. For utilities that are to remain in place, provide adequate means of protection during excavation operations.
1. Locating of existing underground utilities shall include but not be limited to pot-holing prior to the start of construction.

B. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, consult Project Manager, Facilities, and/or utility agency immediately for directions.
1. Cooperate with the Project Manager and public and private utility companies in keeping their respective services and facilities in operation.
2. Repair damaged utilities to the satisfaction of the agency with jurisdiction.

C. Do not interrupt existing utilities serving facilities occupied and used by the District or others, except when permitted in writing by the Project Manager and then only after acceptable temporary utility services have been provided.

1.11 SEQUENCING AND SCHEDULING

A. The sequence of operations shall be reviewed by the Project Manager prior to commencement of any work.

PART 2 PRODUCTS

2.01 MATERIALS

A. General:
   1. Import materials will be subject to approval of the Geotechnical Engineer.
   2. For approval of imported fill material, notify the Project Manager at least 7 days in advance of intention of import material.

B. Select backfill material shall be gravel, free of clay or organic matter and shall conform to the following gradation:

Sieve Size	Percentage Passing
1 inch	100
3/4 inch	90 - 100
No. 4	36 - 60
No. 200	2 - 9

C. For gas pipe and fuel piping select backfill shall be clean, graded building sand conforming to the following gradation:

Sieve Size	Percentage Passing
No. 4	100
No. 200	0 - 5

D. Water: Clean and free from deleterious amounts of acids, alkalis, salts and organic matter.

2.02 BURIED WARNING AND IDENTIFICATION TAPE

A. Polyethylene plastic and metallic core or metallic-faced, acid- and alkali-resistant, polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 75 mm 3 inch minimum width, color coded as specified below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Color and printing shall be permanent, unaffected by moisture or soil.
   1. Warning Tape Color Codes.
      a. Red: Electric
      b. Yellow: Gas, Oil; Dangerous Materials
      c. Orange: Telephone and Other Communications.
      d. Blue: Water Systems.
      e. Green: Sewer Systems.
      f. White: Steam Systems.
      g. Gray: Compressed Air.
   2. Warning Tape for Metallic Piping: Acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Minimum thickness of tape shall be 0.003 inch. Tape shall have a minimum strength of 1500 psi lengthwise, and 1250 psi crosswise, with a maximum 350 percent elongation.
   3. Detectable Warning Tape for Non-Metallic Piping: Polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Minimum thickness of the tape shall be 0.004 inch. Tape shall have a minimum strength of 1500 psi lengthwise and 1250 psi crosswire. Tape shall be manufactured with integral wires, foil backing, or other means

of enabling detection by a metal detector when tape is buried up to 920 mm 3 feet deep. Encase metallic element of the tape in a protective jacket or provide with other mean of corrosion protection.

2.03 DETECTION WIRE FOR NON-METALLIC PIPING

A. Detection wire shall be insulated single strand, solid copper with a minimum of 12 AWG.

PART 3 EXECUTION

3.01 GENERAL

A. Prior to commencement of work, become thoroughly familiar with site conditions.

B. In the event discrepancies are found, immediately notify the Project Manager in writing, indicating the nature and extent of differing conditions.

C. Backfill excavations as promptly as work permits.

D. Do no place Engineered fill or backfill until rubbish and deleterious materials have been removed and areas have been approved by the Project Manager.

E. Place acceptable soil material in layers to required subgrade elevations, for each area classification listed below.

F. In excavations, use satisfactory excavated or borrow material.

G. Under grassed areas, use satisfactory excavated or borrow material.

3.02 COMPACTING

A. Compact by power tamping, rolling or combinations thereof.
   1. Where impractical to use rollers in close proximity to walls, stairs, etc., compact by mechanical tamping.
   2. Scarify and recompact any layer not attaining compaction until required density is obtained.

3.03 SITE PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, which are to remain, from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Protect existing storm drainage system form silt and debris resulting from construction activities. If contamination occurs, remove contamination at no cost to the District.

3.04 EXISTING UTILITIES

A. Identify the location of existing utilities
   1. Prior to trenching, the Contractor shall excavate at location specifically indicated on the Plans, if any, and where new lines cross other utilities of uncertain depth and determine the elevation of the utility in question to ensure that the new line will clear the potential obstruction.
   2. The Contractor shall contact Underground Service Alert - USA at 1-800-227-2600 for assistance in locating existing utilities.
   3. If, after the excavation, a crossing utility does present an obstruction, then the line and grade of the new line will be adjusted as directed by the Project Manager to clear the utility.

B. Protect all existing to remain in operation.

C. Movement of construction machinery and equipment over existing pipes and utilities during construction shall be at Contractor's risk.

D. Excavation made with power-driven equipment is not permitted within 2 feet of any known utility or subsurface structure.
   1. Use hand or light equipment for excavating immediately adjacent to known utilities or for excavations exposing a utility or buried structure.

2. Start hand or light equipment excavation on each side of the indicated obstruction ansd continue until the obstruction is uncovered or until clearance for the new grade is assured.
3. Support uncovered lines or other existing work affected by excavation until approval for backfill is obtained.
4. Report damage of utility line or subsurface structures immediately to the Project Manager.

E. Backfill trenches resulting from utility removal in lifts of 8 inches maximum.

3.05 TRENCH EXCAVATION

A. General
1. Excavation shall include removal of all water and materials that interfere with construction. The Contractor shall remove any water which may be encountered in the trench by pumping or other methods during the pipe laying, bedding and backfill operations. Material shall be sufficiently dry to permit approved jointing.
2. Excavation shall include the construction and maintenance of bridges required for vehicular and pedestrian traffic, support for adjoining utilities.
3. The Contractor shall be responsible to safely direct vehicular and pedestrian traffic through or around his/her work area at all times.
4. The Contractor shall relocate, reconstruct, replace or repair, at his/her own expense, all improvements which are in the line of construction or which may be damaged, removed, disrupted or otherwise disturbed by the Contractor.

3.06 EXISTING PAVING AND CONCRETE:

1. Existing pavement over trench shall be sawcut, removed, and hauled away from the job. Existing pavement shall be neatly sawcut along the limits of excavations.
2. Existing concrete over the trench shall be sawcut to a full depth in straight lines either parallel to the curb or a right angles to the alignment of the sidewalk.
3. Boards or other suitable material shall be placed under equipment outrigging to prevent damage to paved surface.

B. Trench Width:
1. The maximum allowable trench widths at the top of the pipe shall be as follows:

Pipe Type	Trench Width (Maximum)
Copper	Outside diameter of barrel plus 18 inches
Plastic	"
Vitrified Clay	"
Ductile-Iron	"
Reinforced Concrete	"

a. The maximum trench width shall be inclusive of all shoring.
b. If the maximum trench width is exceeded, the State's representative may direct the Contractor to encase or cradle the pipe in concrete at no additional charge.

2. For pipes 3 inch diameter and larger, the free working space on each side of the pipe barrel shall be less than 6 inches.

C. Open Trench:
1. The maximum length of open trench shall be 300 feet or the distance necessary to accommodate the amount of pipe installed in a single day, whatever is greater. No trench shall be left open at the end of the day.
2. Provisions for trench crossings and free access shall be made at all street crossings, driveways, water gate valves, and fire hydrants

D. Excavation Bracing:
1. The excavation shall be supported and excavation operations shall be conducted in accordance with the California Industrial Accident Commission and CAL/OSHA.
2. The Contractor shall, at his/her own expense, furnish, put in place, and maintain, such sheeting and bracing as may be required to support the sides of all excavations (whether

above or below the pipe grade), and to prevent any movement which could in any way diminish the required trench section or otherwise injure or delay the work. The sheeting and bracing shall be withdrawn in a manner such as to prevent any earth movement that might overload the pipe.

E. Excavated Material:
   1. All excavated material not required for backfill shall be immediately removed and properly disposed of in a legal manner by the Contractor.
   2. Material excavated in streets and roadways shall be laid alongside the trench no closer than 2 feet from the trench edge and kept trimmed to minimize inconvenience to public traffic.
   3. Provisions shall be made whereby all storm and wastewater can flow uninterrupted in gutters or drainage channels.

3.07 PIPE BEDDING

A. Bedding Excavation: The trench shall be excavated below the grade of the pipe bottom to the following minimum depths:

Pipe Type	Depth
Copper	6 inch
Reinforced Concrete	6 inch
Plastic: 2 inch diameter and smaller	6 inch
Plastic: over 2 inch diameter	6 inch
Ductile Iron	6 inch

   1. Stabilization of Trench Bottom: When the trench bottom is unstable due to wet or spongy foundation, trench bottom shall be stablized with gravel or crushed rock. The State's inspector will determine the suitability of the trench bottom and the amount of gravel or crushed rock needed to stabilize a soft foundation. Soft material shall be removed and replaced with gravel or crushed rock as necessary.
   2. Placement of Bedding Material: The trench bottom shall be cleaned to remove all loose native material prior to placing select backfill material. Sufficient select backfill material shall be placed in trench and tamped to bring trench bottom up to grade of the bottom of pipe. The relative compaction of tamped material shall be not less than 90 percent. It is the intention of these requirements to provide uniform bearing under the full length of pipe to a minimum width of 60 percent of the external diameter.

3.08 TRENCH BACKFILL

A. Initial Backfill:
   1. Prior to trench backfill, the condition of the trench and laying of pipe must be inspected and approved by the Inspector of Record.
   2. Select backfill material shall be used for initial backfill. After the pipe has been properly laid and inspected, select backfill material shall be placed on both sides of the pipe and compacted to final depth as follows:

Pipe Type	Depth
Copper	12 inches above top of pipe
Plastic: less than 3 inches diameter	12 inches above top of pipe
Plastic: 3 inches diameter and larger	12 inches above top of pipe
Ductile Iron	12 inches above top of pipe
Reinforced Concrete	12 inches above top of pipe

   3. Compaction: Initial backfill compaction shall be by mechanical means. The initial backfill material shall be hand tamped in layers not exceeding 4 inches in uncompacted depth and shall be brought up uniformly on both sides of the pipe to avoid bending or distortional stress. After hand tamping, the relative compaction of the initial backfill material shall be not less than 90 percent.

4. Pipe Detection: In trenches containing pressurized plastic pipes, tracer wire shall be placed directly above the pipe and shall be connected to all valves, existing exposed tracer wires, and other appurtenances as appropriate.

