PROJECT MANUAL
VOLUME TWO OF TWO; DIV 14-33

Kimbel Library Renovation
Coastal Carolina University
Conway, SC

Bid Documents
LAI Project No: 21700
State Project Number: H17-9616-MJ
November 10th, 2023

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Section 000107 – Seals Page

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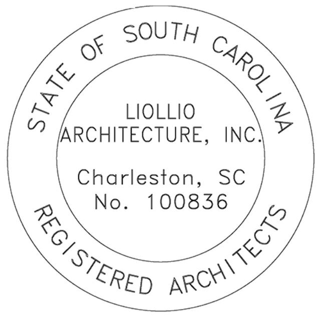
<td></td>
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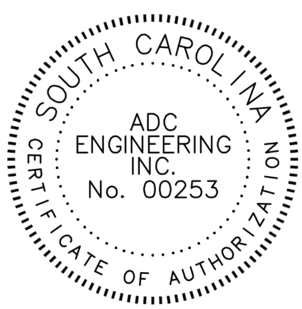
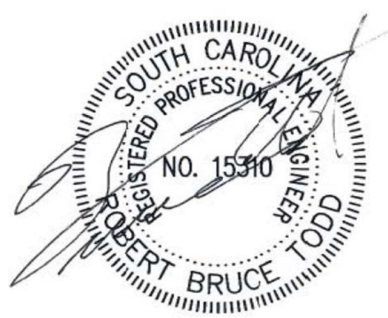
<td></td>
<td>
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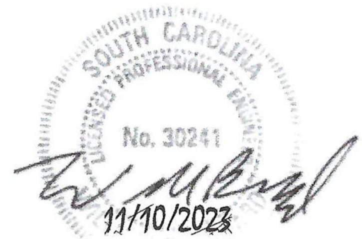

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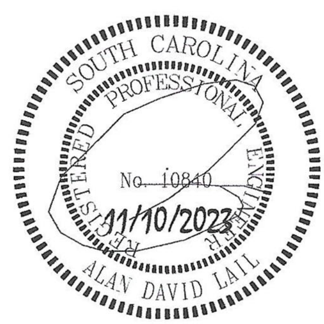

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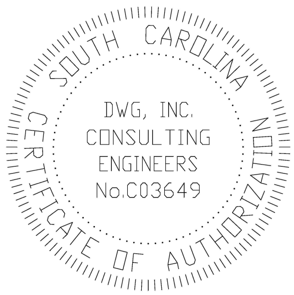
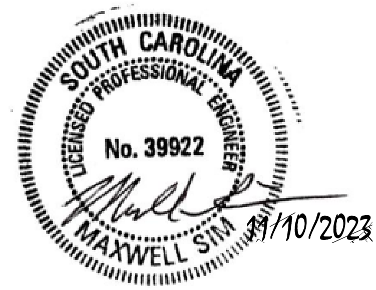
<tr><td>
</td><td>
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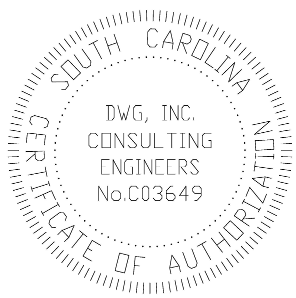
<tr><td>
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TECHNICAL SPECIFICATIONS

VOLUME 1

ADDITIONAL INFORMATION FROM OWNER ENCLOSED FOR REFERENCE:

1. GEOTECHNICAL EXPLORATION REPORT BY S&ME DATED NOVEMBER 5, 2009.
2. REPORT OF SUPPLEMENTAL GEOTECHNICAL EXPLORATIONS, KIMBEL LIBRARY ELEVATOR, BY S&ME DATED NOVEMBER 22, 2022.
3. ASBESTOS CONTAINING MATERIALS INVESTIGATION REPORT BY PHOENIX ENVIROCORP DATE JUNE 1, 2021.
4. ASEBESTOS CONTAINING MATERIALS INVESTIGATION REPORT BY PHOENIX ENVIROCORP DATED JUNE 12, 2019

SECTION 142400 - HYDRAULIC ELEVATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hydraulic passenger elevators.

B. Related Requirements:

1. Section 011000 "Summary" for purchase contract for elevators negotiated by Owner and assigned to Contractor.
2. Section 033000 "Cast-in-Place Concrete" for setting sleeves, inserts, and anchoring devices in concrete.
3. Section 051200 "Structural Steel Framing" for the following:

a. Attachment plates, angle brackets, and other structural-steel preparations for fastening guide-rail brackets.

4. Section 055000 "Metal Fabrications" for the following:

a. Attachment plates and angle brackets for supporting guide-rail brackets.

5. Section 221429 "Sump Pumps" for sump pumps, sumps, and sump covers in elevator pits.
6. Section 283200 "Two Way Communication" and Section 283100 "Fire Detection, Alarm and Mass Notification" for smoke detectors in elevator lobbies to initiate emergency recall operation and heat detectors in shafts and machine rooms to disconnect power from elevator equipment before sprinkler activation and for connection to elevator controllers.
7. State of SC LLR requirements, including communication
8. 2019 Edition ASME A17.1

1.2 DEFINITIONS

A. Definitions in ASME A17.1/CSA B44 apply to work of this Section.

B. Service Elevator: A passenger elevator that is also used to carry freight.

1.3 ACTION SUBMITTALS

A. Product Data: Include capacities, sizes, performances, operations, safety features, finishes, and similar information. Include product data for car enclosures; hoistway entrances; and operation, control, and signal systems.

B. Shop Drawings:

1. Include plans, elevations, sections, and large-scale details indicating service at each landing; machine room layout; coordination with building structure; relationships with other construction; and locations of equipment.
2. Include large-scale layout of car-control station and standby-power operation control panel.
3. Indicate maximum dynamic and static loads imposed on building structure at points of support as well as maximum and average power demands.

C. Samples for Initial Selection: For finishes involving color selection.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Seismic Qualification Certificates: For elevator equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Manufacturer Certificates: Signed by elevator manufacturer, certifying that hoistway, pit, and machine room layout and dimensions, as shown on Drawings, and electrical service, as shown and specified, are adequate for elevator system being provided.

D. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.

1. Submit manufacturer's/installer's standard operation and maintenance manual, in accordance with ASME A17.1/CSA B44 including diagnostic and repair information available to manufacturer's and Installer's maintenance personnel.

B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.

C. Continuing Maintenance Proposal: Submit a continuing maintenance proposal from Installer to Owner, in the form of a standard five-year maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Elevator manufacturer or an authorized representative who is trained and approved by manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials, components and equipment in manufacturer's protective packaging. Store materials, components, and equipment off of ground, under cover, and in a dry location.

1.8 COORDINATION

A. Coordinate installation of sleeves, block outs, elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.

B. Furnish well casing and coordinate delivery with related excavation work.

C. Coordinate locations and dimensions of other work specified in other Sections that relates to hydraulic elevators, including pit ladders; sumps and floor drains in pits; entrance subsills; electrical service; and electrical outlets, lights, and switches in hoistways, pits, and machine rooms.

1.9 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair, restore, or replace elevator work that fails in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.
2. Warranty Period: 1 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Otis Elevator Co.
2. Schindler Elevator Corp.
3. ThyssenKrupp Elevator.

B. Basis of Design: Otis Hydrofit Passenger Elevator. If alternate manufacturer is selected that requires a control room, GC to provide control room adjacent as required by supplier.

1. Capacity: 3,500#
2. Speed: 100 FPM
3. Door: Front Opening, Single Slide
4. Finishes: As shown in Drawings.

C. Source Limitations: Obtain elevators from single manufacturer.

1. Major elevator components, including pump-and-tank units, plunger-cylinder assemblies, controllers, signal fixtures, door operators, car frames, cars, and entrances, are manufactured by single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with ASME A17.1/CSA B44.

B. Accessibility Standard: Comply with applicable provisions in the United States Access Board's ADA-ABA Accessibility Guidelinesand ICC A117.1.

C. ASME A17.1-2019 Safety Code for Elevators and Escalators

D. Seismic Performance: Elevator system withstands the effects of earthquake motions determined according to ASCE/SEI 7 and complies with elevator seismic requirements in ASME A17.1/CSA B44.

1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."
2. Project Seismic Design Category: D.
3. Elevator Component Importance Factor: 1.0.
4. Design earthquake spectral response acceleration short period (Sds) for Project is as indicated on the Drawings.
5. Provide earthquake equipment required by ASME A17.1/CSA B44.
6. Provide seismic switch required by ASCE/SEI 7.

2.3 ELEVATORS

A. Elevator System, General: Manufacturer's standard elevator systems. Unless otherwise indicated, manufacturers' standard components are used, as included in standard elevator systems and as required for complete system.

B. Elevator Description:

1. Type:

   a. Holeless, beside-the-car, telescoping, cylinder.

2. Rated Load: 3500 lb.
3. Rated Speed: 100 fpm.

4. Operation System: Selective-collective automatic operation.
5. Auxiliary Operations:

   a. Standby-power operation.
   b. Standby-powered lowering.
   c. Earthquake Emergency Operation: Comply with requirements in ASME A17.1/CSA B44.
   d. Automatic operation of lights and ventilation fans.

6. Car Enclosures:

   a. Inside Width: Not less than 77 inches from side wall to side wall.
   b. Inside Depth: Not less than 66 inches from back wall to front wall (return panels).
   c. Inside Height: Not less than 93 inches to underside of ceiling.
   d. Front Walls (Return Panels): Satin stainless steel, ASTM A480/A480M, No. 4 finishwith integral car door frames.
   e. Car Fixtures: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
   f. Side and Rear Wall Panels: Wood laminate paneling
   g. Reveals: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
   h. Door Faces (Interior): Satin stainless steel, ASTM A480/A480M, No. 4 finish.
   i. Door Sills: Aluminum.
   j. Ceiling: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
   k. Handrails: satin stainless steel, at sidesandrear of car. See Drawings for locations and sizing.
   l. Floor: As indicated on the Drawings.

7. Hoistway Entrances:

   a. Width: 42 inches.
   b. Height: 84 inches.
   c. Type: Single-speed side sliding.
   d. Frames : Satin stainless steel, ASTM A480/A480M, No. 4 finish.
   e. Doors: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
   f. Sills : Aluminum.

8. Hall Fixtures : Satin stainless steel, ASTM A480/A480M, No. 4 finish.
9. Additional Requirements:

   a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from satin stainless steel, ASTM A480/A480M, No. 4 finish.
   b. Provide hooks for protective pads in and one complete set(s) of full-height protective pads.
   c. Provide UL label for hoistway entrances.
   d.

2.4 SYSTEMS AND COMPONENTS

A. Pump Units: Positive-displacement type with a maximum of 10 percent variation between no load and full load and with minimum pulsations.

   1. Pump is submersible type with submersible squirrel-cage induction motor, and shall be suspended inside oil tank from vibration isolation mounts.
   2. Motor has [wye-delta][or][solid-state] starting.

3. Motor has variable-voltage, variable-frequency control.

B. Hydraulic Silencers: System has hydraulic silencer containing pulsation-absorbing material in blowout-proof housing at pump unit.

C. Piping: Size, type, and weight of piping as recommended by elevator manufacturer, with flexible connectors to minimize sound and vibration transmissions from power unit.

1. Cylinder units are connected with dielectric couplings.
2. Casing for Underground Piping: Schedule 40 PVC pipe complying with ASTM D1785, joined with PVC fittings complying with ASTM D2466 and solvent cement complying with ASTM D2564.

D. Hydraulic Fluid: Elevator manufacturer's standard [fire-resistant]fluid with additives as needed to prevent oxidation of fluid, corrosion of cylinder and other components, and other adverse effects.

E. Hydraulic Fluid: Nontoxic, biodegradable[, fire-resistant] fluid, made from vegetable oil with antioxidant, anticorrosive, antifoaming, and metal-passivating additives, that is approved by elevator manufacturer for use with elevator equipment.

F. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator work. Device installation is specified in another Section.

G. Protective Cylinder Casing: PVC or HDPE pipe casing complying with ASME A17.1/CSA B44, of sufficient size to provide not less than 1-inch clearance from cylinder and extending above pit floor. Casing has means of monitoring effectiveness to comply with ASME A17.1/CSA B44.

H. Corrosion-Protective Filler: A nontoxic, petroleum-based gel formulated for filling the space between hydraulic cylinder and protective casing. Filler is electrically nonconductive, displaces or absorbs water, and gels or solidifies at temperatures below 60 deg F.

I. Car Frame and Platform: Welded steel units.

J. Guides: . Provide Manufacturer's Standard guides at top and bottom of car frame.

2.5 OPERATION SYSTEMS

A. Provide manufacturer's standard microprocessor operation system as required to provide type of operation indicated.

B. Auxiliary Operations:

1. Single-Car Battery-Powered Lowering:

a. When power fails, car is lowered to the lowest floor, opens its doors, and shuts down. System includes rechargeable battery and automatic recharging system.

2. Automatic Dispatching of Loaded Car: When car load exceeds 80 percent of rated capacity, doors start closing.

3. Nuisance Call Cancel: When car calls exceed a preset number while car load is less than a predetermined weight, all car calls are canceled. Preset number of calls[and predetermined weight] can be adjusted.
4. Loaded-Car Bypass: When car load exceeds 80 percent of rated capacity, car responds only to car calls, not to hall calls.
5. Off-Peak Operation: During periods of low traffic, half of the elevators in a group are taken out of service and switched to low-power mode.
6. Independent Service: Keyswitch in car-control station removes car from group operation and allows it to respond only to car calls. Key cannot be removed from keyswitch when car is in independent service. When in independent service, doors close only in response to door close button.
7. Priority Service: Service is initiated by a keyswitch at designated floors. One elevator is removed from group operation and directed to the floor where service was initiated. On arriving at the floor, elevator opens its doors and parks, and a lighted sign directs passengers to exit elevator. Car is placed in operation by selecting a floor and pressing door close button or by operating keyswitch to put car in independent service. After responding to floor selected or being removed from independent service, car returns to group operation. If car is not placed in operation within a preset time after being called, it is returned to group operation.
8. Automatic Operation of Lights and Fan: When elevator is stopped and unoccupied with doors closed, lighting, ventilation fan, and cab displays are de-energized after 5 minutes and are re-energized before car doors open.

C. Security Features: Security features do not affect emergency firefighters' service.

1. Keyswitch Operation: Push buttons are activated and deactivated by security keyswitches at car-control stationsandhall push-button stations. Key is removable in either position.

2.6 DOOR-REOPENING DEVICES

A. Infrared Array: Provide door-reopening device with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more light beams causes doors to stop and reopen.

B. Nudging Feature: After car doors are prevented from closing for predetermined adjustable time, through activating door-reopening device, a loud buzzer sounds and doors begin to close at reduced kinetic energy.

2.7 CAR ENCLOSURES

A. Provide steel-framed car enclosures with nonremovable wall panels, with [removable]car roof, access doors, power door operators, and ventilation.

1. Provide standard railings complying with ASME A17.1/CSA B44 on car tops where required by ASME A17.1/CSA B44.

2.8 HOISTWAY ENTRANCES

A. Hoistway Entrance Assemblies: Manufacturer's standard horizontal-sliding, door-and-frame hoistway entrances complete with track systems, hardware, sills, and accessories. Frame size and profile accommodate hoistway wall construction.