B. Subsequent Backfill:
   1. Above the level of initial backfill, the trench shall be backfilled with non-expansive native material from trench excavation or with imported select backfill material (Contractor's option). Subsequent backfill shall be free of vegetable matter, stone or lumps exceeding 3 inches in greatest dimension, and other unsatisfactory material. The Inspector of Record shall approve the backfill material prior to placement.
   2. Subsequent backfill compaction shall be by mechanical means with backfill material placed in layers not exceeding 8 inches in loose depth. Each layer shall be thoroughly compacted before succeeding layers are placed. The use of machine tampers, except manually held types, shall not be permitted.
   3. Subsequent backfill shall be compacted to a relative compaction of not less than 90 percent except the relative compaction shall not be less than 95 percent within 2-1/2 feet of finished permanent surface grade or 1-1/2 feet below the finished subgrade, whichever is greater.

C. Jetting and Ponding:
   1. Jetting of trench backfill is not permitted

D. Compaction Testing:
   1. Compaction testing shall be in accordance with California Test Method ASTM D1556 or D1557.

3.09 TRENCH SURFACING

A. Unpaved Areas:
   1. In unimproved areas, the trench surface shall be restored to its original condition. No mounds of earth shall be left along the trench. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.
   2. Where completed compacted areas are disturbed by subsequent construction operation or adverse weather, scarify surface, reshape, compact to required density and provide other corrective work, including retesting, prior to further construction.

3.10 TEMPORARY SURFACING:

1. Temporary surfacing shall be a minimum of 2 inches of cutback asphalt on 10 inches of Class 2 aggregate base and shall be placed at all trench locations subject to vehicular or pedestrian traffic.
2. Temporary surfacing shall be laid within one day after backfilling (except where the Contractor elects to place permanent surfacing within this time period).
3. Before the trenching area is opened for traffic, all excess dirt, rock and debris shall be removed, the street surface shall be swept clean and the pavement shall be washed down with a water truck and pressure nozzle.
4. Temporary surfacing shall be maintained to prevent the occurrence of mudholes and prevent the surface from settling below 1 inch or rising more than 1 inch from the existing pavement grade.

3.11 FILL AND COMPACTING

A. General Requirements:
   1. Backfill excavations as promptly as work permits.
   2. Do not place Engineered fill or backfill until rubbish and deleterious materials have been removed and areas have been approved by the Project Manager.
   3. Place acceptable soil material in layers to required subgrade elevations, for each area classification listed below.
   4. In excavations, use satisfactory excavated or borrow material.
   5. Under grassed areas, use satisfactory excavated or borrow material.

B. After subgrade compaction has been approved by the Geotechnical Engineer, spread the Engineered fill materials in 6 to 8 inch loose lifts and uniformly mixed during the spreading operation.
   1. Bring non-expansive fill materials to or slightly above the optimum moisture content and compacted to at least 85 percent of the maximum laboratory dry density, per ASTM D1557.
   2. Bring non-expansive aggregate fill materials to or slightly above the optimum moisture content and compacted to at least 95 percent of the maximum laboratory dry density per ASTM D1557.
   3. Do not compact the top 12 inches of soil in the planting areas.
   4. Fill sections greater than 5 feet in depth shall be compacted to at least 95 percent.

C. Repeat compaction procedure until proper grade is attained.

D. Rocks generated during site earthwork may be used in fill when conforming to material specifications.

3.12 MOISTURE CONTROL

A. Do not resume operations until moisture content and fill density are satisfactory to the Inspector.

3.13 DISPOSAL OF EXCESS AND WASTE MATERIALS

A. Testing Services: Allow testing agency to test each backfill layer. Do not proceed until test results for previously completed work verify compliance with requirements.

B. When testing agency reports that backfills are below specified density, scarify and moisten or aerate, or remove and replace soil to the depth required, recompact and retest until required density is obtained.

3.14 PROTECTION

A. Repair and re-establish grades in settled eroded, and rutted areas to specified tolerances.

B. Where completed compacted areas are disturbed by subsequent construction operation or adverse weather, scarify surface, reshape, compact to required density and provide other corrective work, including retesting, prior to further construction.

3.15 CLEAN-UP

A. Remove all debris, equipment, tools and materials upon completion prior to final inspections to the satisfactions of the Project Manager.

B. In unpaved areas without landscaping, cover with straw erosion control blanket. Follow manufacturer's recommendations for installation. Provide and place straw wattles or biodegradable fiber logs across the slope at the midpoint and along the downhill edge of site. No soil is to be left uncovered at the completion of construction.

END OF SECTION

SECTION 32 10 00
DEMOLITION

PART 1 GENERAL

1.01 SUMMARY

A. Provide labor, material, and equipment required for demolishing, cutting, removing and disposing of existing construction as designated or required to provide for new work.

B. Coordinate all work with capping or sealing of existing utilities.

1.02 SUBMITTALS

A. Comply with requirements of the SUBMITTAL PROCEDURES and GENERAL CONDITIONS.

1.03 QUALITY ASSURANCE

A. Comply with the following Standards: American National Standards Institute, Inc. "American National Standard Safety Requirements for Demolition" (ANSI A10.6 and A10.8).

B. Regulatory Agencies:
   1. Comply with rules and regulations of State of California, California Code of Regulations, Title 8, Industrial Relations, Chapter 4, Subchapter 4, "Construction Safety Order."
   2. Comply with applicable local and state agencies having jurisdiction.
   3. Comply with governing EPA notification regulations.
   4. Comply with applicable state and local regulations regarding dust and noise mitigation during construction.

C. Secure all required Permits or Certificates for demolition prior to beginning the work.

1.04 PROJECT CONDITIONS

1.05 DISTRICT ASSUMES NO RESPONSIBILITY FOR ACTUAL CONDITION OF THE SITE TO BE ALTERED.

1. Conditions existing at time of inspection for bidding purpose will be maintained by District as far as practical.

1.06 DISPOSAL OF EXISTING IMPROVEMENTS:

1. All materials removed shall become the property of the Contractor; dispose of these materials outside the project site.
   a. Do not dispose of removed materials to the general public by sale, gift or in any other manner at the project site.
   b. These provisions shall not be construed as limiting or prohibiting sale or disposal of such materials at the Site to duly licensed Contractors or material suppliers, provided materials are removed from construction site by the Contractor.
2. All removal of debris from the site, including removal of inventory to site of storage, is part of this Contract and shall be done by Contractor's employees and no others.

1.07 SALVAGE:

1. Recycle AC pavement and Class II AB where practical.
2. Recycle concrete where practical.
3. Items indicated to be salvaged shall be removed carefully, cleaned, and returned to the District. Coordinate with the Project Manager.

B. Protection:
   1. Erect and maintain temporary bracing, shoring, lights, barricades, except construction barricades for subsequent new construction, warning signs, and guards necessary to protect public, the District's employees, adjacent improvements to remain, and adjoining property from damage, all in accordance with applicable regulations.
   2. Wet down areas affected by this work as required to prevent dust and dirt from rising.

C. Scheduling:
   1. Coordinate with the Project Manager in scheduling noisy or dirty work.

2. The Project Manager will supply a schedule of days on which no construction will be allowed.
3. Contractor shall take College schedule into consideration during construction.
4. Coordinate and schedule temporary water shut-downs and temporary water service with the Project Manager, Facilities, and the Water Department, and the Fire Department.

D. Traffic Circulations: Ensure minimum interference with roads, streets, driveways, sidewalks, and adjacent facilities.
1. Minimize obstruction to thoroughfares by first obtaining the required approval or permission of the responsible jurisdiction.
2. Where closing of a vehicular traffic circulation route is necessary, provide adequate directional signs to minimize the potential for confusion. Provide access at all times for emergency vehicles.

E. Safety:
1. The Contractor shall take all necessary precautions to eliminate the exposure of workers, students, staff and the public to asbestos fiber, including but not limited to: dust control measures and measures included in Sections 93106 and 93105 of California Code of Regulations, Title 17.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 EXAMINATION

A. Where existing conditions conflict with representations of the Construction Documents, notify the Project Manager and obtain clarifications. Do not perform work affecting the conflicting conditions until clarification of the conflict is received.

3.02 3.02PREPARATION

A. Verify that the area to be demolished or removed has been vacated, and adequate space has been made available to perform the work.

B. Lay out saw cutting and coordinate with related work for which saw cutting is required.

C. Contractor shall coordinate and arrange the shut down of utilities serving the site with Facilities, the Fire Department, and the Project Manager.

3.03 DEMOLITION

A. If known or suspected hazardous materials are encountered during operations, stop operations immediately and notify the Project Manager.

B. Perform work in accordance with ANSI A10.6-1969 unless otherwise noted.

C. Provide noise and dust abatement as required to prevent contamination of adjacent areas.

D. Remove all materials not designated as salvage, in their entirety.

E. If unknown items such as human remains are encountered during operations, stop operations immediately and notify the Project Manager.

F. The Project Manager will provide a list of any items to be stockpiled for future use. Stockpile location will be a site on campus determined by the Project Manager.

3.04 DEMOLITION AND REMOVAL OF AC PAVEMENT

A. Sawcut pavement at edge of demolition area.

B. Break pavement and remove.

C. Remove any base material, gravel, and/or any other non-native soil.

3.05 SAW CUTTING

A. Make new openings neat.

B. Take care not to damage existing AC pavement to remain in place.

3.06 UTILITY REMOVAL

A. Where utility removal is shown on the plans or required for construction, excavate to expose existing utility, demolish and remove the section of pipe or conduit. Cap section of pipe or conduit to remain. Mark end of utility with 12" piece of #4 rebar.

B. Included in demolition are any appurtenances, including but not limited to valves, valve boxes, and irrigation system components.

C. Backfill trench in accordance with requirements of Section 31 23 33 - TRENCHING, BACKFILLING, AND COMPACTING.

3.07 DISPOSAL OF DEMOLISHED MATERIALS

A. Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.

B. Burning of demolished materials is prohibited.

3.08 FIELD QUALITY CONTROL

A. A. The Project Manager will accompany the Contractor before and after performance of work to observe physical condition of existing structures or improvements involved.

END OF SECTION

SECTION 32 12 33
PAVING AND SURFACING

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)); 2012 (Reapproved 2021).

1.02 SUMMARY

A. Section Includes (but is not necessarily limited to):
   1. Asphalt Concrete Paving.
   2. Concrete Paving.
   3. Liquid Asphalt and Asphalt Emulsion.
   4. Aggregate Base.