1. Where gypsum board wall construction is indicated, frames are self-supporting with reinforced head sections.

B. Fire-Rated Hoistway Entrance Assemblies: Door-and-frame assemblies comply with NFPA 80 and be listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction based on testing at as close-to-neutral pressure as possible according to NFPA 252.

1. Fire-Protection Rating: 1 hour.

2.9 SIGNAL EQUIPMENT

A. Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Provide vandal-resistant buttons and lighted elements illuminated with LEDs.

B. Car-Control Stations: Provide manufacturer's standard recessed car-control stations. Mount in return panel adjacent to car door unless otherwise indicated.

1. Mark buttons and switches for required use or function. Use both tactile symbols and Braille.
2. Provide "No Smoking" sign matching car-control station, either integral with car-control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.

C. Emergency Communication System: Two-way visual and voice communication system, with visible signal, which dials preprogrammed number of monitoring station and does not require handset use. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.

D. Firefighters' Two-Way Radio Communication Service: Provide flush-mounted cabinet in each car and required conductors in traveling cable for firefighters' two-way radio communication service specified.

E. Car Position Indicator: Provide illuminated, digital-type car position indicator, located above car door or above car-control station. Also, provide audible signal to indicate to passengers that car is either stopping at or passing each of the floors served. Include travel direction arrows if not provided in car-control station.

F. Hall Push-Button Stations: Provide one hall push-button station at each landing.

1. Provide manufacturer's standard wall-mounted units.
2. Equip units with buttons for calling elevator and for indicating applicable direction of travel.

G. Hall Lanterns: Units with illuminated arrows; however, provide single arrow at terminal landings. Provide the following:

1. Manufacturer's standard wall-mounted units, for mounting above entrance frames.

H. Hall Annunciator: With each hall lantern, provide audible signals indicating car arrival and direction of travel. Signals sound once for up and twice for down.

1. At manufacturer's option, audible signals may be placed on cars.

I. Fire-Command-Center Annunciator Panel: Provide panel containing illuminated position indicators for each elevator, clearly labeled with elevator designation; include illuminated signal that indicates when elevator is operational and when it is at the designated emergency return level with doors open. Provide standby-power elevator selector switch(es), as required by ASME A17.1/CSA B44, adjacent to position indicators. Provide illuminated signal that indicates when normal power supply has failed.

J. Emergency Communication to meet ANSI 2017 A117.1 standards.

K. Emergency Pictorial Signs: Fabricate from materials matching hall push-button stations, with text and graphics as required by authorities having jurisdiction, indicating that in case of fire, elevators are out of service and exits should be used instead. Provide one sign at each hall push-button station unless otherwise indicated.

2.10 FINISH MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, commercial steel, Type B, exposed, matte finish.

B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, commercial steel, Type B, pickled.

C. Stainless Steel Sheet: ASTM A240/A240M, Type 304.

D. Stainless Steel Bars: ASTM A276, Type 304.

E. Stainless Steel Tubing: ASTM A554, Grade MT 304.

F. Aluminum Extrusions: ASTM B221, Alloy 6063.

G. Nickel Silver Extrusions: ASTM B151/B151M, Alloy UNS No. C74500 or No. C77600.

H. Plastic Laminate: High-pressure type complying with NEMA LD 3, Type HGS for flat applications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Verify critical dimensions and examine supporting structure and other conditions under which elevator work is to be installed.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

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

3.2 INSTALLATION

A. Excavation for Cylinder: Drill well hole in each elevator pit to accommodate installation of cylinder; comply with applicable requirements in Section 312000 "Earth Moving."

B. Provide waterproof well casing as necessary to retain well-hole walls.

C. Install cylinder in protective casing within well hole. Before installing protective casing, remove water and debris from well hole and provide permanent waterproof seal at bottom of well casing.

1. Fill void space between protective casing and cylinder with corrosion-protective filler.
2. Align cylinder and fill space around protective casing with fine sand.

D. Install cylinder plumb and accurately centered for elevator car position and travel. Anchor securely in place, supported at pit floor. Seal between well casing and pit floor with 4 inches of nonshrink, nonmetallic grout.

E. Install cylinder plumb and accurately centered for elevator car position and travel. Anchor securely in place, supported at pit floor and braced at intervals as needed to maintain alignment. Anchor cylinder guides at spacing needed to maintain alignment and avoid overstressing guides.

F. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS workmanship and welding operator qualification standards.

G. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts to minimize vibration transmission to structure and structure-borne noise due to elevator system.

H. Install piping above the floor, where possible. Install underground piping in casing.

1. Excavate for piping and backfill encased piping according to applicable requirements in Section 312000 "Earth Moving."

I. Lubricate operating parts of systems as recommended by manufacturers.

J. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay installation of sills and frames until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.

K. Leveling Tolerance: 1/4 inch, up or down, regardless of load and travel direction.

L. Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, nonmetallic grout.

M. Locate hall signal equipment for elevators as follows unless otherwise indicated:

1. For groups of elevators, locate hall push-button stations between two elevators at center of group or at location most convenient for approaching passengers.
2. Place hall lanterns either above or beside each hoistway entrance.
3. Mount hall lanterns at a minimum of 72 inches above finished floor.

3.3 FIELD QUALITY CONTROL

A. Acceptance Testing: On completion of elevator installation and before permitting elevator use (either temporary or permanent), perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and by governing regulations and agencies.

B. Advise Owner, Architect, and authorities having jurisdiction in advance of dates and times that tests are to be performed on elevators.

3.4 PROTECTION

A. Temporary Use: Comply with the following requirements for elevator used for construction purposes:

1. Provide car with temporary enclosure, either within finished car or in place of finished car, to protect finishes from damage.
2. Provide strippable protective film on entrance and car doors and frames.
3. Provide padded wood bumpers on entrance door frames covering jambs and frame faces.
4. Provide other protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
5. Do not load elevators beyond their rated weight capacity.
6. Engage elevator Installer to provide full maintenance service. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleanup, and adjustment as necessary for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
7. Engage elevator Installer to restore damaged work, if any, so no evidence remains of correction. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate, adjust, and maintain elevator(s).

B. Check operation of elevator with Owner's personnel present before date of Substantial Completion and again not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

END OF SECTION

SECTION 210510 – FIRE PROTECTION COORDINATION

PART 1 GENERAL

1.01 QUALITY ASSURANCE:

A. Fire Protection Coordination Drawings: Prepare a set of coordination drawings showing the coordination of the major elements, components, and systems of the Fire Protection work, and showing the coordination of Fire Protection work with other work. Prepare drawings at accurate scale and sufficiently large to show locations of every item, including clearances for installing, maintaining, breaking down equipment, replacing motors and similar requirements. Drawings shall indicate coordination with all other trades including, but not limited to, lighting, structural, mechanical, plumbing, and architectural items. Prepare drawings to include plans, elevations, sections and details as needed to conclusively show successful coordination and integration of the work. Submit drawings for review by the Architect/Engineer and Owner.
1. Plans shall include dimensioned locations of all drains.
2. Plans shall include locations of all ceiling and wall access panels required for equipment access (valves, for example).

B. Record Drawings: During construction operations, the Fire Protection contractor shall faithfully make a record of all approved changes from the contract drawings, including accurate dimensions where applicable, and shall also record accurate dimensions locating all below-grade outside Fire Protection utilities (whether changed or not) with reference to permanent above-grade objects. A minimum of two (2) dimensions from building reference points shall be provided and a bury depth indicated. At completion of the work, all such changes shall be recorded neatly with red ink by the Fire Protection contractor on an unused set of the sprinkler shop drawings supplied by the Fire Protection Contractor.

C. Photographs: For all below-grade Fire Protection piping, photograph installation of trenches before backfilling. Submit to A/E for review and include in closeout documents to the Owner.

1.02 RELATED DOCUMENTS AND OTHER INFORMATION:

A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the portions of work specified in each and every Section of this Division, individually and collectively.

PART 2 PRODUCTS

2.01 FIRE PROTECTION PRODUCT COORDINATION:

A. Power Characteristics: Refer to the electrical sections of the specifications and the electrical drawings for the power characteristics available for the operation of each power driven item of Fire Protection equipment. The electrical design was based on the power requirements of the Fire Protection equipment manufacturer scheduled or specified as "basis of design." Any modifications to the electrical system that are required due to the use of an approved equivalent manufacturer shall be made at no additional cost to the owner. All changes must be clearly documented and submitted for review by the Architect/Engineer prior to purchasing equipment. Coordinate purchases to ensure uniform interface with electrical work. Refer to Division 26 specifications for additional coordination requirements.

B. Coordination of Options and Substitutions: When the contract documents permit the selection from several product options and it becomes necessary to authorize a substitution, do not proceed with purchase until coordination of interface to equipment has been checked and satisfactorily established.

PART 3 EXECUTION

3.01 INSPECTION AND PREPARATION:

A. Substrate Examination: The Installer of each element of the Fire Protection work must examine the condition of the substrate to receive the work, the conditions under which the work will be performed, and must notify the Contractor in writing of conditions detrimental to the proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

B. Do not proceed with the installation of sleeves, anchors, hangers, roof penetrations and similar work until Fire Protection coordination drawings have been processed and released for construction. Where work must be installed prior to that time in order to avoid a project delay, review proposed installation in a project coordination meeting including all parties involved with the interfacing of the work.

3.02 CUTTING AND PATCHING:

A. Structural Limitations: Do not cut structural framing, walls, floors, decks and other members intended to withstand stress, except with the Architect's or Engineer's written authorization. Authorization will be granted only where there is no other reasonable method for completing the Fire Protection work, and where the proposed cutting clearly does not materially weaken the structure.

B. Where authorized, cut opening through concrete (for pipe penetrations and similar services) by core drilling or sawing. Do not cut by hammer-driven chisel or drill.

C. Other work: Do not endanger or damage other work through the procedures and processes of cutting to accommodate Fire Protection work. Review the proposed cutting with the Installer of the work to be cut, and comply with his recommendations to minimize damage. Where necessary, engage the original Installer or other specialists to execute the cutting in the recommended manner.

D. Where patching is required to restore other work, because of either cutting or other damage inflicted during the installation of Fire Protection work, execute the patching in the manner recommended by the original Installer. Restore the other work in every respect, including the elimination of visual defects in exposed finishes, as judged by the Architect. Engage the original Installer to complete patching of the following categories of work:
1. Exposed concrete finishes.
2. Exposed masonry.
3. Waterproofing and vapor barriers.
4. Roofing, flashing and accessories.
5. Interior exposed finishes and casework, where judged by the Architect to be difficult to achieve an acceptable match by other means

3.03 COORDINATION OF FIRE PROTECTION INSTALLATION:

A. General: Sequence, coordinate and integrate the various elements of Fire Protection work so that the Fire Protection system will perform as indicated and be in harmony with the other work of the building. The Architect/Engineer will not supervise the coordination, which is the exclusive responsibility of the Contractor. Comply with the following requirements:
1. Install piping and similar services straight and true, aligned with other work and with overhead structures and allowing for insulation. Conceal where possible.
2. Arrange work to facilitate maintenance and repair or replacement of equipment. Locate services requiring maintenance on valves and similar units in front of services requiring less maintenance. Connect equipment for ease of disconnecting, with minimum of interference with other work.
3. Give the right-of way to piping systems required to slope for drainage (over other service lines). Piping shall be located to avoid interference with ductwork and light fixtures.

B. Drawings: Conform with the arrangement indicated by the contract documents to the greatest extent possible, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, comply with the Architect's decision on resolution of the conflict.

C. Electrical Work: Coordinate the Fire Protection work with electrical work, and properly interface with the electrical service. In general, and except as otherwise indicated, install Fire Protection equipment ready for electrical connection. Refer to the electrical sections of the specifications for electrical connection of Fire Protection equipment.

D. Utility Connections: Coordinate the connection of Fire Protection systems with exterior underground utilities and services. Comply with the requirements of governing regulations, franchised service companies and controlling agencies.

3.04 COORDINATION OF FIRE PROTECTION START-UP:

A. Seasonal Requirements: Adjust and coordinate the timing of Fire Protection system start-ups with seasonal variations, so that demonstration and testing of specified performance can be observed and recorded. Exercise proper care in off-season start-ups to ensure that systems and equipment will not be damaged by the operation.

END OF SECTION

SECTION 211313 - WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

A. Fire Protection Scope of Work: Work includes, but is not limited to:

1. Installation of new aboveground fire sprinkler piping starting at 1’-0” AFF inside building.
2. Installation of an approved backflow preventer for a vertical service riser.
3. Installation of system control valve and flow switch at service entrance.
4. Installation of a full wet pipe sprinkler system. System shall comply with NFPA 13, 2010 edition as well as all State and Local code requirements.

1.2 RELATED DOCUMENTS

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

1.3 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Fire-protection valves.
3. Sprinklers.
4. Pressure gauges.

1.4 DEFINITIONS

A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig maximum.

1.5 SYSTEM DESCRIPTIONS

A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device.

1.6 PERFORMANCE REQUIREMENTS

A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

B. Delegated Design: Design sprinkler system(s), using performance requirements and design criteria indicated.

C. Sprinkler system design shall be approved by authorities having jurisdiction.

1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
2. Sprinkler Occupancy Hazard Classifications:

   a. Kitchen Service Areas: Ordinary Hazard, Group 1.

b. Dining Areas: Ordinary Hazard, Group 1.
c. Equipment Rooms: Ordinary Hazard, Group 1.
d. Restrooms: Light Hazard.
e. Attic Space: Light Hazard.
f. Archive areas: Ordinary Hazard, Group 2
g. Exterior Entry: Dry Type – Light Hazard

D. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7-16.

1.7 SUBMITTALS

A. Submittal process must be in accordance with the Fire Protection Sprinkler Systems Act, SCCL Title 40 Chapter 10. Submittal must be approved prior to installation.

B. Product Data: For each type of product included in sprinkler system design.

C. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.

D. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including shop drawings signed by the S.C. licensed sprinkler system designer, including license number.

E. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. HVAC ductwork.
2. HVAC equipment.
3. Items penetrating finished ceiling including the following:

a. Lighting fixtures.
b. Air outlets and inlets.
c. Kitchen hoods.

F. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

G. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

H. Field quality-control reports.

I. Operation and Maintenance Data: For sprinkler specialties to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13, 2016 Edition, "Installation of Sprinkler Systems."
2. International Building Code, 2018 Edition.
3. International Fire Code, 2018 Edition.
4. The State Fire Marshal and local fire official having jurisdiction.
5. All applicable local codes.

B. All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooved tools shall be of the same manufacturer as the grooved components.

1. All castings used for couplings, housings, fittings, or valve and specialty bodies shall be date stamped for quality assurance and traceability.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.9 COORDINATION

A. Coordinate layout and installation of sprinklers with other trades, including light fixtures; HVAC equipment, piping, and ductwork; plumbing piping; and partition assemblies.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for a minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench.

1.11 OPERATION AND MAINTENANCE INSTRUCTIONS

A. Operating and Maintenance Instructions, printed and bound in hard cover three ring loose leaf notebooks, shall be provided for each item of equipment listed below; 5 separate copies shall be provided. Each notebook shall be provided within an identifying label under a clear plastic cover shield on the front cover which shall identify the Project, Engineer, Contractor, Sprinkler System Designer and Installer, and Date.