B. Related work furnished under other sections but conforming to the provisions of this section:
   1. Subgrade preparation.
   2. Aggregate Base Installation.

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. A615: Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   2. C150: Portland Cement.
   3. D1557: Moisture Unite Weight Relations of Soils and Aggregate Mixtures Using a 10 lb (4.5 kg) Rammer and 18 in. (457 mm) Drop.
   4. D1682: Breaking loads and Elongation of Textile Fabrics.

B. California Code of Regulations (CCR): Title 24, Chapter 2-71, Site development Requirements for Handicapped Accessibility.

C. California Department of Transportation (C.D.T.):
   1. Standard Specifications:
      a. Section 26 Aggregate Bases.
      b. Section 37 Bituminous Seals.
      c. Section 39 Asphalt Concrete.
      d. Section 51 Concrete Structures.
      e. Section 52 Reinforcement.
      f. Section 73 Concrete Curbs and Sidewalks.
      g. Section 90 Portland Cement Concrete.
      h. Section 92 Asphalts.
      i. Section 93 Liquid Asphalts.
      j. Section 94 Asphaltic Emulsions.
   2. Traffic Manual.
   3. Highway Design.

D. Institute of Transportation Engineers: Transportation and Traffic Engineering Handbook.

1.04 SUBMITTALS

A. Requirements: Refer to Section SUBMITTAL PROCEDURES.

B. Asphalt Concrete Paving:
   1. Provide two copies of material certificates signed by the material producer and the Contractor, certifying that each material item complies with or exceeds specified requirements.
   2. The Contractor shall furnish a certified weight or load slip for each load of material used in the construction of the asphalt concrete pavement.

C. Concrete Paving: The Contractor shall furnish mill test reports on the cement, reinforcement bars, and aggregates, showing compliance with the respective specifications. The Testing Engineer may make concrete test cylinders and slump tests as deemed necessary to determine compliance with the Specifications.

D. Liquid Asphalt Paving.

E. Pavement Reinforcement Fabric.

F. Tack Coat.

G. Pavement Reinforcement Mesh.

H. Structural Geotextile Fabric.

1.05 PROJECT CONDITIONS

A. Liquid Asphalt and Asphalt Emulsions:
   1. Prime coat, seal coat, and paint binder shall be applied only when the ambient temperature is above 50 degrees Fahrenheit and when temperature has not been below 35 degrees Fahrenheit for 12 hours immediately prior to application.
   2. Prime coat, fog coat, seal coat, and paint binder shall not be applied when base or surfaces are wet or contain excess moisture.

B. Asphalt Concrete Paving: Asphalt concrete surfaces shall be constructed only when ambient temperature is above 50 degrees Fahrenheit and when base is dry.

1.06 GENERAL DESIGN CRITERIA

A. Services Areas: Approach ramps, driveways and paved work areas in excess of 4 percent slope shall be provided with a rough texture for non-skid surface.

B. Walks and Paths: Concrete exterior slabs (walks, terraces, etc.) shall have a pitch of at least 1 percent.

C. Pavement Markings: All traffic control striping and pavement markings shall conform to the standards illustrated in the C.D.T. Standard Plans Book issued May 2006, General Road Work Section.

PART 2 PRODUCTS

2.01 PAVING MATERIALS

A. Aggregate Base: Aggregate base shall conform to Caltrans Class 2 (R value 78 min) aggregate base, 3/4" maximum size, as specified in Section 26 of the C.D.T. Standard Specifications.

B. Asphalt Concrete Paving:
   1. Paving asphalt to be mixed with aggregate shall be steam-refined asphalt, AR-4000, conforming to Section 92 of the C.D.T. Standard Specifications.
   2. Mineral aggregate shall be Type B mineral aggregate as specified in Section 39 of the C.D.T. Standard Specifications.
   3. Maximum aggregate size shall be as follows:

A.C. Thickness	Max. Ag.
3/4" - 1/12	1/2"
2 & 21/2"	1/2"
3" & 4"	3/4"

   4. Liquid asphalt for prime coast shall be Grade SC-70 in conformance with Section 93 of the C.D.T. Standard Specifications.
   5. Asphaltic emulsion for paint binder, fog coat, and seal coat shall be emulsified asphalt, Type SS-1h, conforming to Section 94 of the C.D.T. Standard Specifications.

C. Portland Cement Concrete:
   1. Concrete shall be Class A concrete conforming to Section 90 of the C.D.T. Standard Specifications.

2. Cement shall be Type II cement conforming to ASTM C150 as modified by Section 90 of the C.D.T. Standard Specifications.
3. Aggregate shall be 3/4-inch maximum size conforming to Section 90 of the C.D.T. Standard Specifications.
4. Water shall be potable and free of organic matter and injurious amounts of oil, acid, alkali, or other deleterious substances.
5. Reinforcing bars shall be deformed and shall conform to ASTM A615.
6. Filled joints, unless noted otherwise on the Drawings, shall be 1/4-inch thick, the full depth of the concrete section and conforming to Section 51 of the C.D.T. Standard Specifications.
7. Joint filler shall conform to Section 51 of the C.D.T. Standard Specifications for premolded expansion joint filler and expanded polystyrene joint filler.
8. No admixtures will be allowed without prior approval of the Project Manager.

D. Pavement Reinforcement Fabric: Pavement reinforcement fabric shall meet Caltrans Section 88-1.02, BP Petromat or approved equivalent.

E. Crack Sealant:
1. Crack sealant shall be rubberized hot-pour type and shall meet ASTM D 3405, Husky 1611 or approved equivalent.
2. Blotting Agent shall be one of: Screened sand, cement, or fly ash.

F. Tack coat: Tack coat shall meet Caltrans Section 39-4.02.

G. Pavement Reinforcement Mesh: Pavement reinforcement mesh for use in Type 2 Overlay shall be Glasgrid Model 8501 or approved equivalent.

H. Structural geotextile fabric: Structural geotextile fabric shall be Mirafi 500X or approved equivalent.

PART 3 EXECUTION

3.01 PREPARATION

A. Subgrade and Aggregate Base:
1. Prepare a subgrade and over excavation paragraph reference 3.4 of Section 31 00 00 EARTHWORK AND GRADING.
2. Aggregate base shall be compacted to 95 percent ASTM D1557. Sections 26-1.04B and 26-1.05 of the C.D.T. Standard Specifications shall apply.
3. Soil sterilant shall be applied to prepared subgrade or after installation of rock and aggregate base uniformly at the rate recommended by the manufacturer.

B. Crack Sealing:
1. Before sealing, cracks shall be cleared of dirt, dust, and all other deleterious materials to a depth of 1/4-inch to 1/2-inch.
2. Cracks 1/8-inch in width and greater shall be sealed.
3. Applications of crack sealer shall be in accordance with the manufacturer's recommendations unless otherwise directed.

3.02 ASPHALT CONCRETE PAVING

3.03 GENERAL:

1. Asphalt concrete shall be proportioned, mixed, placed, spread, and compacted in conformance with Section 39 of the C.D.T. Standard Specifications.
2. Before placing asphalt concrete on untreated base, a liquid asphalt prime coat shall be applied to the base course in conformance with Section 39 of the C.D.T. Standard Specifications. Prime coat shall be applied at the rate of 0.25 gallons per square yard.
3. Before placing asphalt concrete, an asphalt emulsion tack coat shall be applied to all vertical surfaces of pavement, curbs, gutters, construction joints, and all existing pavement to be surfaced, in conformance with Section 39 of the C.D.T. Standard Specifications.

4. Spreading and compacting asphalt concrete shall be performed in accordance with Section 39 of the C.D.T. Standard Specifications.
5. Fog seal shall be applied to all finished surfaces of asphalt concrete pavement at a rate of 0.05 gallons per square yard, in accordance with Section 37 of the C.D.T. Standard Specifications.
6. After fog seal has been applied, ample time shall be allowed for drying before traffic is allowed on the pavement or paint striping is applied.

3.04 CONCRETE CONSTRUCTION

A. General:
1. All concrete shall be mixed in accordance with applicable provisions of Section 90 of the C.D.T. Standard Specifications.
2. Construction of concrete substructures shall conform to applicable provisions to Section 51 of the C.D.T. Standard Specifications. Unless note otherwise in the Specifications, all exposed surfaces of structure shall have Class 1 surface finish or finished to match existing adjacent paving.
3. No pigment shall be used in curing compounds for construction of concrete curbs, gutters, and structures.
4. All work shall be subject to field inspection. No concrete shall be placed until the Project Manager has approved the forms and reinforcement.
5. Expansion joints on curbs and gutters shall be placed 20 feet on centers, adjacent to structures, and at all returns, and shall be filled with joint filler. Control joints shall be formed 10 feet on centers. The score shall 1-inch deep minimum.
6. Concrete shall not be dropped freely where reinforcing bars will cause segregation, nor shall it be dropped freely more than 6 feet. Spouts, elephant trunks, or other approved means shall be used to prevent segregation.

3.05 FIELD QUALITY CONTROL

A. Asphalt Concrete Paving:
1. The specified thickness of the finished pavement shall be the minimum acceptable.
2. Conforms shall form a smooth, pond-free transition between existing and new pavement.
3. Depressions in paving between high spots are not to exceed 1/8-inch when measured below a 10 feet long straight edged placed anywhere on surface in any direction.
4. The finished asphalt pavement shall have positive drainage without ponding.

3.06 CLEAN-UP

3.07 GENERAL:

1. Surplus material remaining upon completion of paving operations shall become the property of the Contractor, to be removed from the work site and disposed of in a lawful manner.
2. Surfaces shall be left in a clean, neat and workmanlike condition, and all construction waste, rubbish, and debris shall be removed from the work site and disposed of in a lawful manner.

END OF SECTION

SECTION 32 17 23
PAVEMENT MARKING

PART 1 GENERAL

1.01 SUMMARY

A. Provide requirements for materials, fabrications, and installation of traffic control and pavement markings.

1.02 SUBMITTALS

A. Submit manufacturer's product data describing application of products and compliance with VOC requirements.

B. Shop Drawings: Show complete layout and location of pavement markings prior to demolition or obliteration of the existing drawings.

C. Submit samples as follows:
   1. Traffic paint.
   2. Pavement markers and adhesives.
   3. Reflectorized markers and posts.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Comply with Division 1 requirements, specifications and the Project Manager.