1.12 WARRANTY

A. All equipment shall be warrantied as specified under the General and Special Conditions. Warranty on all equipment shall start and coincide with the Contractor's warranty obligations.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.2 STEEL PIPE AND FITTINGS

A. Standard Weight, Galvanized- and Black-Steel Pipe: ASTM A 53, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.

B. Schedule 10, Black-Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10, plain end.

C. Galvanized- and Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53, standard-weight, seamless steel pipe with threaded ends.

D. Galvanized and Uncoated, Steel Couplings: ASTM A 865, threaded.

E. Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

F. Malleable- or Ductile-Iron Unions: UL 860.

G. Cast-Iron Flanges: ASME 16.1, Class 125.

H. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

I. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.

J. Grooved-Joint, Steel-Pipe Appurtenances:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Anvil International, Inc.
    b. Tyco Fire & Building Products LP.
    c. Victaulic Company.

2. Pressure Rating: 175 psig minimum.

3. Installation-Ready™ fittings for Schedule [40] [10] grooved end steel piping in sizes NPS 1-¼ thru 2½. Fittings shall consist of a ductile iron housing with Installation-Ready™ ends, prelubricated Grade “E” EPDM Type ‘A’ gasket; and ASTM A449 electroplated steel bolts and nuts. UL listed for a working pressure of 300 psi and FM approved for working pressure 365 psi.

4. Galvanized and Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.

a. In applicable sizes, fittings shall be short-pattern, with flow equal to standard pattern fittings. Basis of Design: Victaulic FireLock.

5. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber center-leg gasket with pipe stop to ensure proper groove engagement, alignment, and pipe insertion depth, and bolts and nuts. Installation-Ready, for direct stab installation without field disassembly.
   a. Rigid: Housings cast with offsetting angle-pattern bolt pads to provide rigidity and support and hanging in accordance with NFPA-13, fully installed at visual pad-to-pad offset contact. (Couplings that require exact gapping at specific torque ratings are not permitted.) Basis of Design: Victaulic Style 009N and 107N.
   b. Flexible Type: For use in locations where vibration attenuation and stress relief are required. Basis of Design: Victaulic Installation-Ready Style 177 or Style 77.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.

   1. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 LISTED FIRE-PROTECTION VALVES

A. General Requirements:

   1. Valves shall be UL listed or FM approved.
   2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig.
   3. Use manufacturer’s approved installation tools for all installation.

B. Ball Valves:

   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

      a. Anvil International, Inc.
      b. Victaulic Company.

   2. Standard: UL 1091 except with ball instead of disc.
   3. Valves NPS 1-1/2and Smaller: Bronze or brass body with threaded or grooved ends.
   4. Valves NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
   5. Valves NPS 3: Ductile-iron body with grooved ends.

C. Bronze Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Fivalco Inc.
    b. Global Safety Products, Inc.
    c. Milwaukee Valve Company.

2. Standard: UL 1091.
3. Pressure Rating: 175 psig.
4. Body Material: Bronze.
5. End Connections: Threaded.

D. Iron Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Anvil International, Inc.
    b. Fivalco Inc.
    c. Global Safety Products, Inc.
    d. Kennedy Valve; a division of McWane, Inc.
    e. Milwaukee Valve Company.
    f. NIBCO INC.
    g. Henry Pratt Company.
    h. Shurjoint Piping Products.
    i. Tyco Fire & Building Products LP.
    j. Victaulic Company.

2. Standard: UL 1091.
3. Pressure Rating: 175 psig.
4. Body Material: Cast or ductile iron.
5. Seat: Pressure responsive elastomer.
6. Stem: Stainless steel, offset from the disc centerline to provide complete 360-degree circumferential seating.
7. Style: Lug or wafer.
8. End Connections: Flanged or Grooved.
9. Basis of Design: Victaulic Series 705.

E. Check Valves:

1. Standard: UL 312.
2. Pressure Rating: 300 psig.
3. Type: Spring-assisted swing check.
4. Body Material: Cast ductile iron.
5. Spring: Stainless steel.
6. Installation: Vertical or horizontal.
7. End Connections: Flanged or grooved.
8. Basis of Design: Victaulic Series 717.

F. Indicating-Type Butterfly Valves:

1. Standard: UL 1091.
2. Pressure Rating: 175 psig minimum.

3. Valves NPS 2 and Smaller:

   a. Valve Type: Ball or butterfly.
   b. Body Material: Bronze.
   c. End Connections: Threaded.

4. Valves NPS 2-1/2 and Larger:

   a. Valve Type: Butterfly.
   b. Body Material: Cast or ductile iron.
   c. End Connections: Flanged, grooved, or wafer.

G. NRS Gate Valves:

1. Standard: UL 262.
2. Pressure Rating: 250 psig minimum.
3. Body Material: Cast iron with indicator post flange.
4. Stem: Nonrising.
5. End Connections: Flanged or grooved.

2.5 SPRINKLER SPECIALTY PIPE FITTINGS

A. Flexible, Sprinkler Hose Fittings:

1. Standard: UL 1474.
2. Type: Braided, stainless steel flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid. Flexible fittings shall only be installed above accessible ceilings, and they shall be installed per UL and FM requirements and in strict accordance with manufacturer's recommendations, including minimum bend radius and maximum number of bends.
3. Pressure Rating: 175 psig minimum.
4. Size: Same as connected piping, for sprinkler.

2.6 SPECIALTY VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating:

   a. Standard-Pressure Piping Specialty Valves: 250 psig minimum.

3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.

5. End Connections: Flanged or grooved.

B. Alarm Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. AFAC Inc.
    b. Globe Fire Sprinkler Corporation.
    c. Reliable Automatic Sprinkler Co., Inc.
    d. Tyco Fire & Building Products LP.
    e. Venus Fire Protection Ltd.
    f. Victaulic Company.
    g. Viking Corporation.

2. Standard: UL 193.
3. Design: For horizontal or vertical installation.
4. Valve internal components shall be replaceable without removal of valve from installed position.
5. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.
6. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
7. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

2.7 SPRINKLERS

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating for Automatic Sprinklers: 175 psig minimum.

B. Automatic Sprinklers with Heat-Responsive Element:

1. Nonresidential Applications: UL 199.
2. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6 or as required per hydraulic calculations, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

C. Sprinkler Finishes:

1. Chrome plated.
2. Bronze.
3. Factory-Painted.

D. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Ceiling Mounting: Chrome-plated steel, one piece, flat.
2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.

C. Install seismic restraints on piping. Comply with requirements for seismic-restraint device materials and installation in NFPA 13.

D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

E. Install unions adjacent to each valve in pipes NPS 2 and smaller.

F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

G. Install sprinkler piping with drains for complete system drainage.

H. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

I. Fill sprinkler system piping with water.

3.2 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts in accordance with the manufacturer’s published instructions. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints. Grooved coupling manufacturer’s factory trained field representative shall provide on-site training for contractor’s field personnel in the proper use of grooving tools, application of groove, and installation of grooved piping products. Factory trained representative shall periodically visit the jobsite to ensure best practices in grooved product installation are being followed. Contractor shall remove and replace any improperly installed products.

I. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts in accordance with the manufacturer’s published instructions. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints. Grooved coupling manufacturer’s factory trained field representative shall provide on-site training for contractor’s field personnel in the proper use of grooving tools, application of groove, and installation of grooved piping products. Factory trained representative shall periodically visit the jobsite to ensure best practices in grooved product installation are being followed. Contractor shall remove and replace any improperly installed products.

J. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.3 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

3.4 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels.

B. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

3.5 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification.

C. Do not install sprinklers that have been dropped, damaged, show a visible loss of fluid, or a cracked bulb.

D. The sprinkler bulb protector shall be removable by hand, without tools or devices that may damage the bulb.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Coordinate with fire-alarm tests. Operate as required.

C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.7 CLEANING

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.

3.8 PIPING SCHEDULE

A. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

B. Standard-pressure, wet-pipe sprinkler system, NPS 1-1/2 and smaller, shall be one of the following:

1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Schedule 40, black-steel pipe with cut-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

C. Standard-pressure, wet-pipe sprinkler system, NPS 2 and larger, shall be one of the following:

1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Schedule 40, black-steel pipe with cut-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3. Schedule 10, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.9 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Suspended Ceilings: Concealed sprinklers.
3. Wall Mounting: Sidewall sprinklers.
4. Spaces Subject to Freezing: Pendent, dry sprinklers.

B. Provide sprinkler types in subparagraphs below with finishes indicated.

1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
2. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
3. Pendent and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view.

END OF SECTION 211313

SECTION 220000 - BASIC PLUMBING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 IMPOSED REGULATIONS:

A. Applicable provisions of the State and Local Codes and codes and standards in addition to those listed elsewhere in the contract documents are hereby imposed on a general basis for plumbing work.

1.2 SCOPE OF WORK:

A. Provide all labor, materials, equipment and supervision to construct complete and operable plumbing systems as indicated on the drawings and specified herein. All materials and equipment used shall be new, undamaged and free from any defects.

1.3 RELATED DOCUMENTS AND OTHER INFORMATION:

A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the portions of work specified in each and every Section of this Division, individually and collectively.

1.4 EXISTING SERVICES AND FACILITIES:

A. Damage to Existing Services: Existing services and facilities damaged by the Contractor through negligence or through use of faulty materials or workmanship shall be promptly repaired, replaced, or otherwise restored to previous conditions by the Contractor without additional cost to the Owner.

B. Interruption of Services: Interruptions of services necessary for connection to or modification of existing systems or facilities shall occur only at prearranged times approved by the Owner. Contractor shall provide no less than 14 days notice to owner when scheduling outages. Interruptions shall only occur after the provision of all temporary work and the availability of adequate labor and materials will assure that the duration of the interruption will not exceed the time agreed upon.

1.5 PRODUCT WARRANTIES:

A. Provide manufacturer's standard printed commitment in reference to a specific product and normal application, stating that certain acts of restitution will be performed for the Purchaser or Owner by the manufacturer, when and if the product fails within certain operational conditions and time limits. Where the warranty requirements of a specific specification section exceeds the manufacturer's standard warranty, the more stringent requirements will apply and modified manufacturer's warranty shall be provided. In no case shall the manufacturer's warranty be less than one (1) year.

1.6 PRODUCT SUBSTITUTIONS:

A. General: Materials specified by manufacturer's name shall be used unless prior approval of an alternate is given by addenda. Requests for substitutions must be received in the office of the Architect at least 14 days prior to opening of bids. Refer to the general conditions for the substitution request form and required documentation.

PART 2 - NOT USED.

PART 3 - EXECUTION

3.1 PRODUCT INSTALLATION, GENERAL:

A. Except where more stringent requirements are indicated, comply with the product manufacturer's installation instructions and recommendations, including handling, anchorage, assembly, connections, cleaning and testing, charging, lubrication, startup, test operation and shut-down of operating equipment. Consult with manufacturer's technical experts, for specific instructions on unique product conditions and unforeseen problems.

B. Protection and Identification: Deliver products to project properly identified with names, models numbers, types, grades, compliance labels and similar information needed for distinct identifications; adequately packaged or protected to prevent deterioration during shipment, storage and handling. Store in a dry, well ventilated, indoor space, except where prepared and protected by the manufacturer specifically for exterior storage.

C. Permits and Tests: Provide labor, material and equipment to perform all tests required by the governing agencies and submit a record of all tests to the Owner or his representative. Notify the Architect five days in advance of any testing.

END OF SECTION 220000

SECTION 22 05 10 - PLUMBING COORDINATION

PART 1 - GENERAL

1.1 QUALITY ASSURANCE:

A. Retain or delete this article in all Sections of Project Manual.

B. Plumbing Coordination Drawings: Prepare a set of coordination drawings showing the coordination of the major elements, components, and systems of the Plumbing work, and showing the coordination of Plumbing work with other work. Prepare drawings at accurate scale and sufficiently large to show locations of every item, including clearances for installing, maintaining, insulating, breaking down equipment, replacing motors and similar requirements. Drawings shall indicate coordination with all other trades including, but not limited to, lighting, structural, plumbing, and architectural items. Prepare drawings to include plans, elevations, sections and details as needed to conclusively show successful coordination and integration of the work. Submit drawings for review by the Architect/Engineer and Owner.

1. Plans shall include dimensioned locations of all Floor Drains
2. Plans shall include locations of all ceiling and wall access panels required for equipment access (valves, for example).

C. Record Drawings: During construction operations, the Plumbing contractor shall faithfully make a record of all approved changes from the contract drawings, including accurate dimensions where applicable, and shall also record accurate dimensions locating all below-grade outside Plumbing utilities (whether changed or not) with reference to permanent above-grade objects. A minimum of two (2) dimensions from building reference points shall be provided and a bury depth indicated. At completion of the work, all such changes shall be recorded neatly with red ink by the Plumbing contractor on an unused set of the Plumbing contract drawings supplied by the architect.

D. Photographs: For all below-grade plumbing piping, photograph installation of trenches before backfilling. Submit to A/E for review and include in closeout documents to the Owner.

1.2 RELATED DOCUMENTS AND OTHER INFORMATION:

A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the portions of work specified in each and every Section of this Division, individually and collectively.

PART 2 - PRODUCTS

1.1 PLUMBING PRODUCT COORDINATION:

A. Power Characteristics: Refer to the electrical sections of the specifications and the electrical drawings for the power characteristics available for the operation of each power driven item of Plumbing equipment. The electrical design was based on the power requirements of the Plumbing equipment manufacturer scheduled or specified as "basis of design." Any modifications to the electrical system that are required due to the use of an approved equivalent manufacturer shall be made at no additional cost to the owner. All changes must be clearly documented and submitted for review by the Architect/Engineer prior to purchasing equipment. Coordinate purchases to ensure uniform interface with electrical work. Refer to Division 26 specifications for additional coordination requirements.

B. Coordination of Options and Substitutions: When the contract documents permit the selection from several product options and it becomes necessary to authorize a substitution, do not proceed with purchase until coordination of interface to equipment has been checked and satisfactorily established.

PART 3 - EXECUTION

1.1 INSPECTION AND PREPARATION:

A. Substrate Examination: The Installer of each element of the Plumbing work must examine the condition of the substrate to receive the work, the conditions under which the work will be performed, and must notify the Contractor in writing of conditions detrimental to the proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

B. Do not proceed with the installation of sleeves, anchors, hangers, roof penetrations and similar work until Plumbing coordination drawings have been processed and released for construction. Where work must be installed prior to that time in order to avoid a project delay, review proposed installation in a project coordination meeting including all parties involved with the interfacing of the work.

1.2 CUTTING AND PATCHING:

A. Structural Limitations: Do not cut structural framing, walls, floors, decks and other members intended to withstand stress, except with the Architect's or Engineer's written authorization. Authorization will be granted only where there is no other reasonable method for completing the Plumbing work, and where the proposed cutting clearly does not materially weaken the structure.

B. Where authorized, cut opening through concrete (for pipe penetrations and similar services) by core drilling or sawing. Do not cut by hammer-driven chisel or drill.

C. Other work: Do not endanger or damage other work through the procedures and processes of cutting to accommodate Plumbing work. Review the proposed cutting with the Installer of the work to be cut, and comply with his recommendations to minimize damage. Where necessary, engage the original Installer or other specialists to execute the cutting in the recommended manner.

D. Where patching is required to restore other work, because of either cutting or other damage inflicted during the installation of Plumbing work, execute the patching in the manner recommended by the original Installer. Restore the other work in every respect, including the elimination of visual defects in exposed finishes, as judged by the Architect. Engage the original Installer to complete patching of the following categories of work:

1. Exposed concrete finishes.
2. Exposed masonry.
3. Waterproofing and vapor barriers.
4. Roofing, flashing and accessories.
5. Interior exposed finishes and casework, where judged by the Architect to be difficult to achieve an acceptable match by other means

1.3 COORDINATION OF PLUMBING INSTALLATION:

A. General: Sequence, coordinate and integrate the various elements of Plumbing work so that the Plumbing system will perform as indicated and be in harmony with the other work of the building. The Architect/Engineer will not supervise the coordination, which is the exclusive responsibility of the Contractor. Comply with the following requirements:
   1. Install piping and similar services straight and true, aligned with other work and with overhead structures and allowing for insulation. Conceal where possible.
   2. Arrange work to facilitate maintenance and repair or replacement of equipment. Locate services requiring maintenance on valves and similar units in front of services requiring less maintenance. Connect equipment for ease of disconnecting, with minimum of interference with other work.
   3. Give the right-of way to piping systems required to slope for drainage (over other service lines). Piping shall be located to avoid interference with ductwork and light fixtures.

B. Drawings: Conform with the arrangement indicated by the contract documents to the greatest extent possible, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, comply with the Architect's decision on resolution of the conflict.

C. Electrical Work: Coordinate the Plumbing work with electrical work, and properly interface with the electrical service. In general, and except as otherwise indicated, install Plumbing equipment ready for electrical connection. Refer to the electrical sections of the specifications for electrical connection of Plumbing equipment.

D. Utility Connections: Coordinate the connection of Plumbing systems with exterior underground utilities and services. Comply with the requirements of governing regulations, franchised service companies and controlling agencies.
   1. Provide a single connection for each service except where multiple connections are indicated. Water, tap, meter, and vault cost shall be incurred by the Contractor.

1.4 COORDINATION OF PLUMBING START-UP:

A. Seasonal Requirements: Adjust and coordinate the timing of Plumbing system start-ups with seasonal variations, so that demonstration and testing of specified performance can be observed and recorded. Exercise proper care in off-season start-ups to ensure that systems and equipment will not be damaged by the operation.

END OF SECTION 200510

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

2.2 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. GPT (Link-Seal).
4. Metraflex Company (The).
5. Pipeline Seal and Insulator, Inc.

6. Proco Products, Inc.
7. Or approved equal.

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

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

C. Install sleeves in concrete floors, concrete roof slabs, concrete walls, and masonry walls as new slabs and walls are constructed.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

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

1. Exterior Concrete Walls above Grade:

   a. Galvanized-steel wall sleeves with sleeve-seal system.

2. Concrete Slabs-on-Grade:

   a. Galvanized-steel-pipe sleeves with sleeve-seal system.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs above Grade:

   a. Galvanized-steel sleeves with sleeve-seal system.

END OF SECTION 220517

SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.
3. Bronze swing check valves.

B. Related Sections:

1. Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
2. Section 221116 "Domestic Water Piping" for valves applicable only to this piping.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

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

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS

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

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

C. NSF/ANSI Compliance: NSF 61 for valve materials for potable-water service.

D. NSF/ANSI Compliance: NSF 372 for low lead construction for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and weld ends.
3. Set ball valves open to minimize exposure of functional surfaces.
4. Block check valves in either closed or open position.

B. Use the following precautions during storage:

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

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Standards: NSF/ANSI 61 & 372.

C. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

D. Valve Sizes: Same as upstream piping unless otherwise indicated.

E. Valve Actuator Types:
1. Handlever: For quarter-turn valves NPS 6 and smaller.

F. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.

2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

G. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With threads according to ASME B1.20.1.

H. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRASS BALL VALVES

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

1. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

2.3 BRONZE BALL VALVES

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

1. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

2.4 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:

1. Description:

    a. Standard: MSS SP-80, Type 4.
    b. CWP Rating: 200 psig.
    c. Body Design: Horizontal flow.
    d. Body Material: ASTM B 62, bronze.
    e. Ends: Threaded.
    f. Disc: PTFE.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

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

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

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

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

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

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

E. Install check valves for proper direction of flow and as follows:

    1. Swing Check Valves: In horizontal position with hinge pin level.
    2. Lift Check Valves: With stem upright and plumb.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

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

1. Shutoff Service: Ball valves.
2. Throttling Service: Ball valves.
3. Pump-Discharge Check Valves:

a. NPS 2 and Smaller: Bronze swing check valves with nonmetallic disc.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, full port, brass or bronze with stainless-steel trim.
3. Bronze Swing Check Valves: Class 150, nonmetallic disc.

END OF SECTION 220523

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

B. Related Sections:

1. Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE 7-16.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment.

1.5 ACTION SUBMITTALS

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

B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Pipe stands.
4. Equipment supports.

C. Engineered Seismic Submittal: For pipe and equipment hangers and supports, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of seismic restraints.
2. Design Calculations: Calculate requirements for seismic restraints.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural stainless-steel shapes with MSS SP-58 stainless-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
2. Standard: MFMA-4.
3. Channels: Continuous slotted steel channel with inturned lips.
4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.4 THERMAL-HANGER SHIELD INSERTS

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

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

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

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless-steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support piping.

B. High-Type, Single-Pipe Stand:
1. Base: Stainless steel.
2. Vertical Members: Two or more stainless-steel, continuous-thread rods.
3. Horizontal Member: stainless-steel rod with stainless-steel, roller-type pipe support.

C. High-Type, Multiple-Pipe Stand:

1. Bases: stainless steel.
2. Vertical Members: Two or more stainless-steel channels.
3. Horizontal Member: Stainless-steel channel.
4. Pipe Supports: Stainless-steel, clevis-type pipe hangers.

2.7 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.8 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural stainless-steel shapes.

2.9 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, stainless-steel plates, shapes, and bars.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, stainless-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

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

E. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

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

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

I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

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

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

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

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

N. Insulated Piping:

1. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

2. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.

c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

4. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

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

3.6 HANGER AND SUPPORT SCHEDULE

A. Use stainless-steel pipe hangers and stainless-steel attachments.

B. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

C. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

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

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

H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.

13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

K. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

M. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

N. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

O. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

P. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

SECTION 220548 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUBMITTALS

A. Submit signed and sealed shop drawings from a professional engineer. Shop drawings to include project specific details, sketches, product data cut sheets.

B. See drawings for additional requirements.

PART 2 - NOT USED.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Refer to the details and notes on the construction documents.

3.2 FIELD QUALITY CONTROL

A. Inspect installation after installation and submit report.

END OF SECTION 220548

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipe labels.
2. Valve tags.
3. Warning tags.

1.3 ACTION SUBMITTALS

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

B. Valve numbering scheme.

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

1.4 COORDINATION

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

B. Coordinate installation of identifying devices with locations of access panels and doors.

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

PART 2 - PRODUCTS

2.1 PIPE LABELS

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

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

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

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

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

2.2 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Stainless Steel, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass beaded chain.

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

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

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 25 feet along each run. Reduce intervals to 15 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Pipe Label Color Schedule:

1. Domestic Water Piping:

    a. Background Color: Blue.
    b. Letter Color: White.

2. Sanitary Waste and Storm Drainage Piping:

    a. Background Color: Black or Green.
    b. Letter Color: White.

3.3 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

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

1. Valve-Tag Size and Shape:

    a. Cold Water: 2 inches, round.

3.4 VALVE – ACCESS POINT LABEL

A. Color coded/round dot labels at each vav access point (Indicating location of isolation valves. Label shall be placed on ceiling grid tile or access panel door showing corresponding Isolation Valve tag.

1. Tag Material: Vinyl or plastic, color coded, with black (or other contrasting color) text.
2. Size: Label shall be no smaller than ½". Font type shall be plan, font size shall be large enough to be legible from 5'0'' A.F.F.
3. Placement: Labels shall be placed so that the tile the text label is the best ceiling tile to remove for access to the equipment marked by the label. Labels placed on grid shall be centered on the tile. Label shall be oriented so they can be read from the most likely access point. In the case of a corridor, all labels shall be placed with uniform orientation, allowing maintenance to read all labels in a single path down the hall. For access panels, label shall be placed below the access panel.

END OF SECTION 220553

SECTION 220719 - PLUMBING PIPING INSULATION

GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulating the following plumbing piping services:

1. Piping insulation for domestic hot, tempered, and cold water piping.
2. Supplies and drains for handicap-accessible lavatories and sinks.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).

1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

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

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

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

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PRODUCTS

1.8 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General" article for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

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

a. Aeroflex USA, Inc.; Aerocel.
b. Armacell LLC; AP Armaflex.
c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.
d. Or approved equal.

1.9 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Aeroflex USA, Inc.; Aeroseal.
b. Armacell LLC; Armaflex 520 BLV Adhesive.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
d. K-Flex USA; R-373 Contact Adhesive.

e. Or approved equal.

2. Adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

EXECUTION

1.10 EXAMINATION

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

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

1.11 PREPARATION

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

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

1.12 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

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

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

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

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

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

G. Keep insulation materials dry during application and finishing.

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

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

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

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

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

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

1.13 PENETRATIONS

A. Insulation Installation at Underground Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

B. Insulation Installation at Aboveground Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

1.14 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Finish exposed surfaces with a metal jacket.

1.15 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.

2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

1.16 FIELD-APPLIED JACKET INSTALLATION

A. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

1.17 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

1.18 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.

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

1.19 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

1.20 PIPING INSULATION SCHEDULE

A. Domestic Water Piping:
1. NPS 1 and Smaller: Insulation shall be one of the following:

a. Flexible Elastomeric: 3/4 inch thick.

2. NPS 1-1/4 and Larger: Insulation shall be one of the following:

a. Flexible Elastomeric:1 inch thick.

B. Domestic Hot and Recirculated Hot Water:

1. Insulation shall be one of the following:

a. Flexible Elastomeric: 1 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

C. Roof Drain, Stormwater, Overflow Piping and Drain Bodies:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Cellular Glass: 1 inches thick.
b. Flexible Elastomeric: 1 inch thick.

D. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 3/4 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
c. Under-lavatory shield

E. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F :

1. All Pipe Sizes: Insulation shall be one of the following:

a. Cellular Glass: 1-1/2 inches thick.
b. Flexible Elastomeric: 3/4 inch thick.

END OF SECTION 220719

SECTION 220800 - COMMISSIONING OF SERVICE WATER HEATING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes commissioning process requirements for Service Water Heating Systems, assemblies, and equipment.

B. Related Sections: Section 019113 "General Commissioning Requirements" for general commissioning process requirements.

1.3 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

C. Service Water Heating Systems: Service Water Heating Equipment, Pressure Regulating Devices, Mixing Valves, Piping, Insulation, Pumps, Variable Speed Drives, Controls, Interlocks, Interfaces, Safeties, Accessories and Appurtenances.

D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 INFORMATIONAL SUBMITTALS

A. Certificates of readiness.

B. Pre-Functional Test Checklists and Equipment Start up Reports.

1.5 CONTRACTOR'S RESPONSIBILITIES

A. Perform commissioning tests at the direction of the CxA.

B. Attend construction phase controls coordination meetings.

C. Attend testing, adjusting, and balancing review and coordination meetings.

D. Participate in the commissioning of Service Water Heating Systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

E. Provide information requested by the CxA for final commissioning documentation.

F. Provide measuring instruments and logging devices, calibrated within one year of date of test unless specifications or industry standards require more stringent calibration periods, to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.6 CxA'S RESPONSIBILITIES

A. Provide Project-specific construction checklists and commissioning process test procedures for actual Service Water Heating Systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.

B. Direct commissioning testing.

C. Verify testing, adjusting, and balancing of Work are complete.

D. Organize Contractor provided test data, inspection reports, and certificates in Systems Manual.

1.7 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:
   1. Plan for delivery and review of submittals, operation and maintenance manuals, and other documents and reports.
   2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
   3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for Service Water Heating Systems, assemblies, equipment, and components to be verified and tested.
   4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
   5. Certificate of readiness certifying that Service Water Heating Systems, subsystems, equipment, and associated controls are ready for testing.
   6. Test and inspection reports and certificates.
   7. Corrective action documents.
   8. Verification of testing, adjusting, and balancing reports.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Provide a fully executed Certificate of Readiness signed by Contractor, Subcontractors, TAB Agent and BAS provider certifying that Service Water Heating Systems, instrumentation and control systems have been completed and calibrated, pre-tested and inspected and that they are operating according to the Contract Documents, and that pretest set points have been recorded. Provide completed Certificate of Readiness to CxA no less than 7 days prior to the scheduled beginning of on-site CxA verification testing.

B. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

C. Inspect and verify the position of each device and interlock identified on checklists.

D. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 TESTING AND BALANCING VERIFICATION

A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Notify the CxA at least 30 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.

C. Provide technicians, instrumentation, and tools to verify testing and balancing of Service Water Systems at the direction of the CxA.

D. The CxA will notify Service Water Heating testing and balancing Subcontractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.
   1. The testing and balancing Subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
   2. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report.
   3. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of Service Water Systems testing shall include entire Service Water Heating Systems installation, from central equipment for heat generation through distribution systems to each water outlet and device.

C. Testing of systems and equipment shall include measuring capacities and effectiveness of operational and control functions, in addition to, or in conjunction with any statutory and regulatory testing required by Authorities Having Jurisdiction over the project and testing required in other Sections of this Project Manual.

D. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

E. The CxA along with the Service Water Heating Systems Subcontractor shall prepare detailed testing plans, procedures, and checklists for Service Water Heating Systems, subsystems, and equipment.

F. Tests will be performed using design conditions whenever possible.

G. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

H. The CxA may direct that set points be altered when simulating conditions is not practical.

I. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

J. If tests cannot be completed because of a deficiency outside the scope of the Service Water Heating Systems system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

K. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

END OF SECTION 220800

SECTION 221113 - FACILITY WATER DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes water-distribution piping and related components outside the building for combined water service and fire-service mains.

B. Utility-furnished products include water meters that will be furnished to the site, ready for installation.

1.3 DEFINITIONS

A. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

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

B. Field quality-control test reports.

C. Operation and Maintenance Data: For water valves and specialties to include in emergency, operation, and maintenance manuals.

D. Record Drawings:

1. Upon completion of installation of the potable water system, a Land Surveyor registered in the State of South Carolina shall prepare and provide Preliminary Record Drawings to the Engineer for review.

    a. As a minimum, these drawings shall show all pipe sizes, materials, valves, fittings, fire hydrants, and pertinent data input as attributes as required by the Public Utility, SCDHEC, and ***tied to State Plane Coordinates***.
    b. Record drawings shall meet the requirements of the Public Utility. Surveyor completed checklists from the Public Utility (if applicable) shall accompany all record drawings provided to the Engineer for review.
    c. Record drawings shall accommodate the Engineer’s seal, signature, and certification.

2. After review by the Engineer, the Surveyor shall make all required changes and/or revisions and submit to the Engineer signed and sealed sets along with electronic media.

3. Contractor shall include in his project schedule 30 calendar days for the approval of the as-built drawings by the Public Utility and/or SCDHEC after incorporation of Engineer's comments.