B. Deliver and store packaged products in original containers with seals unbroken and labels intact until time of installation.

C. Provide proper facilities for handling and storage of products to prevent damage. Where necessary, stack products off ground on level platform, fully protected from weather.

PART 2 PRODUCTS

2.01 MATERIALS

A. Traffic Marking and Symbol Paint: Water-Born, Fast-Dry, Traffic Paint distributed by Fuller-O'Brien Corp. D.J. Simpson (#108-273, White); (#108-280, Blue); or approved equivalent.

B. Handicapped Symbol Background Paint: Blue Color. Glidden Co. "Glid-Guard Lifemaster Finish No. 2500 / series, Color 1/M 79", or approved equivalent.

C. Thermoplastic Stripes and Markings:
   1. Thermoplastic stripes and markings shall be hot applied conforming to CSS Section 84 and shall be Cataphote-Catatherm brand, Pavemark thermoplastic brand, or approved equal.
   2. Thermoplastic stripes and markings shall have a minimum skid friction value of BPN 35.

D. Pavement Markers and Adhesive:
   1. Fire hydrant pavement markers shall be two-way retrofective "Blue" markers and shall conform to the applicable requirements of CSS Section 85.
   2. Adhesive for pavement markers shall be standard set epoxy adhesive conforming to the requirements of CSS Section 95-2.05.

PART 3 EXECUTION

3.01 INSPECTION

A. Examine receiving surfaces and verify that surfaces are clean and proper for installation.

B. Do not start work until unsatisfactory conditions have been corrected.

3.02 APPLICATION

A. Preparation:
   1. Clean and prepare surfaces to receive traffic paint in accordance with CSS Section 84-3.05 and these special provisions. Where required, remove existing striping and markings

by wet blasting or equivalent method. Do not use dry sandblasting or other dust producing methods.

B. Traffic Paint:
   1. Traffic paint shall be machine applied in accordance with CSS Section 84-3.04.

C. Striping Layout:
   1. Traffic stripe shall be single and double, solid and broken, and of the color to match existing conditions.
   2. Traffic striping shall be placed in patterns to match existing conditions, contractor shall document.

D. Thermoplastic Stripes and Markings:
   1. Thermoplastic stripes and markings shall be applied hot in conformance with manufacturer's recommended instructions and the applicable requirements of CSS Section 84-2.06.

E. Pavement Markers:
   1. Blue pavement markers shall be installed to delineate the location of fire hydrants along campus roads or as shown on plans. No markers shall be installed until the surface has been approved by the Project Manager and until at least 10 days after the slurry seal on asphalt concrete has been placed. Place markers in accordance with CSS Section 851.06.

F. Apply marking paint in accordance with approved manufacturer's recommendations.

G. Density of paint coverage shall hide color and texture of substrate.

H. Parking Stripes: Paint four inches wide unless otherwise noted.

I. Symbol Marking: Paint to match existing conditions.

3.03 CLEANING AND PROTECTION:

A. Comply with requirements of Section CLEANING.

B. Upon completion of work, remove surplus materials and rubbish and clean off spilled or splattered paint resulting from this work.

C. Permit no surface traffic until pavement and symbol marking has dried thoroughly.

END OF SECTION

SECTION 32 32 13
PORTLAND CEMENT CONCRETE RETAINING WALLS

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete; 2020.

B. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete; 2025.

C. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Asphalt Types); 2023.

D. ASTM D1752 - Standard Specification for Preformed Sponge Rubber, Cork, and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction; 2018 (Reapproved 2023).

E. PS 1 - Structural Plywood; 2023.

1.02 SUMMARY

A. A. This section describes general requirements, products, and methods of execution relating to on-site Portland Cement Concrete Retaining Walls, unless otherwise noted:
   1. Concrete mix design.
   2. Formwork.
   3. Reinforcement.
   4. Removal of unused concrete and materials.

B. Contractor shall provide all labor, equipment, materials and testing services unless otherwise noted.

C. Related Sections:
   1. Section 31 10 00 - SITE PREPARATION.
   2. Section 31 23 33 - TRENCHING, BACKFILLING, & COMPACTING.

1.03 1.02 SUBMITTALS

A. Comply with requirements of Section 01 33 00 - SUBMITTALS.

B. Submit product data for proprietary materials and items, admixtures, joint systems, curing compounds, dry-shake finish materials, and others if requested by District.

C. Submit design mixes for each class of concrete. Includes revised mix proportions when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

D. Submit laboratory test reports for evaluation of concrete materials and mix design tests.

E. Provide material certificates in lieu of material laboratory test reports when permitted by Architect.
   1. Provide material certificates signed by manufacturer and Contractor certifying that each material item complies with or exceeds requirements.
   2. Provide certification from admixture manufacturers that chloride content complies with requirements.

F. Shop Drawings: Submit shop drawings showing elevations, control joint layout, finish, and rebar schedule.

1.04 QUALITY ASSURANCE

A. Comply with latest edition of the following standards and regulations:
   1. American Society for Testing and Materials (ASTM).
   2. California Department of Transportation (CALTRANS) Standard Plans (CSP) and Standard Specifications (CSS).
   3. American Concrete Institute (ACI).

4. Local requirements where they are applicable.

B. Prevent damage to adjacent concrete curbs, walks, utilities, walls, etc., during installation.
   1. Repair any damage to concrete edges or breaks in concrete at no cost to the District, by removal and replacement of complete sections.
   2. Patching will not be acceptable.

1.05 SITE CONDITIONS

A. Submit to District in writing any discrepancy between existing conditions and the Contract Documents.

B. Commencement of any part of the work shall constitute acceptance of existing site conditions as satisfactory.

C. Provide protection of materials if required by weather conditions so as not to compromise the quality of work.

D. Provide protection of surfaces adjacent to work.

E. Traffic Control: Maintain access for vehicular and pedestrian traffic as required by District.

PART 2 PRODUCTS

2.01 CONCRETE

A. Provide concrete materials conforming to the applicable requirements for Portland Cement Concrete as specified in CSS Section 90 Portland Cement Concrete (P.C.C.) for ASTM Type II P.C.C., Class 1 Concrete.
   1. Concrete shall not contain less than 675 lb of Portland cement per cubic yard.
   2. Concrete shall have a 4000 psi, 28-day compressive strength.
   3. Concrete shall have a water-cement ratio of 0.44 maximum (non-air-entrained), or 0.35 maximum (air-entrained).
   4. Mix design adjustments may be requested when materials, job conditions, weather, test results, or other circumstances warrant adjustment. Laboratory tests must be submitted to and accepted by the District's representative before using in work.

B. Aggregate for normal weight concrete shall be free of deleterious material and conform to CSS Section 90-3.04, 1 inch maximum grading.
   1. Coarse Aggregate shall conform to CSS Section 90-2.02A.
   2. Fine Aggregate shall conform to CSS Section 90-2.02B.

C. Water: Water shall be clean and potable.

D. Admixtures: Admixture may be used with approval of the Engineer. If more than one admixture is used, Contractor shall certify that all admixtures are compatible. Admixtures shall conform to CSS Section 90-4.

E. Slump Limit: Slump shall be not less than 1 inch and not more than 4 inches.

F. Patching Mortar: Mortar shall conform to CSS Section 51-1.135. Color shall match surrounding concrete.

G. Grout: Non Shrink Grout shall be factory pre-mixed conforming to ASTM C1107, Grade B, capable of developing 2400 psi in 48 hours, 7000 psi in 28 days.

2.02 FORMS

A. General: Provide forms of wood or steel, straight and of sufficient strength and stiffens to resist springing during depositing and consolidating concrete, of a height equal to the full depth of the finished concrete, and conforming to CSS Section 51.105 Forms, unless otherwise specified.

B. Wood forms:
   1. Use minimum 5/8-inch thick plywood complying with U.S. Product Standard PS 1 for s for Concrete Form plywood for exposed surfaces.
   2. Wood forms for exposed surfaces shall be straight and free from warp, twist, loose knots, splits or other defects.

3. Wood forms for unexposed surfaces shall be of sufficient strength and stiffness to hold concrete properly in place.

C. Steel forms:
   1. Provide channel-formed sections with a flat top surface and with welded braces at each end and at not less than 2 intermediate points.
   2. Form ends shall be interlocked and self-aligning.
   3. Forms shall include flexible forms for radius forming, corner forms, form spreaders, and fillers.
   4. Stake pins shall be solid steel rods with chamfered heads and pointed tips, designed for use with steel forms.

D. Form ties: Form ties shall be snap-off metal of fixed length, leaving no metal within 1-1/2 inch of surface and no fractures or other surface defects larger than 1 inch in diameter. Manufactured by Burke, Dayton, or approved equivalent.

E. Chamfer strips: Chamfer strips shall be rigid PVC, 3/4 inch x 3/4 inch or 1 inch x 1 inch size, as indicated on the Plans.

F. Form release agent: Form release agent shall be a colorless, non-staining agent, free from oils, that shall not impair bonding of paint or other coatings.

2.03 OTHER MATERIALS

A. Concrete Curing Material:
   1. Burlap: Conforming to AASHTO M182 with a weight of 14 ounces or more per square yard when dry.
   2. Impervious Sheeting: Comply with ASTM C171.
   3. Liquid Membrane Curing Compound: Comply with ASTM C309. Provide curing compound free of paraffin or petroleum.

B. Expansion Joint Fillers: Comply with ASTM D1751 or provide a resin-impregnated fiberboard conforming to the physical requirements of ASTM D1752.

C. Reinforcement: Provide dowels, reinforcement bars and welded wire mesh conforming to the requirements in CSS Section 52, Reinforcement, as required in the Plans.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the surfaces and areas at the locations for the retaining walls to establish acceptable conditions.
   1. Examine areas where formwork will be constructed and verify that:
      a. The excavations are sufficient to permit placement, inspection, and removal of forms.
      b. The excavations for earth forms have been neatly and accurately cut.
      c. Conditions are otherwise proper for formwork construction.
   2. Verify the formwork is complete.
   3. Verify that the excavation is free of debris and excess water.

B. Coordinate size and location of openings and penetrations in the concrete.

C. Coordinate location of items to be embedded into the corner.

D. If unsuitable conditions are found, immediately notify the District's Representative in writing, indicating the nature and extent of the unsuitable conditions.

E. Do not begin installation until defects have been corrected.

3.02 SUBGRADE PREPARATION

A. Remove material deflecting more than 1/2 inch under the roller to a depth of 4 inches below subgrade elevation and replace with and approved granular material.
   1. Compact new material as specified in Section 31 23 33 - TRENCHING, BACKFILLING & COMPACTING, or as shown in the Construction Documents.

2. Test completed subgrade for grade and cross section with a template extending the full width of the footing and supported between side forms.
3. Provide subgrade of materials equal in bearing quality to the subgrade under the adjacent pavement.
4. Place and compact additional subgrade material as needed.

B. Maintenance of Subgrade:
1. Maintain subgrade in a smooth, compacted condition, in conformity with the required section until the concrete is placed.
2. Prepare and protect subgrade so as to produce a subgrade free from frost and excessive moisture when the concrete is deposited.

3.03 FORM SETTING

A. Construct formwork to produce concrete surfaces to the tolerances of ACI 301.

B. Provide temporary ports in formwork to facilities cleaning and inspections. Locate openinga at the bottom or forms to allow flushing water to drain. Close ports with tight-fitting panels, flush with the inside face of the forms, neatly fitted so that joints will not be apparent in exposed concrete surfaces.

C. Provide chamfer strips on external corners of walls.

D. At exposed surfaces, keep the number of panel joints to a practical minimum. Ensure vertical joints are plumb and horizontal joints are level.

E. After forms are set, check grade and alignment with a 10-foot straightedge.
1. Forms shall conform to line and grade with an allowable tolerance of 1/4 inch in any 10-foot long section.
2. Forms shall have a transverse slope with the low side adjacent to the roadway unless otherwise indicated on Drawings.

3.04 FORM RELEASE AGENT:

1. Apply a coating of form release agent immediately before use, but prior to installation of reinforcing steel and embedded items.
2. Do not apply agent where concrete surfaces are scheduled to receive special finishes with may be affected by the agent.
3. Soak contact surfaces of untreated forms with clean water.

B. Embedded parts and openings:
1. Provide formed openings for work passing through concrete where indicated on Electrical drawings.
2. Do not install sleeves or openings, except as indicated on the Plans, without approval of the Engineer.
3. Properly locate and place inserts and embedded items required by work prior to casting concrete.

C. Expansion Joints:
1. Provide expansion joints and isolation joints where shown or noted on the Plans.
2. Provide sealed joints where concrete surface remains exposed to view or at conditions with non-bituminous or liquid waterproofing, unless otherwise shown or noted.
3. Place joint filler in straight line with edge held back to specified dimension from finish surface and secure to formwork or previously placed construction.
4. Use fiber type joints typically and hold edge back 1/4 inch from concrete surface.
5. Use cork type joint fillers at sealed joints and hold edge back 1/2 inch.
6. After curing concrete, carefully clean, prime and fill joints with sealant to 1/4 inch from the finished surface in accordance with manufacturer's recommendations.

3.05 DO NOT REMOVE SIDE FORMS WITHIN 12 HOURS AFTER FINISHING HAS BEEN COMPLETED.

3.06 EARTH FORMS

A. Footing forms may be omitted and foundation concrete may be placed directly into neatly and accurately cut excavations, provided that the walls are stable as determined by the Geotechnical Engineer, subject to approval by the Engineer.

B. Where sides are deemed unstable or excavations are not accurately cut to tolerances of ACI 301, construct forms to the extent required.

C. Remove loose dirt prior to placing concrete.

3.07 FORM REMOVAL

A. Do not removal forms until concrete has hardened and attained sufficient strength to permit safe removal and adequate support of adjacent loads.

B. Remove forms carefully to avoid damaging corners and edges of exposed concrete. Prying against the face of concrete is not allowed.

C. Curing, where forms are removed in less than 14 days, shall be continued as follows:
   1. Wet down concrete immediately after stripping.
   2. Appy curing compound as soon as areas are surface dry.

D. After concrete is placed, forms and shores shall remain in place for not less than 7 days for wall forms and 3 days for side forms of slabs and foundations.

3.08 REUSE OF FORMS

A. The District's Representative will approve reuse of forms. Forms shall be straight, clean, free from nails, hardened concrete, and other deleterious matter. Edges and surfaces should be in good condition.

B. Clean and repair all damage caused by placing, removal, or storage. Reuse of formwork with patches or repairs that could affect the exposed concrete finish will not be permitted.

C. Forms shall not be reused for Architectural Concrete if there is any evidence of surface damage or defect which could affect the quality of the surface.

D. Reseal form faces as required to achieve concrete of specified quality.

3.09 REINFORCEMENT PLACEMENT

A. Place bars at location shown on the Plans, maintaining minimum cover, to the following tolerances:
   1. Clear distance to formed surfaces: Plus or minus 1/4 inch.
   2. Top bars in slabs 8 inches deep or less: Plus or minus 1/4 inch.
   3. Tops bars in beams and slabs over 8 inches deep: Plus 1/4 inch and minus 1/2 inch.
   4. Bar Spacing: Plus or minus one inch, but not less than minimum spacing.
   5. Ends of Bars: Plus or minus 2 inches, except plus or minus 1/2 inch at discontinuous ends.

B. Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement placement and supports, and as herein specified.

C. Clean reinforcement of loose rust and mill scale, earth, ice, and other bond-reducing materials.

D. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers.

E. Accurately position, support and secure reinforcement against displacement by formwork, construction, or concrete placement operations.

F. Place reinforcement to obtain at least minimum coverage for concrete protection.
   1. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations.
   2. Set wire so ends are directed into concrete, not toward exposed concrete surfaces.

G. Reinforcement to be welded shall conform to requirement of American Welding Society Specifications, AWS D12.1.

1. If mill test reports are not available, chemical analysis shall be made of bars representative of the bars to be welded.
2. ASTM A706 bars may be assumed to have a carbon equivalent (C.E.) not exceeding
   a. 0.55. Bars with a C.E. above 0.75 shall not be welded.
3. Welding shall not be done on or within two bar diameters of any bent portion of a bar which has been cold.
4. Welding of crossing bass shall not be permitted for assembly of reinforcement unless authorized by the Structural Engineer of Record and approved by the Inspector of Record.
5. Welding is not permitted unless specifically detailed on plans or approved by Architect.

H. Splicing: Make splices only at those locations shown on the Plans or as accepted by the Owner's Representative. Stagger splices in adjacent bars whenever possible.

I. Dowels: Dowels shall be tied securely in place before concrete is deposited. In the event there are no bars in position to which dowel may be tied, No. 3 bars (minimum) shall be added to provide proper support and anchorage.

J. Install deformed bar anchors in accordance with the manufacturer's recommendations.

K. Install mechanical splices and reinforcing couplers in accordance with manufacturer's recommendations.

L. Reinforcement shall not be bent after being embedded in hardened concrete.

M. Protection Against Rust
1. Where the is damage of rust staining adjacent surfaces, wrap reinforcement with impervious tape or otherwise prevent rust staining.
2. Remove protective materials and clean reinforcement as required before proceeding with concrete placement.

3.10 CONCRETE PLACEMENT

A. Placing Record: Record time, date and location of concrete placement; maintain record open to inspection by the Inspector-of-Record.

B. Place concrete in accordance with ACI 301, or CSS Section 51-1.09 Placing Concrete.

C. Convey concrete as rapidly and directly as practicable to preserve quality and to prevent separation.
1. Do not deposit concrete which has initially set.
2. Retempering of concrete which has partially set will not be permitted.

D. The free vertical drop of the concrete deposited at any point in forms during conveying shall not exceed 3 feet. Chutes may be issued only where they discharge into a hopper before distribution.

E. Deposit concrete in a continuous operation to permit proper and thorough integration.
1. Carry work started in a section continuously to construction joint.
2. Place concrete at rate and in such manner that concrete surfaces not carried to joint levels will not attain initial set before additional concrete is placed.
3. Use equipment that will permit the concrete to be placed in a manner that will prevent segregation and accumulations or hardened concrete above the level of the concrete.

F. Keep forms and reinforcement clean above pour line by removing clinging concrete.
1. Keep forms and reinforcement clean above pour line by removing clinging concrete.

G. Cold Weather Placement: Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing, or low temperatures, in compliance with ACI 306 and as herein specified.
1. When air temperature has fallen to or is expected to generally fall below 40 degrees F (4 degrees C), uniformly heat water and aggregates before missing to obtain a concrete mixture temperature of not less than 50 degrees F (10 degrees C), and not more than 80 degrees F (27 degrees C) at point of placement.

2. Thin upper level slabs should obtain a concrete mixture temperature of not less than 55 degrees F (13 degrees C).
3. Do not use frozen materials or materials containing ice or snow.
4. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
5. Do not use calcium chloride, salt and other mineral containing anti-freeze agents or chemical accelerators, unless otherwise accepted by Architect.

H. Hot Weather Placement: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and herein specified.
1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 degrees F (32 degrees C). Mixing water may be chilled, or chopped ice may be used to control concrete temperature provided water equivalent of ice is calculated to total amount of mixing water.
2. Place concrete immediately upon delivery. Keep exposed concrete surfaces, and formed shaft extensions, moist by fog sprays, wet burlap or other effective means.
3. Do not use retarding admixtures without acceptance of Architect.

I. Consolidation:
1. Use internal vibrators for thorough consolidation of all concrete, in compliance with ACI 309 and as herein specified. Use largest size and most powerful vibrators that can be accommodated in the work.
2. Do not place vibrators against reinforcement, attach to forms, or use to spread concrete.
3. Exposed Concrete: Vibrate with rubber type heads and spade along forms with flat strap or plate.
4. Architectural Concrete:
   a. Proper placement and thorough compaction of architectural concrete are critical.
   b. Place vibrators in the concrete rapidly to minimize entrapped air between the concrete and the form and to blend the two layers.
   c. Insert vibrators in accordance with manufacturer’s recommended radius of influence.
   d. Usa a minimum of three 180-cycle motor-in-hand vibrators for concrete placing. Minimum frequency 9,000 impulses per minute, minimum head diameter 1-1/2 inches.
5. Keep vibrator heads a minimum of 2-1/2 inches from the architectural concrete face.
6. If, during the placing operation, there is any delay of more than 15 minutes, the previous lift will be manipulated with the vibrators just prior to the placement of fresh concrete.

3.11 FINISHING

A. Finish of formed surfaces to be smooth and free of fins, honeycomb, or segregation. When defects occur, they are to be remedied by chipping cavities and patching, or by other methods approved by Owner.