E. Easement Plat

1. Upon completion of installation of the potable water system, a Land Surveyor registered in the State of South Carolina shall prepare and provide Preliminary Easement Plats and Legal Description(s) as required by the Public Utility and for recording at the appropriate County RMC Office. Easement Plats shall be ***tied to State Plane Coordinates.***
2. Easement Plats shall meet the requirements of the Public Utility. Surveyor completed checklists from the Public Utility shall accompany all plats provided to the Engineer for review.
3. After review by the Engineer and Public Utility, the surveyor may be responsible for recording the plat(s). The Surveyor is required to provide to the Engineer signed and sealed prints with the recording information placed on the prints.
4. Contractor shall include in his project schedule 30 calendar days for the approval of the easement plat by the Public Utility and/or SCDHEC after incorporation of Engineer's comments.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
3. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.
4. <u>All materials and installation shall be in accordance with the latest City of Conway specifications and regulations. The City of Conway specifications and regulations shall govern over specification section 221113 Facility Water Distribution Piping.</u>

B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

E. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.

F. All material/products that contact potable water must be third party certified as meeting the specifications of ANSI/NSF Standard 61. The certifying party shall be accredited by ANSI.

G. Lubricants which will support microbiological growth shall not be used for slip-on joints. Vegetable shortening shall no be used to lubricate joints.

H. Natural rubber or other material which will support microbiological growth may not be used for any gaskets, O-rings, and other products used for jointing pipes, setting meters ort valves, or other appurtenances which will expose the material to the water.

I. All pipe material, solder and flux shall be lead free (less than .2% lead in solder and flux and less than 8.0% lead in pipes and fittings.)

1.6 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:

1. Ensure that valves are dry and internally protected against rust and corrosion.
2. Protect valves against damage to threaded ends and flange faces.
3. Set valves in best position for handling. Set valves closed to prevent rattling.

B. During Storage: Use precautions for valves, including fire hydrants, according to the following:

1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

F. Protect flanges, fittings, and specialties from moisture and dirt.

G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of service.

1.8 COORDINATION

A. Coordinate connection to water main with utility company.

PART 2 - PRODUCTS

2.1 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.

1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Gaskets: AWWA C111, rubber.

C. Grooved-Joint, Ductile-Iron Pipe: AWWA C151, with cut, rounded-grooved ends.

1. Grooved-End, Ductile-Iron Pipe Appurtenances:

   a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. Manufacturers: Subject to compliance with requirements and approval by system owner, provide products by one of the following:

      1) Anvil International, Inc.
      2) Victaulic Company of America.

   c. Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.
   d. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

D. Flanges: ASME 16.1, Class 125, cast iron.

2.2 PVC PIPE AND FITTINGS

A. PVC, Schedule 40 Pipe: ASTM D 1785.

1. PVC, Schedule 40 Socket Fittings: ASTM D 2466.

B. PVC, Schedule 80 Pipe: ASTM D 1785.

1. PVC, Schedule 80 Socket Fittings: ASTM D 2467.
2. PVC, Schedule 80 Threaded Fittings: ASTM D 2464.

C. PVC, AWWA Pipe: AWWA C900, Class 200, with bell end with gasket, and with spigot end.

1. Comply with UL 1285 for fire-service mains if indicated.
2. PVC Fabricated Fittings: AWWA C900, Class 200, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
3. PVC Molded Fittings: AWWA C907, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
4. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

    a. Gaskets: AWWA C111, rubber.

5. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

    a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.3 GATE VALVES

A. AWWA, Cast-Iron Gate Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements and approval by system owner, provide products are manufactured in the United States by one of the following:

    a. American AVK Co.; Valves & Fittings Div.
    b. American Cast Iron Pipe Co.; American Flow Control Div.
    c. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
    d. Crane Co.; Crane Valve Group; Stockham Div.
    e. East Jordan Iron Works, Inc.
    f. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
    g. McWane, Inc.; Kennedy Valve Div.
    h. McWane, Inc.; M & H Valve Company Div.
    i. McWane, Inc.; Tyler Pipe Div.; Utilities Div.
    j. Mueller Co.; Water Products Div.
    k. NIBCO INC.
    l. U.S. Pipe and Foundry Company.

3. Nonrising-Stem, Metal-Seated Gate Valves:

    a. Description: Gray- or ductile-iron body and bonnet; with cast-iron or bronze double-disc gate, bronze gate rings, bronze stem, and stem nut.

        1) Standard: AWWA C500.
        2) Minimum Pressure Rating: 200 psig (1380 kPa).
        3) End Connections: Mechanical joint.
        4) Interior Coating: Complying with AWWA C550.

4. Nonrising-Stem, Resilient-Seated Gate Valves:

a. Description: Gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.

1) Standard: AWWA C509.
2) Minimum Pressure Rating: 200 psig (1380 kPa).
3) End Connections: Mechanical joint.
4) Interior Coating: Complying with AWWA C550.

5. Nonrising-Stem, High-Pressure, Resilient-Seated Gate Valves:

a. Description: Ductile-iron body and bonnet; with bronze or ductile-iron gate, resilient seats, bronze stem, and stem nut.

1) Standard: AWWA C509.
2) Minimum Pressure Rating: 250 psig (1725 kPa).
3) End Connections: Push on or mechanical joint.
4) Interior Coating: Complying with AWWA C550.

6. OS&Y, Rising-Stem, Resilient-Seated Gate Valves:

a. Description: Cast- or ductile-iron body and bonnet, with bronze or gray- or ductile-iron gate, resilient seats, and bronze stem.

1) Standard: AWWA C509.
2) Minimum Pressure Rating: 200 psig (1380 kPa).
3) End Connections: Flanged.

B. UL/FMG, Cast-Iron Gate Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements and approval by system owner, provide products manufactured in the United States by one of the following:

a. American Cast Iron Pipe Co.; American Flow Control Div.
b. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
c. Crane Co.; Crane Valve Group; Stockham Div.
d. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
e. McWane, Inc.; Kennedy Valve Div.
f. McWane, Inc.; M & H Valve Company Div.
g. Mueller Co.; Water Products Div.
h. NIBCO INC.
i. U.S. Pipe and Foundry Company.

3. UL/FMG, Nonrising-Stem Gate Valves:

a. Description: Iron body and bonnet with flange for indicator post, bronze seating material, and inside screw.

1) Standards: UL 262 and FMG approved.
2) Minimum Pressure Rating: 175 psig (1207 kPa).
3) End Connections: Flanged.

4. OS&Y, Rising-Stem Gate Valves:

   a. Description: Iron body and bonnet and bronze seating material.

      1) Standards: UL 262 and FMG approved.
      2) Minimum Pressure Rating: 175 psig (1207 kPa).
      3) End Connections: Flanged.

C. Bronze Gate Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements and approval by system owner, provide products manufactured in the United States by one of the following:

   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Crane Co.; Crane Valve Group; Stockham Div.
   d. Hammond Valve.
   e. Milwaukee Valve Company.
   f. NIBCO INC.
   g. Red-White Valve Corporation.

3. OS&Y, Rising-Stem Gate Valves:

   a. Description: Bronze body and bonnet and bronze stem.

      1) Standards: UL 262 and FMG approved.
      2) Minimum Pressure Rating: 175 psig (1207 kPa).
      3) End Connections: Threaded.

4. Nonrising-Stem Gate Valves:

   a. Description: Class 125, Type 1, bronze with solid wedge, threaded ends, and malleable-iron handwheel.

      1) Standard: MSS SP-80.

2.4 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements and approval by system owner, provide products manufactured in the United States by one of the following:

   a. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
   b. East Jordan Iron Works, Inc.
   c. Flowserve.
   d. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
   e. McWane, Inc.; Kennedy Valve Div.

f. McWane, Inc.; M & H Valve Company Div.
g. Mueller Co.; Water Products Div.
h. U.S. Pipe and Foundry Company.

3. Description: Sleeve and valve compatible with drilling machine.

a. Standard: MSS SP-60.
b. Tapping Sleeve: Cast- or ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
c. Valve: AWWA, cast-iron, nonrising-stem, resilient-seated gate valve with one raised face flange mating tapping-sleeve flange.

B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches (125 mm) in diameter.

1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

C. Indicator Posts: UL 789, FMG-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

2.5 CHECK VALVES

A. AWWA Check Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements and approval by system owner, provide products manufactured in the United States by one of the following:

a. American AVK Co.; Valves & Fittings Div.
b. American Cast Iron Pipe Co.; American Flow Control Div.
c. APCO Williamette; Valve and Primer Corporation.
d. Crane Co.; Crane Valve Group; Crane Valves.
e. Crane Co.; Crane Valve Group; Stockham Div.
f. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
g. McWane, Inc.; Kennedy Valve Div.
h. McWane, Inc.; M & H Valve Company Div.
i. Mueller Co.; Water Products Div.
j. NIBCO INC.
k. Watts Water Technologies, Inc.

3. Description: Swing-check type with resilient seat. Include interior coating according to AWWA C550 and ends to match piping.

a. Standard: AWWA C508.
b. Pressure Rating: 175 psig (1207 kPa).

B. UL/FMG, Check Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements and approval by system owner, provide products manufactured in the United States by one of the following:

    a. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
    b. Crane Co.; Crane Valve Group; Stockham Div.
    c. Globe Fire Sprinkler Corporation.
    d. Kidde Fire Fighting.
    e. MATCO-NORCA, Inc.
    f. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
    g. McWane, Inc.; Kennedy Valve Div.
    h. Mueller Co.; Water Products Div.
    i. NIBCO INC.
    j. Reliable Automatic Sprinkler Co., Inc.
    k. Tyco Fire & Building Products.
    l. United Brass Works, Inc.
    m. Victaulic Company of America.
    n. Viking Corporation.
    o. Watts Water Technologies, Inc.

3. Description: Swing-check type with pressure rating; rubber-face checks, unless otherwise indicated; and ends matching piping.

    a. Standards: UL 312 and FMG approved.
    b. Pressure Rating: 175 psig.

2.6 CORPORATION VALVES AND CURB VALVES

A. Manufacturers:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements and approval by system owner, provide products manufactured in the United States by one of the following:

    a. Amcast Industrial Corporation; Lee Brass Co.
    b. Ford Meter Box Company, Inc. (The); Pipe Products Div.
    c. Jones, James Company.
    d. Master Meter, Inc.
    e. McDonald, A. Y. Mfg. Co.
    f. Mueller Co.; Water Products Div.
    g. Red Hed Manufacturing & Supply.

B. Service-Saddle Assemblies: Comply with AWWA C800. Include saddle and valve compatible with tapping machine.

1. Service Saddle: Copper alloy with seal and AWWA C800, threaded outlet for corporation valve.
2. Corporation Valve: Bronze body and ground-key plug, with AWWA C800, threaded inlet and outlet matching service piping material.
3. Manifold: Copper fitting with two to four inlets as required, with ends matching corporation valves and outlet matching service piping material.

C. Curb Valves: Comply with AWWA C800. Include bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.

D. Service Boxes for Curb Valves: Similar to AWWA M44 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over curb valve and with a barrel approximately 3 inches (75 mm) in diameter.

1. Shutoff Rods: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.

2.7 WATER METERS

A. Choose from approved City of Conway list of meters.

2.8 DETECTOR-TYPE WATER METERS

A. Detector-Type Water Meters:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements and approval by system owner, provide products manufactured in the United States by one of the following:

   a. Badger Meter, Inc.
   b. Mueller Co.; Hersey Meters.
   c. Neptune Technology Group Inc.
   d. Sensus Metering Systems.

B. Description: Main line, proportional meter with second meter on bypass. Register flow in gallons (liters).

1. Standards: AWWA C703, UL listed, and FMG approved.
2. Pressure Rating: 150 psig (1035 kPa).
3. Bypass Meter: AWWA C702, compound-type, bronze case.

   a. Size: At least one-half nominal size of main-line meter.

2.9 RELIEF VALVES

A. Air-Release Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements and approval by system owner, provide products manufactured in the United States by one of the following:

   a. Crispin-Multiplex Manufacturing Co.
   b. GA Industries, Inc.
   c. Val-Matic Valve & Manufacturing Corp.

3. Description: Hydromechanical device to automatically release accumulated air.

    a. Standard: AWWA C512.
    b. Pressure Rating: 300 psig (2070 kPa).
    c. Body Material: Cast iron.
    d. Trim Material: Stainless steel, brass, or bronze.
    e. Water Inlet Size: 1” NPS (DN).
    f. Air Outlet Size: 1” NPS (DN).
    g. Orifice Size: 1” inch (mm).
    h. Design Air-Release Capacity: 150 psig (kPa) pipeline pressure.

2.10 BACKFLOW PREVENTERS

A. Double Check, Backflow-Prevention Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products manufactured in US as approved by the South Carolina Department of Health and Environmental Control.

2.11 WATER METER BOXES

A. Description: Cast-iron body and cover for disc-type water meter, with lettering "WATER METER" in cover; and with slotted, open-bottom base section of length to fit over service piping.

1. Option: Base section may be cast-iron, PVC, clay, or other pipe.

B. Description: Cast-iron body and double cover for disc-type water meter, with lettering "WATER METER" in top cover; and with separate inner cover; air space between covers; and slotted, open-bottom base section of length to fit over service piping.

C. Description: Polymer-concrete body and cover for disc-type water meter, with lettering "WATER" in cover; and with slotted, open-bottom base section of length to fit over service piping. Include vertical and lateral design loadings of 15,000 lb minimum over 10 by 10 inches (6800 kg minimum over 254 by 254 mm) square.

2.12 CONCRETE/MASONRY VAULTS

A. See Detail.

2.13 FIRE HYDRANTS

A. Dry-Barrel Fire Hydrants:
1. Manufacturers: Subject to compliance with requirements and approval by system owner, provide products manufactured in the United States by one of the following:

    a. American Cast Iron Pipe Co.; American Flow Control Div.
    b. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
    c. McWane, Inc.; M & H Valve Company Div.
    d. Mueller Co.; Water Products Div.

e. U.S. Pipe and Foundry Company.

2. Description: Freestanding, with one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, 5-1/4-inch (133-mm) main valve, drain valve, and NPS 6 (DN 150) mechanical-joint inlet. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure.

   a. Standards: UL 246, FMG approved.
   b. Pressure Rating: 150 psig (1035 kPa) minimum.
   c. Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
   d. Operating and Cap Nuts: Pentagon, 1-1/2 inches (38 mm) point to flat.
   e. Direction of Opening: Open hydrant valve by turning operating nut to left or counterclockwise.
   f. Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.

3. AWWA Fire Hydrants: Comply with AWWA C502.

2.14 YARD HYDRANTS

A. Manufacturers: Subject to compliance with requirements and approval by system owner, provide products manufactured in the United States by one of the following:

   1. Woodford Manufacturing Co.

   2. Description: Freezeless Model W34 bury depth minimum 3 feet

PART 3 - EXECUTION

3.1 EARTHWORK

A. Bedding:
   a. Continuous and uniform bedding shall be provided in the trench for all buried pipes.
   b. Back-fill material shall be tamped in layers around the pipe and to a sufficient height above the pipe to adequately support and protect the pipe.
   c. Stones, other than crushed bedding, shall not come into contact with the pipe and shall not be within six (6) inches of the pipe.

B. All pipes must have a minimum cover of 30", unless the pipe material is concrete, DIP, or other approved material, and insulated to prevent freezing.

3.2 PIPING APPLICATIONS

A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.

B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.

C. Do not use flanges or unions for underground piping.

D. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.