B. Exposed surfaces to be "sacked" by rubbing cement mortar into voids with burlap or canvas. Fins to be ground smooth and loose mortar to be removed.

C. Vertical edges of the walls to have 3/4-inch chamfer.

D. Horizontal edges of the walls to have 1/2-inch chamfer.

E. Unformed surfaces to be steel troweled to a smooth dense finish. After the trowel finish has sufficiently hardened, walking surfaces of the entire surface to be given a medium broom finish perpendicular to the direction of travel. The broom finish to be applied just prior to the application of the curing compound/sealer.

3.12 CURING AND PROTECTION

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperature in accordance with ACI 308 and as specified herein.
1. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing concrete. Weather permitting, keep continuously moist for not less than 7 days.

2. Begin final curing procedures immediately following initial curing and before concrete has dried.
3. Continue final curing for at least 7 days in accordance with ACI 301 procedures.
4. Avoid rapid drying at end of final curing period.

B. Curing Methods:
1. Mat Method: Provide moist curing by any of the following methods to keep concrete surface continuously wet:

C. Cover concrete continuously with water.

D. Provide a continuous water fog spray.

E. Cover concrete with a saturated absorptive mat. Prior to placing mats on concrete surface, thoroughly wet the exposed surface with water. Cover the entire exposed surface with 2 or more layers of burlap. Mats shall overlap each other at least 6 inches. Continuously keep mats in a saturated condition and in intimate contact with concrete for not less than 7 days.

F. Impervious Sheeting Method: Provide moisture-cover curing as follows:
1. Wet the entire exposed surface with a fine spray of water and then cover with impervious sheeting material.
2. Lay sheets directly on the concrete surface, placed in widest practicable width with sides and ends lapped at least 12 inches when a continuous sheet is not used.
3. Provide impervious sheeting at least 18 inches wider than the concrete surface to be cured.
4. Securely weighh sheeting down with heavy wood planks, or by placing a bank of moist earth along edges and laps in the sheets, or by sealing with waterproof tape or adhesive.
5. Immediately repair any holes or tears in cover curing period using cover material and waterproof tape.
6. Sheets shall be satisfactorily repaired or replaced if torn or otherwise damaged during curing.
a. The curing sheet shall remain on the concrete surface to be cured for not less than 7 days.

G. Membrane Curing Method: Provide curing compound to slabs as follows:
1. Cover the entire exposed surface with a membrane-forming curing compound.
2. Apply specified curing and sealing compound as soon as final finishing operations are complete (within 2 hours).
3. Apply uniformly in continuous operation by power-spray or roller in accordance with manufacturer’s direction, or apply in 2 coats by hand-operated pressure sprayers as recommended by the manufacturer.
4. Apply an additional coat to all surfaces showing discontinuity, pinholes or other defects.
5. Recoat areas subjected to heavy rainfall within 3 hours after initial application.
6. Maintain continuity of coating and repair damage during curing period.
7. Protect concrete surfaces to which membrane-curing compounds have been applied.
8. Any area covered with curing compound and damaged by subsequent construction operations within 7-day curing period shall be resprayed.

H. Do not use membrane curing compounds on concrete surfaces which are to be covered with material applied directly to concrete, such as liquid floor hardener, waterproofing, dampproofing, membrane roofing, flooring, painting, and other coatings and finish materials, unless otherwise acceptable to Engineer.

3.13 CONSTRUCTION JOINTS

A. General: Construction joints shall conform to typical details and be located where shown on the Plans or where approved by the Engineer. Locate joints to minimize impairment to the strength of the structure.

B. Place construction joints perpendicular to the main reinforcement. Continue reinforcement across construction joints.

C. Walls: To assure a level an straight joint in exposed vertical surfaces, tack a 3/4 inch x 1-1/4 inch strip of dressed lumber to exposed face form at construction joint.
   1. Place concrete 1 inch above underside of strip.
   2. During stripping, carefully remove tack strip to prevent chipping or spalling.
   3. Maximum spacing between vertical construction joints shall be 60 feet.

D. Provide keyways at least 1-1/2-inches deep in construction joints in walls and slabs, unless shown otherwise. Bulkheads design for this purpose may be used for slabs if approved by Architect.

3.14 CONTRACTION (CONTROL) JOINTS

A. Provide joints of size and at locations specified below:
   1. Provide 3/4" Chamfer joints at 20 feet maximum spacing in each direction, unless otherwise shown or noted.

B. Sawcut as soon as concrete has hardened sufficiently to prevent aggregates being dislodged by saw. Complete sawcutting operations within 24 hours of the introduction of water to the mix.

C. REPAIR OF DEFECTIVE WORK
   1. Where concrete is under strength, out of line, level or plumb , or show objectionable cracks, honeycombing, rock pockets, voids, spalling, exposed reinforcement, or is otherwise defective, and in the Engineer’s judgement, these defects impair the proper strength or appearance of the work, the Engineer will require in its removal and replacement at the Contractor's expense.
   2. Immediately after stripping and before concrete is thoroughly dry, patch minor defects, form-tie holes, honeycombed areas with patches that match finish of adjacent surface.
   3. The holes shall be filled solid with patching mortar.
   4. Cut out honeycombed or otherwise defective areas to solid concrete to a depth of not less than 1 inch.
      a. The edges of the cut shall be perpendicular to the surface of the concrete.
      b. Saturate the area to be patched and at least 6 inches adjacent thereto with water before placing the mortar.
      c. Mix the mortar approximately 1 hour before placing and remix occasionally during this period with a trowel without the addition of water.
      d. A grout of cement and water mixed to the consistency of paint shall then be brushed on to the surfaces to which the mortar is to be bonded.
      e. Compact the mortar into place and screed slightly higher than the surrounding surface.
      f. Finish patches on exposed surfaces to match the adjoining surfaces, after they have set for an hour or more.
      g. Cure patches as specified for the concrete.
   5. The specified patching mortar may be used in lieu of the above method when color match of the adjacent concrete is not required. Prior approval by the Engineer is required.
   6. The specified patching mortar may be used in lieu of the above method when color match of the adjacent concrete is not required. Prior approval by the Engineer is required.

3.15 FIELD QUALITY CONTROL

A. Comply with requirements of Section 01 45 23 - TESTING AND INSPECTION SERVICES.

B. The Owner's Testing Agency will:
   1. Provide full time special inspection for concrete placement.
   2. Inspect concrete placement for conformance with the Contract Documents in accordance with the California Building Code.

C. Sampling Fresh Concrete: Samples for strength tests shall be taken in accordance with ASTM C172. Cylinders and cores for acceptance shall be made, cured and tested in accordance with ASTM C31 and ASTM C39.

1. Slump ASTM C 143; one test for each concrete load at point of discharge; and one test for each set of compressive strength test specimens.
2. Air Content: Air content tests shall be made each time compressive strength cylinders are taken of concrete required to be air entrained.
3. Compression Test Specimen: One set of 4 standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required.
4. Compressive Strength Tests: One set for each 10 cubic yards or fraction thereof, of each concrete type and strength placed in any one day, 1 specimen tested at 7 days, 2 specimens tested at 28 days, and 1 specimen retained in reserve for later testing if required. Compressive strength tests are not required for exterior concrete paving.
5. When frequency of testing will provide less than 5 tests for a given type and strength of concrete, conduct testing from at least 5 randomly selected batches or from each batch if fewer than 5 are used.
6. When strength of field-cured cylinders os leaa rhan 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
7. Strength level of concrete will be considered satisfactory if averages of sets of two consecutive strength test results equal or exceed specified compressive strength, and no individual strenght test results falls below specified 28 day compressive strength by more than 500 psi.

D. Structural Grout for Horizontal Joints: Verify that required mixing procedures are taken. One set of four samples will be taken for compression tests for each day grouting takes place. Observe initial grout placement and conduct periodic visual inspections of in-place work.

E. Additional Tests: The testing agency will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Engineer.
   1. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.
   2. Owner shall back charge the Contractor for such tests conducted, and any other additional testing as may be required, when unacceptable concrete is verified.

3.16 BACKFILL

A. After curing, remove debris: backfill, grade and compact the area adjoining the concrete to conform to the surrounding area in accordance with lines and grades indicated.

3.17 CLEANING

A. Comply with requirements of Section 01 71 00 - CLEANING.

B. Protect completed concrete from damage until accepted.

C. Repair damaged concrete and clean concrete discolored during construction.
   1. Concrete that is damaged shall be removed and reconstructed for the entire length between regularly scheduled joints.
   2. Refinishing the damaged portion will not be acceptable.
   3. Remove damaged portions and dispose of as directed.

D. Ensure removal of bituminous materials, form release agents, bond breakers, curing compounds or other materials employed in work of concreting which would otherwise prevent proper application of sealants, liquid waterproofing, or other delayed finishes or treatments.

E. Where cleaning is required, take care not to damage surrounding surfaces or leave residue from cleaning agents.

END OF SECTION

SECTION 32 50 00
RESTORATION OF SURFACES

PART 1 GENERAL

1.01 SUMMARY

1.02 SECTION INCLUDES BUT IS NOT LIMITED TO:

1. General surface restoration.
2. Asphalt concrete surface restoration.
3. Concrete surface restoration.
4. Pavement Marking.
5. Landscape/Planting restoration.

B. Related Sections:

1. Section 02315 - TRENCHING, BACKFILLING & COMPACTING.
2. Section 02750 - PAVING AND SURFACING.
3. Section 32 17 23 - PAVING AND MARKING.

PART 2 PRODUCTS

2.01 MATERIALS

A. Refer to Section 31 23 33 - TRENCHING, BACKFILLING & COMPACTING.

B. Refer to Section - PAVING AND SURFACING.

C. Refer to Section - PAVEMENT MARKING.

PART 3 EXECUTION

3.01 GENERAL

A. Surface restoration shall be in kin or better.

3.02 ASPHALT CONCRETE SURFACE RESTORATION

A. The base course for permanent asphalt concrete surface restoration shall be Class II Aggregate Base, equal in depth to the existing pavement structural section, but not less than 8 inches in depth.

B. The wearing surface for permanent surface restoration or improved streets shall be asphalt concrete equal in thickness to the existing pavement, but not less than 3 inches in depth. The asphalt concrete shall be Type B Asphalt Concrete, in accordance with Section 32 12 23 PAVING AND SURFACING.

3.03 CONCRETE SURFACE RESTORATION

A. The base for permanent concrete surface restoration shall be Class II Aggregate base, equal in dept to the existing section, but not less than 6 inches in depth.

B. The weaving surface for permanent concrete surface restoration shall be concrete equal to thickness to the existing concrete section, but not less than 4 inches in depth for Pedestrian Areas and not less than 6 inches in depth for Vehicular areas. The concrete shall be 6-sack concrete, in accordance with Section 32 12 33 – PAVING AND SURFACING.

3.04 PAVEMENT MARKING RESTORATION

A. Replace pavement marking disturbed by construction operations/activity to the satisfaction of the Project Manager in kind in accordance with Section 31 17 23 - PAVEMENT MARKING.

3.05 LANDSCAPE RESTORATION

A. Replace landscaping, planting, trees, shrubs, ground cover, irrigations systems disturbed by construction operations/activity to the satisfaction of the Project Manager in kind or better.

B. Disturbed lawn are shall be replace with Sod in kind or better to the satisfaction of the Project Manager.

END OF SECTION

SECTION 33 61 13
UNDERGROUND THERMAL ENERGY DISTRIBUTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pipe and pipe fittings for:
   1. Underground Heating Hot Water piping system.
   2. Underground Chilled Water piping system.
   3. Precast Vaults for Underground Piping Systems

B. Valves:
   1. Butterfly valves.
   2. Balancing valves

1.02 REFERENCE STANDARDS

A. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.

B. ASME B31.1 - Power Piping; 2024.

C. ASME B31.9 - Building Services Piping; 2025.

D. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.

E. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2023).

F. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2025.

G. ASTM A743/A743M - Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application; 2021.

H. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025.

1.03 SUBMITTALS

A. See Division 1 for submittal procedures.

B. Shop Drawings: Submit complete shop drawings for piping system showing all fittings, elevations, pipe accessories, hanger locations and all connected equipment. Submit shop drawings electronically in PDF or DWG format. Drawings shall be produced in AutoCad 2018, or Revit 2018 or later releases..

C. Product Data: Include data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.

D. Welders Certificate: Include welders certification of compliance with AWS D1.1.

E. Project Record Documents: Record actual locations of pipe routing, valve locations and unforeseen utilities.. Submit in same format as for Shop Drawings above.

F. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

G. Piping Pressure Test Reports: Provide piping pressure test reports indicating:
   1. Owner
   2. Project Address
   3. Project Name
   4. Testing Contractor
   5. Pipe Segment Tested
   6. Pipe Size, Service and material (including wall thickness information (schedule, SDR, etc.)
   7. Test Medium
   8. Date and Time of Test Start
   9. Starting Pressure and Temperature of Test Medium
   10. Starting Ambient Temperature

11. Date and Time of Test End
12. Ending Pressure and Temperature of Test Medium
13. Ending Ambient Temperature
14. Observations and Conclusions

H. Prefabricated Piping Systems: Provide manufacturer's shop drawings with dimensioned piping layout and details of all expansion loops, elbows, anchor points, building and/or manhole entry points and all other pertinent information needed to verify that the type of materials being offered are in accordance with these specifications. Prefabricated pipe units are to be subsequently dimensionalized and numbered to fit actual job conditions as field verified by the installing contractor prior to the start of factory fabrication work.

I. Thermal Stress Analysis: Submit computer modeled thermal stress analysis for piping systems handling fluids over 95 F. Analysis shall include reaction forces at anchors, maximum bending moments and stresses for all elbows, z-bends and expansion loops and shall show that proposed layout of piping system is within allowable stresses per ANSI/ASME B-31.9.Stress analysis shall be in two submittals, one prior to fabrication and one for final, as-built conditions. Final stress calcs shall be submitted with As-Built drawings described below.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified in this section, with minimum three years of experience.

C. Welder Qualifications: Certify in accordance with AWS D1.1.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.06 FIELD CONDITIONS

A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.01 HYDRONIC SYSTEM REQUIREMENTS

A. Comply with ASME B31.9 and applicable federal, state, and local regulations.

B. Piping: Provide piping, bolsters, anchors and supports as required, as indicated, and as follows:
1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized. Common anchors for chilled water and heating hot water are not allowed.
2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
3. Provide pipe anchors, loops, and bolsters per drawing details and as per manufacturer's recommendations.
4. Provide temporary flanges/blinds, caps and temporary anchors, test connections and other ancilliaries as required to perform hydro testing of piping system, in segments as required to meet project requirements and time constraints. Remove temporary flanges, caps, anchors, etc, from all direct buried portions of piping at completion of testing.

C. Pipe-to-Valve Connections: Use flanges or unions to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections. Flanges or unions shall be used in accessible manholes or tunnels only, unless otherwise indicated or shown on contract drawings. Grooved fittings and couplings are not acceptable for use on systems conveying fluids in excess of 95 degrees F.

D. Valves: Provide valves where indicated.

2.02 HEATING WATER PIPING, BURIED

A. STEEL CARRIER, HDPE JACKET: Underground piping for lines shall consist of a factory prefabricated, pre insulated system suitable for direct burial, consisting of a carrier pipe, insulation, and a corrosion resistant outer casing. Prefabricated piping system shall be , Ferro-Therm as manufactured by Thermacor Process, L.P., or approved equal. All straight sections, expansion loops, fittings, anchors and other accessories shall be factory fabricated to job dimensions and designed to minimize the number of field welds. Each system layout shall be computer-analyzed by the piping system manufacturer to determine stress on the carrier pipe and anticipated thermal movement of the service pipe. The system design shall be in strict conformance with ANSI B31.9 latest edition.

1. Carrier Pipe: ASTM A 53, Grade A or B, Schedule 40 for pipe sizes under 12", 0.375" wall for 12" and over, black, seamless or electric resistance welded .
2. Fittings: ASTM A 234/A 234M, forged steel welding type .
3. Joints: Welded.
4. Insulation: Polyurethane, spray applied, nominal density 2 pounds per cubic foot foam for straight sections and preformed foam for fittings - thickness as scheduled on drawings. K = .16 BTU-in/hr-SF-F.
5. Casing: Jacketing material shall be extruded, black, high density polyethylene (HDPE), having a minimum wall thickness of 125 mils for jacket sizes less than or equal to 12", 150 mils for jacket sizes larger than 12" to 24", and 175 mils for jacket sizes greater than 24".
6. Fittings: Fittings shall be factory fabricated and provide sufficient straight lengths of pipe on each end to allow for field joints in straight piping only. Insulation and casing shall be the same as for the straight piping system.
7. End Seals: Moisture barrier end seals shall be factory applied, sealed to the jacket and carrier pipe. Field applied end seals shall be installed at any field cut to the piping before continuing with the installation. End seals shall be:
   a. Heat Shrink: A single piece, polyethylene molded heat shrink end seal that is specifically designed for each pipe size
8. Field Joints (Pressure Testable): Straight run joints shall be field-insulated per the manufacturer's instructions, using polyurethane foam, same thickness as for pipe, and jacketed with an electro-fusion welded split sleeve. The manufacturer shall provide the fusion machine, straps, rubber bands, pressure gauges, and closure patches for the pressure testable joint cover. Heat shrink sleeve materials will not be accepted as the primary sealing method. ALL FIELD JOINTS ARE REQUIRED TO BE PRESSURE TESTED at 5 psi for 5 minutes while simultaneously soap tested at the joint closure’s seams for possible leaks. After passing the pressure test, the field joint is insulated and a closure patch is welded (as per joint closure instructions) over the foam holes. All field joint closures and insulation shall occur at straight sections of pipe only
9. Piping system shall be capable of field modifications (cutting and joining), to allow for rerouting to avoid unforeseen obstructions without affecting system warranty.
10. Anchors: Factory fabricated, solid steel plate welded to carrier pipe, extending through insulation, wrapped with high shrink ratio HDPE heat shrink wrapping. The steel plate shall be a minimum of ½" thick with an outside diameter 2" greater than that of the outer jacket.
11. Expansion Loops: Expansion loops shall be factory fabricated to verified dimensions. Manufacturer's recommended exterior bolstering material shall be installed to accomodate thermal movement. Bolsters to be provided by piping manuacturer.

B. STEEL PIPING IN VAULTS: Steel piping inside vaults shall conform to the following:

1. Pipe: ASTM A 53, Grade A or B, Schedule 40 for pipe sizes under 12", 0.375" wall for 12" and over, black, seamless or electric resistance welded.
2. Fittings: ASTM A 234/A 234M, forged steel welding type or 150 lb flanged.
3. Joints: Welded, or 150 lb flanged.

C. PIPE INSULATION IN VAULTS: Pipe insulation inside vaults shall conform to the following:
1. Aerogel: Aspen Aerogels, Pyrogel XTE: Flexible high performance aerogel blanket, hydrophobic and breathable, with long lasting water resistance for both insulation and pipng. Thermal conductivity of 0.16 BTU-in/hr-sq.ft-F at 212 F. Thickness as scheduled on drawings.
2. Jacketing: PVC jackets with pipe ID and flow direction markers with snap around anchoring system. Tape system not acceptable.
3. Labeling: Factory fabricated, mechanically attached PVC pipe ID labels, indicating service, supply or return and arrows indicating flow direction. Locate for ease of reading

2.03 CHILLED WATER PIPING, BURIED

A. PVC CARRIER, HDPE JACKET
1. Underground piping for lines shall consist of a factory prefabricated, pre insulated system suitable for direct burial, consisting of a carrier pipe, insulation, and a corrosion resistant outer casing. Prefabricated piping system shall be Chill-Therm as manufactured by Thermacor Process, L.P., or approved equal.solvent welded PVC. All straight sections,anchors and other accessories shall be factory fabricated to job dimensions and designed to minimize the number of field joints.
a. Carrier Pipe:
1) Pipe size less than 14": Schedule 40 PVC
2) Pipe sizes 14" and over: C900-DR18 PVC
b. Fittings:
1) Pipe size less than 14": PVC schedule 80, solvent welded.
2) Pipe sizes 14" and over:C900-DR18 PVC, solvent welded bell and spigot.
c. Joints:
1) Pipe Size less than 14": Solvent weld factory schedule 80 fittings.
2) Pipe size 14" and over: solvent welded bell & spigot.
d. Transitions: Provide appropriate transition fittings for C900 to schedule 40 pipe connections.
e. Thrust restraints (anchors): Provide poured in place concrete anchors to undisturbed earth to restrain all solvent welded PVC joints 8" and larger, as detailed on contract drawings..
f. Insulation: Polyurethane, spray applied, nominal density 2 pounds per cubic foot foam for straight sections and preformed foam for fittings - thickness as scheduled on drawings. K = .16 BTU-in/hr-SF-F.
g. Casing: Jacketing material shall be extruded, black, high density polyethylene (HDPE), having a minimum wall thickness of 125 mils for jacket sizes less than or equal to 12", 150 mils for jacket sizes larger than 12" to 24", and 175 mils for jacket sizes greater than 24".[<>]
h. Fittings: Fittings solvent welded and shall be field assemblied and insulated (sticks and kits). Utilize pre-molded PVC fitting covers as molds and two part pour in polyurithane foam witn HDPE jackets to match adjacent thicknesses.
i. End Seals: Moisture barrier end seals shall be factory applied, sealed to the jacket and carrier pipe. Field applied end seals shall be installed at any field cut to the piping before continuing with the installation. End seals shall be:
1) Heat Shrink: A single piece, polyethylene molded heat shrink end seal that is specifically designed for each pipe size
j. Field Joints: Straight run joints and fittings shall be field-insulated per the manufacturer's instructions, using polyurethane foam poured in an HDPE sleeve and sealed with a heat shrink sleeve. All insulation and jacketing materials shall be furnished by piping system manufacturer.
k. Piping system shall be capable of field modifications (cutting and joining), to allow for rerouting to avoid unforeseen obstructions without affecting system warranty.