E. Underground water-service piping NPS 3/4 to NPS 3 (DN 20 to DN 80) shall be the following:

1. PVC, Schedule 40 pipe; PVC, Schedule 40 socket fittings; and solvent-cemented joints.

F. Underground water-service piping NPS 4 to NPS 8 (DN 100 to DN 200) shall be the following:

1. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints. Solvent-welds shall not be used.

G. Water Meter Box Water-Service Piping NPS 3/4 to NPS 2 (DN 20 to DN 50) shall be same as underground water-service piping.

H. Underground Fire-Service-Main Piping NPS 4 to NPS 12 (DN 100 to DN 300) shall be the following:

1. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.

I. Underground Combined Water-Service and Fire-Service-Main Piping NPS 6 to NPS 12 (DN 150 to DN 300) shall be the following:

1. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.

3.3 VALVE APPLICATIONS

A. General Application: Use mechanical-joint-end valves for NPS 3 (DN 80) and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 (DN 50) and smaller installation.

B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Underground Valves, NPS 3 (DN 80) and Larger: AWWA, cast-iron, nonrising-stem, resilient-seated gate valves with valve box.
2. Underground Valves, NPS 4 (DN 100) and Larger, for Indicator Posts: UL/FMG, cast-iron, nonrising-stem gate valves with indicator post.
3. Use the following for valves in vaults:

    a. Gate Valves, NPS 2 (DN 50) and Smaller: Bronze, nonrising stem.
    b. Gate Valves, NPS 3 (DN 80) and Larger: AWWA, cast iron, AWWA, cast iron, OS&Y rising stem, resilient seated UL/FMG, cast iron, OS&Y rising stem.

c. Check Valves: AWWA C508 UL/FMG, swing type.

4. Relief Valves: Use for water-service piping in vaults and aboveground.

a. Air-Release Valves: To release accumulated air.

3.4 PIPING SYSTEMS - COMMON REQUIREMENTS

A. See Division 22 Section "Common Work Results for Plumbing" for piping-system common requirements.

3.5 PIPING INSTALLATION

A. Water-Main Connection: Tap water main according to requirements of water utility company and of size and in location indicated.

B. Make connections larger than NPS 2 (DN 50) with tapping machine according to the following:

1. Install tapping sleeve and tapping valve according to MSS SP-60.
2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
3. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
4. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.

C. Make connections NPS 2 (DN 50) and smaller with drilling machine according to the following:

1. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company standards.
2. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.
3. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.
4. Install corporation valves into service-saddle assemblies.
5. Install manifold for multiple taps in water main.
6. Install curb valve in water-service piping with head pointing up and with service box.

D. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.

E. Install PVC, AWWA pipe according to ASTM F 645 and AWWA M23.

F. Bury piping with depth of cover over top at least 36 inches, with top at least 12 inches below level of maximum frost penetration, and according to the following:

a. Under Driveways: With at least 36 inches cover over top.

G. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.

H. Sleeves are specified in Division 22 Section "Common Work Results for Plumbing."

I. Mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."

J. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

K. See Division 21 Section "Water-Based Fire-Suppression Systems" for fire-suppression-water piping inside the building.

L. See Division 22 Section "Domestic Water Piping" for potable-water piping inside the building.

3.6 JOINT CONSTRUCTION

A. See Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.

B. Make pipe joints according to the following:
1. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
2. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
3. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.
4. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure. Refer to Division 22 Section "Common Work Results for Plumbing" for joining piping of dissimilar metals.

3.7 ANCHORAGE INSTALLATION

A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:

1. Concrete thrust blocks.
2. Locking mechanical joints.
3. Set-screw mechanical retainer glands.
4. Bolted flanged joints.
5. Pipe clamps and tie rods.

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:

1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
3. Fire-Service-Main Piping: According to NFPA 24.

3.8 VALVE INSTALLATION

A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.

C. UL/FMG, Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.

D. UL/FMG, Valves Other Than Gate Valves: Comply with NFPA 24.

E. MSS Valves: Install as component of connected piping system.

F. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.

G. Relief Valves: Comply with AWWA C512. Install in meter box with shutoff valve on inlet.

3.9 WATER METER INSTALLATION

A. Install water meters, piping, and specialties according to utility company's instructions.

B. Water Meters: Install displacement-type water meters, NPS 2 (DN 50) and smaller, in meter boxes with shutoff valves on water meter inlets. Include valves on water meter outlets and valved bypass around meters unless prohibited by authorities having jurisdiction.

C. Water Meters: Install compound-type water meters, NPS 3 (DN 80) and larger, in meter vaults. Include shutoff valves on water meter inlets and outlets and valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.

D. Water Meters: Install detector-type water meters in meter vault according to AWWA M6. Include shutoff valves on water meter inlets and outlets and full-size valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.

3.10 ROUGHING-IN FOR WATER METERS

A. Rough-in piping and specialties for water meter installation according to utility company's instructions.

3.11 WATER METER BOX INSTALLATION

A. Install water meter boxes in paved areas flush with surface.

B. Install water meter boxes in grass or earth areas with top 2 inches above surface.

3.12 FIRE HYDRANT INSTALLATION

A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.

3.13 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. See Division 22 Section "Common Work Results for Plumbing" for piping connections to valves and equipment.

C. Connect water-distribution piping to existing water main. Use tapping sleeve and tapping valve.

D. Connect water-distribution piping to interior domestic water and fire-suppression piping.

3.14 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests: Hydrostatic tests on pipe shall be made by the Contractor with equipment approved by the Engineer, system owner, and in accordance with AWWA Standards C600. The Contractor shall test sections of mains between valves, at intervals not exceeding 2,000 feet, at a pressure of not less than 1.5 times the maximum working pressure of the system. Test pressure shall be maintained for not less than two hours and as long as the Engineer may require in order to detect any leakage or defective material. Any makeup water required shall be carefully measured and the leakage shall not exceed the requirements listed below. Any leakage or sweating joints shall be corrected. All visible leaks, regardless of the amount of leakage, shall be repaired. Allowable leakage per hour shall be calculated as follows:

$L = (S \times D \times (P)^{0.5})/133{,}200$ **Ductile Iron**
$L = (N \times D \times (P)^{0.5})/7{,}400$ **PVC**
L = Allowable Leakage (gallon/hour)
S = Length of the pipeline tested (feet)
N= Number of joints being tested
D = Pipe diameter nominal (inches)
P = Average Test Pressure (psig)

C. Prepare reports of testing activities.

3.15 IDENTIFICATION

A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Division 31 Section "Earth Moving."

3.16 CLEANING

A. Clean and disinfect water-distribution piping as follows:

1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.
3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:

a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.
e. The contractor shall collect a minimum of two (2) samples from each sampling site for total Coliform analysis. The number of sites depends on the amount of new construction but must include all dead-end lines, be representative of the water in the newly constructed mains, and shall be collected a minimum of every 1200 linear feet.
f. Prior to sampling, the chlorine residual must be reduced to normal system residual levels or be non-detectable in those systems not chlorinating.
g. The samples must be collected twenty-four (24) hours apart and must show the water line to be absent of total Coliform bacteria.
h. The chlorine residual must also be measured and reported.
i. If the membrane filter method of analysis is used for Coliform analysis, non-Coliform growth must also be reported.
j. If non-Coliform growth is greater than eighty (80) colonies per one hundred (100) milliliters, the sample result is invalid and must be repeated.
k. All samples must be analyzed by a State certified laboratory.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION 221113

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Aboveground domestic water pipes, tubes, and fittings inside buildings.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

B. Field quality-control reports.

1.5 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Architect/Engineer/Owner no fewer than five days in advance of proposed interruption of water service.
2. Do not interrupt water service without Architect/Engineer/Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 14 and NSF 61.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

B. Soft Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

F. Copper Unions:

1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.4 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.

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

   a. Cascade Waterworks Manufacturing.
   b. Dresser, Inc.; Piping Specialties Products.
   c. Ford Meter Box Company, Inc. (The).
   d. JCM Industries.
   e. Romac Industries, Inc.
   f. Smith-Blair, Inc.; a Sensus company.
   g. Viking Johnson.
   h. Or approved equal.

2.5 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

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

   a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
   b. Central Plastics Company.
   c. Hart Industries International, Inc.
   d. Jomar International.
   e. Matco-Norca.
   f. McDonald, A. Y. Mfg. Co.
   g. Watts; a division of Watts Water Technologies, Inc.
   h. Wilkins; a Zurn company.
   i. Or approved equal.

2. Standard: ASSE 1079.
3. Pressure Rating: 250 psig minimum at 180 deg F.
4. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

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

   a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
   b. Central Plastics Company.
   c. Matco-Norca.
   d. Watts; a division of Watts Water Technologies, Inc.
   e. Wilkins; a Zurn company.
   f. Or approved equal.

2. Standard: ASSE 1079.
3. Factory-fabricated, bolted, companion-flange assembly.
4. Pressure Rating: 175 psig minimum at 180 deg F.

5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing according to CDA's "Copper Tube Handbook."

C. Install shutoff valve immediately upstream of each dielectric fitting.

D. Install domestic water piping level and plumb. Provide drain with hose fitting at all low points where possible.

E. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

F. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

G. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

H. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

I. Install piping to permit valve servicing.

J. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

K. Install piping free of sags and bends.

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

M. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

N. Install pressure gages on each supply to a restroom.

O. Install sleeves for piping penetrations of walls, ceilings, and floors.

P. Install sleeve seals for piping penetrations of concrete walls and slabs.

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.2 JOINT CONSTRUCTION

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

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

F. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.3 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

3.4 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or 42, clamps.

2. Individual, Straight, Horizontal Piping Runs: MSS Type 1, adjustable, steel clevis hangers, with insulation shield.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
6. NPS 6: 10 feet with 5/8-inch rod.
7. NPS 8: 10 feet with 3/4-inch rod.

F. Install supports for vertical copper tubing every 10 feet.

G. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.

3.7 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Label pressure piping with system operating pressure.

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

    a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
    b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

        1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
        2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

    c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
    d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

    a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
    b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
    c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
    d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
    e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
    f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.9 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
4. Remove and clean strainer screens. Close drain valves and replace drain plugs.
5. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.

6. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.10 CLEANING

A. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

B. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system according to either of the following:

1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Repeat procedures if biological examination shows contamination.
e. Submit water samples in sterile bottles to authorities having jurisdiction.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

3.11 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Aboveground domestic water piping shall be the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.

3.12 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
2. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 221116

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Temperature-actuated, water mixing valves.
2. Hose bibbs.
3. Drain valves.
4. Water-hammer arresters.
5. Flexible connectors.

B. Related Requirements:

1. Section 221116 "Domestic Water Piping".

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF 61.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Thermostatic, Water Mixing Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Armstrong International, Inc.
    b. Lawler Manufacturing Company, Inc.
    c. Leonard Valve Company.
    d. Powers; a division of Watts Water Technologies, Inc.
    e. Symmons Industries, Inc.
    f. Or approved equal.

2. Standard: ASSE 1070.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
4. Type: Exposed-mounted, thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Tempered-Water Setting: 105°F
9. Tempered-Water Design Flow Rate: 1.5 gpm
10. Pressure Drop at Design Flow Rate: 5 psi
11. Tempered-Water Minimum Flow Rate at setpoint temperature: 0.5 gpm.
12. Valve Finish: Rough bronze.
13. Piping Finish: Copper.

2.4 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Finished Rooms: Stainless steel or chrome plated.
9. Operation for Service Areas: Wheel handle.
10. Operation for Rooms Accessible to the General Public: Operating key.
11. Include operating key with each operating-key hose bibb.
12. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.5 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Stainless Steel.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered stainless steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.
10. Provide with hose-connection backflow preventer confirming to ASSE 1052.

2.6 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following

   a. Josam Company.
   b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   c. Watts Drainage Products.
   d. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.
   e. Or approved equal.

2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Metal bellows.
4. Size: ASSE 1010, Sizes A and A through F, or PDI-WH 201, Sizes A through F.

2.7 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Flex-Hose Co., Inc.
2. Flexicraft Industries.
3. Flex Pression, Ltd.
4. Flex-Weld Incorporated.
5. Hyspan Precision Products, Inc.
6. Mercer Gasket & Shim, Inc.
7. Metraflex, Inc.
8. Proco Products, Inc.
9. TOZEN Corporation.
10. Unaflex.Universal Metal Hose; a Hyspan company.
11. Or approved equal.

B. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig.
2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install male hose-end drain valve with hose connection backflow preventer at all low points in the plumbing system.

B. Install outlet boxes recessed in wall or surface mounted on wall. Install wood blocking, wall reinforcement between studs.

C. Install water-hammer arresters in water piping according to PDI-WH 201.

D. Install air vents at high points of water piping.

END OF SECTION 221119

SECTION 221313 - FACILITY SANITARY SEWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Nonpressure and pressure couplings.

1.3 SUBMITTALS

A. Product Data for all installed material items.

B. As-Built (Record) Drawings

1. Upon completion of installation of the Wastewater system, a Land Surveyor registered in the State of South Carolina shall prepare and provide Preliminary Record Drawings to the Engineer for review.

    a. As a minimum, these drawings shall show all manhole rim and invert elevations, pipe invert elevations, pipe slopes, pipe sizes, materials and pertinent data inputs as required by the Public Utility, SCDHEC, and ***tied to State Plane Coordinates***.
    b. Record drawings shall meet the requirements of the Public Utility. Surveyor completed checklists from the Public Utility shall accompany all record drawings provided to the Engineer for review.
    c. Record drawings shall accommodate the Engineer’s seal, signature, and certification.

2. After review by the Engineer, the Surveyor shall make all required changes and/or revisions and submit to the Engineer signed and sealed sets along with electronic media.
3. Contractor shall include in his project schedule 30 calendar days for the approval of the as-built drawings by the Public Utility and/or SCDHEC after incorporation of Engineer’s comments.

C. Easement Plats

1. Upon completion of installation of the Wastewater system, a Land Surveyor registered in the State of South Carolina shall prepare and provide Preliminary Easement Plats and Legal Description(s) as required by the Public Utility and for recording at the appropriate County RMC Office. Easement Plats shall be ***tied to State Plane Coordinates.***

2. Easement Plats shall meet the requirements of the Public Utility. Surveyor completed checklists from the Public Utility shall accompany all plats provided to the Engineer for review.
3. After review by the Engineer and Public Utility, the Surveyor may be responsible for recording the plat(s). The Surveyor is required to provide to the Engineer signed and sealed prints with the recording information placed on the prints.
4. Contractor shall include in his project schedule 30 calendar days for the approval of the as-built drawings by the Public Utility and/or SCDHEC after incorporation of Engineer’s comments.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes according to manufacturer's written rigging instructions.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of service.

PART 2 - PRODUCTS

2.1 DUCTILE-IRON, GRAVITY SEWER PIPE AND FITTINGS

A. Pipe: ASTM A 746, for push-on joints.

B. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.

C. Compact Fittings: AWWA C153, ductile iron, for push-on joints.

D. Gaskets: AWWA C111, rubber.

2.2 PVC PIPE AND FITTINGS

A. PVC Type PSM Sewer Piping:

1. Pipe: ASTM D 3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D 3034, PVC with bell ends.
3. Gaskets: ASTM F 477, elastomeric seals.