2.04 PVC PIPING IN VAULTS:

A. Pipe: Piping specs in vaults shall be the same as for the main underground PVC system as specified in Article 2.03, above.

B. Companion Flanges: Solvent weld Van Stone flange with ANSI Class 150 bolt drilling with flat gakets.

C. Closed cell Armacell Armaflex pipe insulation with UV reistant jacket.

D. Jacketing: Factory fabricated molded PVC jackets, sealed water and vapor tight.

E. Labeling: Factory fabricated, mechanically attached PVC pipe ID labels, indicating service, supply or return and arrows indicating flow direction. Locate for ease of reading.

2.05 UNIONS, FLANGES, AND COUPLINGS - IN VAULTS ONLY

A. Unions for Pipe 2 Inches (50 mm) and Under:
   1. Ferrous Piping: 150 psig (1034 kPa) malleable iron, threaded.
   2. PVC Pipe: schedule 80 PVC solvent welded two piece union.

B. Flanges for Pipe Over 2 Inches (50 mm):
   1. Ferrous Piping: 150 psig (1034 kPa) forged steel, slip-on, welded..
   2. PVC Piping: Class 150 solvent weld Van Stone flange.
   3. Gaskets: 1/16 inch (1.6 mm) thick preformed neoprene.

C. Dielectric Connections: Waterway with electro zinc plated casing, chemically inert, non corrosive, self-cleaning NSF/FDA listed dielectric thermoplastic waterway. Thermoplastic liner shall meet requirements of ASTM Standard F-492. Threaded ends. Victaulic, ClearFlow, or approved equal.

2.06 BUTTERFLY VALVES - IN MANHOLES AND VAULTS

A. Manufacturers
   1. DeZurik Water Controls; Model AWWA Butterfly Valves (BAW): www.dezurikwater.com. or equal, no known equal.
   2. Substitutions: See Division 1

B. General: Butterfly valves shall meet the requirements of AWWA C504 standards. Butterfly Valve shall have offset disc design, corrosion resistant shaft, stainless steel disc edge, and self-compensating shaft seals. Molded-in body seat with disc locators provides positive sealing and longer seat life on sizes 3 - 20". Large valves, 24" and larger shall have adjustable, replaceable seat, non-hollow disc structure, and rubber seat retained within a dovetail groove in the valve body and locked in place by an epoxy wedge.
   1. Temperature Range: to 290°F
   2. AWWA Class: 150B
   3. Body Material: Cast iron ASTM A126 Class B
   4. Disc Material: 316 Stainless Steel ASTM A743 Type CF8M
   5. Shaft Material: 316 Stainless Steel ASTM A276 Type 316
   6. Seat Material: Chloramine resistant EPDM Terpolymer of Ethylene Propylene & a Diene (-20 to 290 F)
   7. Packing Material: Chloramine resistant EPDM Self adjusting (-20 to 290 F)
   8. Valve Style: Flanged joint
   9. Coating: Epoxy coated, minimum 8 mils dry finish
   10. Actuator Type: Valves between 3"-36" shall have a scotch yoke mechanism that allows the actuators to provide a torque curve matching the torque required by the valve. The actuator shall have a steel threaded input shaft and ductile iron yoke nuts (traveling nut actuator). Valves between 30"-72" shall have a link-arm mechanism that will allow the actuator to provide characterized closure which slows valve travel as the disc comes into the seat. Provide handwheel for use in manholes and standard operating nut for buried service.

2.07 BALANCING VALVES

A. Manufacturers:

1. ITT Bell & Gossett: Model Circuit Setter: www.bellgossett.com.

B. Construction:
   1. 1/2" to 2" Pipe Size
      a. Bronze body, brass ball construction with glass and carbon filled TFE seat rings. Valves to have differential pressure read-out ports across valve seat area. Read-out ports shall have integral EPT insert and check valve. Valve bodies shall have 1/4" tapped drain/purge point. Valve to have memory stop feature and integral calibrated nameplate with position indication. 300 psig design pressure, NPT connections. 250 F operating termperature.
   2. 2-1/2" to 12" Pipe Size
      a. Cast iron, flanged construction with 125 psig flanged connections suitable up to 175 psig working pressure at 250 F. Valves 2-1/2" - 3" shall have a brass ball with glass and carbon filled TFE seat rings. Valves 4" - 12" shall be fitted with a bronze seat, replaceable bronze disc with EPDM seal insert, and stainless steel stem. Valves shall have memory stop feature and calibrated nameplate with position indication.

2.08 PRECAST CONCRETE VAULTS FOR HYDRONIC ENERGY UTILITIES

A. As specified and detailed on Contract Drawings.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment using jointing system specified.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

E. After completion, fill, clean, and treat systems. Refer to Section 23 25 00 for additional requirements.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install heating water and chilled water piping to ASME B31.9 requirements.

C. Route piping in orderly manner, parallel to building structure, and maintain gradient.

D. Group piping whenever practical at common elevations.

E. Slope piping and arrange to drain at low points.

F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

G. Underground piping: Refer to Section 31 23 33 for trenching and backfilling.

H. Pipe Hangers and Supports:
   1. See Contract Drawings for piping supports and restraints inside valve vaults.

I. Provide clearance from structure and other equipment for installation of insulation and access to valves and fittings. .

J. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.

K. Install valves with stems upright or horizontal, not inverted.

L. Document on Record Drawings exact location and elevation of all utilites installed underground. Dimensions shall be recorded from permanent surface features on site. Document all existing utilites crossed with location marked from permanent surface features and elevation of each utility

M. In addition to installed piping exact locations and elevations per above, also document all existing utilities uncovered, crossed or otherwise discovered with information for Size, Service,

Pipe and Insulation materials, elevation, location from permanent surface features, and direction of pipe, using compass headings. dcoument all such informaiton on Contract Record Drawings and As-Built Drawings.

N. Information from Record Drawings shall be included on the final As-Built drawings.

3.03 PREFABRICATED PIPING SYSTEM INSTALLATION

A. Follow manufacturer's written instructions for all installation procedures.

B. Coordinate with manufacturer for field inspection prior to testing or backfilling. To assure proper installation of the piping materials, a manufacturer's field service instructor who is technically qualified to determine whether or not the installation is being made in accordance with the manufacturer's recommendations shall be present during critical periods of the materials installation and testing.

C. Polyurethane insulation shall be poured in place into the field weld area. All field applied insulation shall be placed inside preformed PVC or ABS pipe jacketing sections secured to pipe.. For straight sections, the mold for the insulation shall be made of clear adhesive backed polyester film. Joint area shall be sealed with a heat shrinkable adhesive backed wrap.

D. All insulation and coating materials for making the field joint shall be furnished by the prefabricated piping manufacturer.

E. Bedding and Backfilling:
   1. See also Section 31 23 16.13 Trenching for Site Utilities.
   2. Backfilling shall not begin until the heat shrink wrap has cooled,.
   3. Install external bolstering material of the type and dimensions as recommended/required by the manufacturer for external expansion compensation.
   4. Provide 4 inch layer of sand or fine gravel, tamped in the trench for a uniform bedding.
   5. The entire trench width shall be evenly backfilled with a similar material as the bedding in 6 inch compacted layers to a minimum height of 12 inches above the top of the piping system. The remaining trench shall be evenly and continuously backfilled in uniform layers with suitable excavated soil. Remove all unused spoils from site at end of contstruction in the designated area(s).

F. Field Modifications for rerouting
   1. Line and grade shall be modified in the field to avoid existing obstructions as required. Field modifications to slope and grade shall be as delineated on the Drawings. No increase in contract price will be permitted for piping installed within the defined tolerance.
   2. Modifications to pre-fabbed pipe shall be accomplished with pipe and fittings as specified for manhole applications, with preformed insulation and PVC jacketing.

3.04 TESTING

A. Unless otherwise noted, hydrostatically test all piping installed under this contract to 1-1/2 times the normal working pressure or 100 psig, whichever is higher for a period of not less than 30 minutes with no perceptable drop in pressure.

B. Provide necessary caps or blinds to protect equipment not rated for test pressure (safety valves, regulators, etc.).

C. Pressure test all buried piping prior to backfilling, unless otherwise noted.

D. Prefabricated/Preinsulated Piping Systems:
   1. Carrier piping shall be hydrostatically tested at 1-1/2 times normal operating pressure or 100 psig, whichever is higher, for a minimum of 30 minutes with no perceptable drop in pressure. Test prior to backfilling/insulating/wrapping field joints.

E. Pneumatic Testing:
   1. Pneumatic testing is expressly prohibited on any non-metallic piping.
   2. Other than as excepted above, pneumatic testing will not be considered without written consent from Owner or architect, and substantiation as to why hydrotesting is

inapplicable. Additional testing requirements and measures may be required for a pneumatic test and will be considered on a case-by-case basis.

F. Reports: Submit test reports for all pipeline sections tested per Submittals requirements in Part 1 of this specification.

END OF SECTION