2.3 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 inches (1200 mm) minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
4. Base Section: 6-inch (150-mm) minimum thickness for floor slab and 4-inch (100-mm) minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
5. Riser Sections: 4-inch (100-mm) minimum thickness, of length to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated; with top of cone of size that matches grade rings.
7. Joint Sealant: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
9. Steps: Individual FRP steps or FRP ladder; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm).
10. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser, with 4-inch- (100-mm-) minimum-width flange and 26-inch- (660-mm-) diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
2. Material: ASTM A 48/A 48M, Class 35 gray iron unless otherwise indicated.

2.4 CONCRETE

A. General: Cast-in-place concrete complying with ACI 318, ACI 350/350R (ACI 350M/350RM), and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.

a. Invert Slope: 2 percent through manhole.

2. Benches: Concrete, sloped to drain into channel.

a. Slope: 8 percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi (20.7 MPa) minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure, drainage piping according to the following:

1. Install piping pitched down in direction of flow, at minimum slope of 1 percent unless otherwise indicated.

2. Install ductile-iron, gravity sewer piping according to ASTM A 746.
3. Install PVC Type PSM sewer piping according to ASTM D 2321 and ASTM F 1668.

G. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure, drainage piping according to the following:

1. Join PVC Type PSM sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
2. Join dissimilar pipe materials with nonpressure-type, flexible or rigid couplings.

3.4 MANHOLE INSTALLATION

A. General: Install manholes complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Install FRP manholes according to manufacturer's written instructions.

D. Form continuous concrete channels and benches between inlets and outlet.

E. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches (76 mm) above finished surface elsewhere unless otherwise indicated.

F. Install manhole-cover inserts in frame and immediately below cover.

3.5 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.6 CONNECTIONS

A. Make connections to existing piping and underground manholes.
1. Make branch connections to underground manholes by cutting opening into existing unit large enough to allow 3 inches (76 mm) of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches (150 mm) of concrete for minimum length of 12 inches (300 mm) to provide additional support of collar from connection to undisturbed ground.

a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi (20.7 MPa) unless otherwise indicated.
b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

2. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.7 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.

1. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.8 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (600 mm) of backfill is in place, and again at completion of Project.

1. Submit separate report for each system inspection.
2. Defects requiring correction include the following:

    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    d. Infiltration: Water leakage into piping.
    e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:

    a. Fill sewer piping with water. Test with pressure of at least 10-foot (3-m) head of water, and maintain such pressure without leakage for at least 15 minutes.
    b. Close openings in system and fill with water.
    c. Purge air and refill with water.
    d. Disconnect water supply.
    e. Test and inspect joints for leaks.

6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:

   a. Option: Test plastic gravity sewer piping according to ASTM F 1417.
   b. Option: Test concrete gravity sewer piping according to ASTM C 924 (ASTM C 924M).

7. Manholes: Perform hydraulic test according to ASTM C 969 (ASTM C 969M).

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.9 CLEANING

A. Clean dirt and superfluous material from interior of piping. Flush with potable water.

END OF SECTION 221313

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water.

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE 7-16.

1.4 ACTION SUBMITTALS

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

B. Shop Drawings: For coordination. Include plans, elevations, sections, and details.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Architect/Owner no fewer than five days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Architect's/Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Heavy-Duty, Hubless-Piping Couplings:

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

   a. ANACO-Husky.
   b. Charlotte Pipe & Foundry.
   c. MIFAB, Inc.
   d. Mission Rubber Company; a division of MCP Industries, Inc.
   e. Tyler Pipe.
   f. Or approved equal.

2. Standards: ASTM C 1540.
3. Description: Stainless-steel shield, 0.015 inch minimum thickness, with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

C. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.

D. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

E. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.4 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

3. Shielded, Nonpressure Transition Couplings:

a. Standard: ASTM C 1460.
b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:

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

1) Capitol Manufacturing Company.
2) Central Plastics Company.
3) Hart Industries International, Inc.
4) Jomar International Ltd.
5) Matco-Norca, Inc.
6) McDonald, A. Y. Mfg. Co.
7) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
8) Wilkins; a Zurn company.
9) Or approved equal.

b. Description:

1) Standard: ASSE 1079.
2) Pressure Rating: 125 psig minimum at 180 deg F.
3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric-Flange Insulating Kits:

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

1) Advance Products & Systems, Inc.
2) Calpico, Inc.
3) Central Plastics Company.
4) Pipeline Seal and Insulator, Inc.
5) Or approved equal.

b. Description:

1) Nonconducting materials for field assembly of companion flanges.
2) Pressure Rating: 150 psig .
3) Gasket: Neoprene or phenolic.
4) Bolt Sleeves: Phenolic or polyethylene.
5) Washers: Phenolic with steel backing washers.

4. Dielectric Nipples:

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

1) Elster Perfection.
2) Grinnell Mechanical Products.
3) Matco-Norca, Inc.
4) Precision Plumbing Products, Inc.
5) Victaulic Company.
6) Or approved equal.

b. Description:

1) Standard: IAPMO PS 66
2) Electroplated steel nipple.
3) Pressure Rating: 300 psig at 225 deg F .
4) End Connections: Male threaded or grooved.
5) Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

L. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Sanitary Drainage Piping: 1/4” per foot downward in direction of flow for piping NPS 2 and smaller; 1/8” per foot downward in direction of flow for piping NPS 3 and larger.
2. Vent Piping: 1/8” per foot down toward vertical fixture vent or toward vent stack.

M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

N. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

O. Install engineered soil and waste drainage and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.

P. Plumbing Specialties:

1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."

2. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."

Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

R. Install sleeves for piping penetrations of walls, ceilings, and floors.

S. Install sleeve seals for piping penetrations of exterior concrete walls and slabs.

T. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.2 JOINT CONSTRUCTION

A. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

B. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

C. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

3.3 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Shielded, nonpressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or unions.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install stainless-steel pipe hangers for horizontal piping.

2. Install stainless-steel pipe support clamps for vertical piping.
3. Vertical Piping: MSS Type 8 or Type 42, clamps.
4. Install individual, straight, horizontal piping runs: MSS Type 1, adjustable, clevis hangers

C. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with 3/4-inch rod.

I. Install supports for vertical copper tubing every 10 feet.

J. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.

3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Comply with requirements for cleanouts and drains specified in Section 221319 "Sanitary Waste Piping Specialties."
6. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

3.6 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.7 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before

inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.8 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.9 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil, waste, and vent piping shall be any of the following:

1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
2. For stubouts through walls to fixture trap arm: Copper DWV tube, copper drainage fittings, and soldered joints.

END OF SECTION 221316

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Cleanouts.
2. Floor drains.
3. Roof flashing assemblies.
4. Miscellaneous sanitary drainage piping specialties.
5. Flashing materials.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer Seismic Qualification Certification: Submit certification that accessories, and components will withstand seismic forces defined in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Exposed Metal Cleanouts, CO:

1. ASME A112.36.2M, Cast-Iron Cleanouts:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Josam Company.
2) MIFAB, Inc.
3) Smith, Jay R. Mfg. Co.
4) Tyler Pipe.
5) Watts Drainage Products.
6) Zurn Plumbing Products Group.
7) Or approved equal.

2. Standard: ASME A112.36.2M for cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Closure: Stainless-steel plug with seal.

B. Metal Floor Cleanouts, FCO:

1. ASME A112.36.2M, Cast-Iron Cleanouts:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Josam Company.
2) Smith, Jay R. Mfg. Co.
3) Watts Drainage Products.
4) Zurn Plumbing Products Group.
5) Or approved equal.

2. Standard: ASME A112.36.2M for heavy-duty, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Heavy-duty, adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: Not required.
7. Outlet Connection: Spigot.
8. Closure: Brass plug with tapered threads.
9. Adjustable Housing Material: Cast iron.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
11. Frame and Cover Shape: Round.

12. Top Loading Classification: Heavy Duty.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts, WCO:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Josam Company; Josam Div.
    b. MIFAB, Inc.
    c. Smith, Jay R. Mfg. Co.
    d. Tyler Pipe; Wade Div.
    e. Watts Drainage Products.
    f. Zurn Plumbing Products Group.
    g. Or approved equal.

2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hub-and-spigot, cast-iron soil pipe T-branch or Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk, drilled-and-threaded brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, stainless-steel cover plate with screw.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains: See Plumbing Fixture Schedule.

2.3 FLOOR SINKS

A. Stainless-Steel Floor Drains: See Plumbing Fixture Schedule.

2.4 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

1. Description: Manufactured assembly made of 6.0-lb/sq. ft., 0.0938-inch-thick, lead flashing collar and skirt extending at least 8 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

    a. Low-Silhouette Vent Cap: With vandal-proof vent cap.

2.5 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Floor-Drain, Trap-Seal Fittings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. MIFAB, Inc.
    b. Precision Plumbing Products, Inc.
    c. Smith, Jay R. Mfg. Co.
    d. RectorSeal
    e. Or approved equal.

2. Description: Barrier, type, HDPE (High Density Poly Ethylene) housing with heavy duty silicone diaphragm and soft EPDM sealing gasket, conforming to ASSE 1072.
3. Size: Same as floor drain outlet.

B. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

C. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

D. Expansion Joints:

1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

2.6 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Fasteners: Metal compatible with material and substrate being fastened.

C. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

D. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet.
4. Locate at base of each vertical soil and waste stack.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

E. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

F. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

G. Install deep-seal traps on floor drains and other waste outlets, if indicated.

H. Install floor-drain, trap-seal fittings on floor drains: barrier type conforming to ASSE 1072.

I. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

J. Install vent caps on each vent pipe passing through roof.

K. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

L. Install wood-blocking reinforcement for wall-mounting-type specialties.

M. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings.

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319

SECTION 221413 - FACILITY STORM DRAINAGE PIPING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.
3. Encasement for underground metal piping.

B. Related Sections:

1. Section 221429 "Sump Pumps" for storm drainage pumps.
2. Section 334100 "Storm Utility Drainage Piping" for storm drainage piping outside the building.

1.03 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Storm Drainage Piping: 10-foot head of water.

B. Seismic Performance: Storm drainage piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.04 ACTION SUBMITTALS

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

B. LEED Submittals:

1. Product Data: VOC content limits per SCAQMD Rule 1168, per Section 016116, Volatile Organic Compound (VOC) Content Restrictions.
2. Laboratory Test Reports: VOC emissions per CDPH Standard Method v1.2, per Section 016116, Volatile Organic Compound (VOC) Content Restrictions.

1.05 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For storm drainage piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.06 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF/ANSI 14, "Plastics Piping System Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

PART 2 PRODUCTS

2.01 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.02 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service classes.

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.03 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. ANACO-Husky.
b. Clamp-All Corp.

c. Dallas Specialty & Mfg. Co.
d. MIFAB, Inc.
e. Mission Rubber Company; a division of MCP Industries, Inc.
f. Stant.
g. Tyler Pipe.

2. Standards: ASTM C 1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.04 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A 674 or AWWA C105.

B. Material: High-density, cross-laminated PE film of 0.004-inch or LLDPE film of 0.008-inch minimum thickness.

C. Form: Sheet or tube.

D. Color: Black or natural.

2.05 PIPE TERMINATION FITTING

A. Overflow pipe termination fitting type shall be coordinated with Architect.

B. Coordinate flexible connection fitting with Civil.

2.06 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.

C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

D. Adhesive Primer: ASTM F 656.
1. For all interior (inside the weatherproofing of the building) adhesives applied on site, provide manufacturer documentation that the product meets the VOC content limits SCAQMD Rule 1168, per Section 016116, Volatile Organic Compound (VOC) Content Restrictions.
2. Provide documentation the product has been tested according to CDPH Standard Method v1.2 and complies with the VOC limits per Section 016116, Volatile Organic Compound (VOC) Content Restrictions.

E. Solvent Cement: ASTM D 2564.
1. For all interior (inside the weatherproofing of the building) adhesives applied on site, provide manufacturer documentation that the product meets the VOC content limits

SCAQMD Rule 1168, per Section 016116, Volatile Organic Compound (VOC) Content Restrictions.

2. Provide documentation the product has been tested according to CDPH Standard Method v1.2 and complies with the VOC limits per Section 016116, Volatile Organic Compound (VOC) Content Restrictions.

2.07 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.

3. Shielded, Nonpressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Cascade Waterworks Mfg. Co.
2) Mission Rubber Company; a division of MCP Industries, Inc.

b. Standard: ASTM C 1460.
c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Capitol Manufacturing Company.
2) Central Plastics Company.
3) Hart Industries International, Inc.
4) Jomar International Ltd.
5) Matco-Norca, Inc.
6) McDonald, A. Y. Mfg. Co.
7) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
8) Wilkins; a Zurn company.

b. Description:

1) Standard: ASSE 1079.
2) Pressure Rating: 150 psig at 180 deg F.
3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Capitol Manufacturing Company.
2) Central Plastics Company.
3) Matco-Norca, Inc.
4) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
5) Wilkins; a Zurn company.

b. Description:

1) Standard: ASSE 1079.
2) Factory-fabricated, bolted, companion-flange assembly.
3) Pressure Rating: 175 psig minimum.
4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Advance Products & Systems, Inc.
2) Calpico, Inc.
3) Central Plastics Company.
4) Pipeline Seal and Insulator, Inc.

b. Description:

1) Nonconducting materials for field assembly of companion flanges.
2) Pressure Rating: 150 psig.
3) Gasket: Neoprene or phenolic.
4) Bolt Sleeves: Phenolic or polyethylene.
5) Washers: Phenolic with steel-backing washers.

5. Dielectric Nipples:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Elster Perfection.
2) Grinnell Mechanical Products.
3) Matco-Norca, Inc.

4) Precision Plumbing Products, Inc.
5) Victaulic Company.

b. Description:

1) Electroplated steel nipple complying with ASTM F 1545.
2) Pressure Rating: 300 psig at 225 deg F
3) End Connections: Male threaded or grooved.
4) Lining: Inert and noncorrosive, propylene.

PART 3 EXECUTION

3.01 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.02 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations from layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

K. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

L. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

M. Install storm drainage piping at the following minimum slopes unless otherwise indicated:

1. Building Storm Drain: 1 percent downward in direction of flow.
2. Horizontal Storm-Drainage Piping: 1 percent downward in direction of flow.

N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.

O. Install underground PVC piping according to ASTM D 2321.

P. Install steel piping according to applicable plumbing code.

Q. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

R. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.03 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hub-and-Spigot, Cast-Iron Soil Piping Calked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Hubless, Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fittings. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

E. Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.04 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Shielded, nonpressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges, flange kits, or nipples.
4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.05 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
3. Vertical Piping: MSS Type 8 or Type 42, clamps.
4. Individual, Straight, Horizontal Piping Runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

5. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
6. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
5. Spacing for 10-foot pipe lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.06 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
2. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.07 IDENTIFICATION

A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.08 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

3.09 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.10 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground storm drainage piping shall be the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.

2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.

C. Underground storm drainage piping shall be one of the following:

1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

END OF SECTION

SECTION 221429 - SUMP PUMPS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Submersible sump pumps.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Wiring Diagrams: For power, signal, and control wiring.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

PART 2 PRODUCTS

2.01 SUBMERSIBLE SUMP PUMPS

A. Submersible, Fixed-Position, Sump Pumps:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

   a. Barnes; Crane Pumps & Systems.
   b. Bell & Gossett Domestic Pump; ITT Corporation.
   c. Flo Fab inc.
   d. Glentronics, Inc.
   e. Goulds Pumps; ITT Corporation.
   f. Grundfos Pumps Corp.
   g. Liberty Pumps.
   h. Little Giant Pump Co.
   i. McDonald, A. Y. Mfg. Co.
   j. Pentair Pump Group; Hydromatic Pumps.
   k. Pentair Pump Group; Myers.
   l. Stancor, Inc.
   m. Sta-Rite Industries, Inc.
   n. Weil Pump Company, Inc.
   o. Weinman Division; Crane Pumps & Systems.
   p. Zoeller Company.

2. Description: Factory-assembled and -tested sump-pump unit.
3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.
4. Pump Casing: Cast iron, with strainer inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
5. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
6. Seal: Mechanical.
7. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

8. Controls:

   a. Enclosure: NEMA 250, Type 4X.
   b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
   c. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
   d. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

9. Control-Interface Features:

   a. Remote Alarm Contacts: For remote alarm interface.
   b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

1) On-off status of pump.
2) Alarm status.

B. Pump Discharge Piping: Factory or field fabricated, galvanized, ASTM A 53/A 53M, Schedule 40, steel pipe with galvanized grooved couplings or galvanized threaded fittings.

2.02 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Motors for submersible pumps shall be hermetically sealed.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.02 INSTALLATION

A. Pump Installation Standards: Comply with HI 1.4 for installation of sump pumps.

3.03 CONNECTIONS

A. Comply with requirements for piping specified in Section 221413 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.04 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.

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

C. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Pumps and controls will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.05 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.06 ADJUSTING

A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.07 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

3.08 COMMISSIONING

A. The manufacturer’s representatives and installing contractors shall participate and cooperate with the Commissioning Authority with the pre-functional testing, pre-installation meetings, witnessing start-up and functional testing of all equipment and systems.

END OF SECTION

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUBMITTALS

A. Product Data: Provide catalog cut sheets of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

B. Closeout:

1. Manufacturer's Instructions: Indicate installation, maintenance, operation, cleaning methods, and replacement procedures.

2. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer. Warranty shall be minimum 1 year parts and labor.

1.2 QUALITY ASSURANCE

A. ANSI Standards: Comply with ANSI Standards pertaining to plumbing fixtures and systems.

B. ANSI Standards: Comply with ANSI A117.1 standard pertaining to plumbing fixtures for handicapped.

C. PDI Compliance: Comply with standards established by Plumbing and Drainage institute (PDI) pertaining to plumbing fixture supports.

D. Federal Standards: Comply with applicable Federal Standard FS WW-P-541/Series sections pertaining to plumbing fixtures.

PART 2 - PRODUCTS

2.1 PLUMBING FIXTURES

A. General: Provide factory-fabricated fixtures of the type, style and material indicated in the Plumbing Fixture Schedule. For each type of fixture, unless otherwise specified, provide fixture manufacturer's standard trim, carrier. Seats. and valves as indicated by their published product information, either as designed and constructed, or as recommended by the manufacturer, and as required for a complete installation.

2.2 MATERIALS

A. General: Unless otherwise specified, comply with applicable Federal Specification WW-P-541/series sections pertaining to plumbing fixtures, fittings, trim, metals and finishes. Comply with requirements of WW-P-541/specification relative to quality of ware, glazing, enamel, composition and finish of metals, air gaps and vacuum breakers, even though some plumbing fixtures specified in this section are not described in WW-P-541.

B. Provide materials that have been selected for their surface flatness and smoothness. Exposed surface which exhibit pitting, seam marks, roller marks, foundry sand holes, stains, discoloration or other surface imperfections on finished units are not acceptable.

C. Where fittings, trim and accessories are exposed or semi-exposed, provide bright chrome-plated or polished stainless steel units.

D. Unless noted otherwise, provide solid chrome-plated heavy cast brass (17 gauge) P-Trap with 2" minimum water seal and cast brass slip nut. Exposed P-Traps shall be fitted with cleanout plug.

E. Vitreous China: High quality, free from fire cracks, spots, blisters, pinholes and speck; glaze exposed surfaces and test for crazing resistance in accordance with ASTM C 554. Vitreous China Fixtures shall be white.

F. Comply with additional fixture requirements contained in the fixture schedule.

2.3 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Lavatory Supply Fittings:

1. Supply Piping Stub-out: Chrome-plated-brass pipe or chrome-plated-copper tube matching water-supply piping size. Include chrome-plated wall flange.

2. Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression stop with inlet connection matching water-supply piping type and size. Wheel handle operation.

D. Risers:

1. Size: NPS 3/8 for lavatories and kitchen sinks, NPS 1/2 for tank-type water closets.

2. Material: ASME A112.18.6, braided-stainless-steel flexible hose riser.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install plumbing fixtures of types indicated where shown and at indicated heights or where not shown in accordance with manufacturer's written instruction, roughing-in drawings and with recognized industry practices.

B. Fasten plumbing fixtures and water supplies securely to supports or building structure, and ensure that fixtures are level and plumb and tight against mounting surface.

C. Seal the outer perimeter of wall mounted lavatories and urinals and water closets to the wall and floor mounted water closets to the floor with a smooth bead of white silicone compound.

D. Provide supply fittings for lavatories, sinks, and water closets.

E. Install flush handle accessible water closets with handle mounted on wide side of compartment.

F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories and sinks.

3.2 FIELD QUALITY CONTROL

A. Upon completion of installation of plumbing fixtures and after units are water pressurized, test and adjust fixtures for proper operation.

3.3 ADJUSTING

A. Operate and adjust plumbing fixtures and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow.

3.4 CLEANING AND PROTECTION

A. After completing installation of plumbing fixtures, inspect and repair damaged finishes.

B. Clean plumbing fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed plumbing fixtures and fittings.

D. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224000

SECTION 230000 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 IMPOSED REGULATIONS:

A. Applicable provisions of the State and Local Codes and of the following codes and standards in addition to those listed elsewhere in the specifications are hereby imposed on a general basis for mechanical work: codes and standards listed on the mechanical drawings.

1.2 SCOPE OF WORK:

A. Provide all labor, materials, equipment and supervision to construct complete and operable mechanical systems as indicated on the drawings and specified herein. All materials and equipment used shall be new, undamaged and free from any defects.

1.3 RELATED DOCUMENTS AND OTHER INFORMATION:

A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the portions of work specified in each and every Section of this Division, individually and collectively.

B. It is recognized that separate sub-contracts may be instituted by THIS CONTRACT'S GENERAL CONTRACTOR with others. It is the responsibility of THIS CONTRACT'S GENERAL CONTRACTOR to completely inform, coordinate and advise those sub-contractors as to all of the requirements, conditions and information associated with providing and installing their portion of the total job.

1.4 EXISTING SERVICES AND FACILITIES:

A. Damage to Existing Services: Existing services and facilities damaged by the Contractor through negligence or through use of faulty materials or workmanship shall be promptly repaired, replaced, or otherwise restored to previous conditions by the Contractor without additional cost to the Owner.

B. Interruption of Services: Interruptions of services necessary for connection to or modification of existing systems or facilities shall occur only at prearranged times approved by the Owner. Interruptions shall only occur after the provision of all temporary work and the availability of adequate labor and materials will assure that the duration of the interruption will not exceed the time agreed upon.

C. Removed Materials: Existing materials made unnecessary by the new installation shall be stored on site. They shall remain the property of the Owner and shall be stored at a location and in a manner as directed by the Owner. If classified by the Owner's authorized representative as unsuitable for further use, the material shall become the property of the Contractor and shall be removed from the site at no additional cost to the owner.

1.5 PRODUCT WARRANTIES:

A. Provide manufacturer's standard printed commitment in reference to a specific product and normal application, stating that certain acts of restitution will be performed for the Purchaser or Owner by the manufacturer, when and if the product fails within certain operational conditions and time limits. Where the warranty requirements of a specific specification section exceeds the manufacturer's standard warranty, the more stringent requirements will apply and modified manufacturer's warranty shall be provided. In no case shall the manufacturer's warranty be less than one (1) year.

1.6 PRODUCT SUBSTITUTIONS:

A. General: Materials specified by manufacturer's name shall be used unless prior approval of an alternate is given by addenda. Requests for substitutions must be received in the office of the Architect at least 10 days prior to opening of bids. Refer to the general conditions for the substitution request form and required documentation.

PART 2 - PRODUCTS

2.1 GENERAL MECHANICAL PRODUCT REQUIREMENTS

A. Standard Products: Provide not less (quality) than manufacturer's standard products, as specified by their published product data. In addition to the indication that a particular product/model number is acceptable, comply with the specified requirements. Do not assume that the available off-the-shelf condition of a product complies with the requirements; as an example, a specific finish or color may be required.

B. Uniformity: Where multiple units of a general product are required for the mechanical work, provide identical products by the same manufacturer, without variations except for sizes and similar variations as indicated.

C. Product Compatibility, Options: Where more than one product selection is specified, either generically or proprietarily, selection is Purchaser's or Installer's option. Provide mechanical adaptations as needed for interfacing of selected products in the work.

D. Equipment Nameplates: Provide a permanent operational data nameplate on each item of power operated mechanical equipment, indicating the manufacturer, product name, model number, serial number, speed, capacity, power characteristics, labels of tested compliance, and similar essential operating data.

E. Locate nameplates in easy-to-read locations. When product is visually exposed in an occupied area of the building, locate nameplate in a concealed position (where possible) which is accessible for reading by service personnel.

PART 3 - EXECUTION

3.1 PRODUCT INSTALLATION, GENERAL:

A. Except where more stringent requirements are indicated, comply with the product manufacturer's installation instructions and recommendations, including handling, anchorage, assembly, connections, cleaning and testing, charging, lubrication, startup, test operation and shut-down of operating equipment. Consult with manufacturer's technical experts, for specific instructions on unique product conditions and unforeseen problems.

B. Protection and Identification: Deliver products to project properly identified with names, models numbers, types, grades, compliance labels and similar information needed for distinct identifications; adequately packaged or protected to prevent deterioration during shipment, storage and handling. Store in a dry, well ventilated, indoor space, except where prepared and protected by the manufacturer specifically for exterior storage.

C. Permits and Tests: Provide labor, material and equipment to perform all tests required by the governing agencies and submit a record of all tests to the Owner or his representative. Notify the Architect five days in advance of any testing.

END OF SECTION 230000

SECTION 230510 – MECHANICAL COORDINATION

PART 1 - GENERAL

1.1 QUALITY ASSURANCE

A. Mechanical Coordination Drawings: Prepare a set of coordination drawings showing the coordination of the major elements, components and systems of the mechanical work, and showing the coordination of mechanical work with other work. Prepare drawings at accurate scale and sufficiently large to show locations of every item, including clearances for installing, maintaining, insulating, breaking down equipment, replacing motors and similar requirements. Drawings shall indicate coordination with all other trades including, but not limited to, lighting, structural, plumbing and architectural items. Where applicable, existing conditions shall be accounted for. Prepare drawings to include plans, elevations, sections and details as needed to conclusively show successful coordination and integration of the work. Submit drawings for review by the Architect/Engineer.

PART 2 - PRODUCTS

2.1 MECHANICAL PRODUCT COORDINATION

A. Power Characteristics: Refer to the electrical sections of the specifications and the electrical drawings for the power characteristics available for the operation of each power driven item of mechanical equipment. The electrical design was based on the power requirements of the mechanical equipment manufacturer scheduled or specified as "basis of design." Any modifications to the electrical system that are required due to the use of an approved equivalent manufacturer shall be made at no additional cost to the owner. All changes must be clearly documented and submitted for review by the Architect/Engineer prior to purchasing equipment. Coordinate purchases to ensure uniform interface with electrical work. Refer to specification Div. 26 for additional coordination requirements.

B. Coordination of Options and Substitutions: When the contract documents permit the selection from several product options and it becomes necessary to authorize a substitution, do not proceed with purchase until coordination of interface to equipment has been checked and satisfactorily established.

PART 3 - EXECUTION

3.1 INSPECTION AND PREPARATION

A. Substrate Examination: The Installer of each element of the mechanical work must examine the condition of the substrate to receive the work, the conditions under which the work will be performed, and must notify the Contractor in writing of conditions detrimental to the proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

B. Do not proceed with the installation of sleeves, anchors, hangers, roof penetrations and similar work until mechanical coordination drawings have been processed and released for construction. Where work must be installed prior to that time in order to avoid a project delay, review proposed installation in a project coordination meeting including all parties involved with the interfacing of the work.

3.2 CUTTING AND PATCHING

A. Structural Limitations: Do not cut structural framing, walls, floors, decks and other members intended to withstand stress, except with the Architect's or Engineer's written authorization. Authorization will be granted only where there is not other reasonable method for completing the mechanical work, and where the proposed cutting clearly does not materially weaken the structure.

B. Where authorized, cut opening through concrete (for pipe penetrations and similar services) by core drilling or sawing. Do not cut by hammer-driven chisel or drill.

C. Other work: Do not endanger or damage other work through the procedures and processes of cutting to accommodate mechanical work. Review the proposed cutting with the Installer of the work to be cut, and comply with his recommendations to minimize damage. Where necessary, engage the original Installer or other specialists to execute the cutting in the recommended manner.

D. Where patching is required to restore other work, because of either cutting or other damage inflicted during the installation of mechanical work, execute the patching in the manner recommended by the original Installer. Restore the other work in every respect, including the elimination of visual defects in exposed finishes, as judged by the Architect. Engage the original Installer to complete patching of the following categories of work:
   1. Exposed concrete finishes.
   2. Exposed masonry.
   3. Waterproofing and vapor barriers.
   4. Roofing, flashing and accessories.
   5. Interior exposed finishes and casework, where judged by the Architect to be difficult to achieve an acceptable match by other means.

3.3 COORDINATION OF MECHANICAL INSTALLATION

A. General: Sequence, coordinate and integrate the various elements of mechanical work so that the mechanical plant will perform as indicated and be in harmony with the other work of the building. The Architect/Engineer will not supervise the coordination, which is the exclusive responsibility of the Contractor. Comply with the following requirements:

B. Install piping, ductwork and similar services straight and true, aligned with other work and with overhead structures and allowing for insulation. Conceal where possible.

C. Arrange work to facilitate maintenance and repair or replacement of equipment. Locate services requiring maintenance on valves and similar units in front of services requiring less maintenance. Connect equipment for ease of disconnecting, with minimum of interference with other work.

D. Give the right-of way to piping systems required to slope for drainage (over other service lines).

E. Piping shall be located to avoid interference with ductwork and light fixtures.

F. Drawings: Conform with the arrangement indicated by the contract documents to the greatest extent possible, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, comply with the Architect's decision on resolution of the conflict.

G. Electrical Work: Coordinate the mechanical work with electrical work, and properly interface with the electrical service. In general, and except as otherwise indicated, install mechanical equipment ready for electrical connection. Refer to the electrical sections of the specifications for electrical connection of mechanical equipment.

H. Utility Connections: Coordinate the connection of mechanical systems with exterior underground utilities and services. Comply with the requirements of governing regulations, franchised service companies and controlling agencies. Provide a single connection for each service except where multiple connections are indicated.

3.4 COORDINATION OF MECHANICAL START-UP

A. Seasonal Requirements: Adjust and coordinate the timing of mechanical system start-ups with seasonal variations, so that demonstration and testing of specified performance can be observed and recorded. Exercise proper care in off-season start-ups to ensure that systems and equipment will not be damaged by the operation.

B. Painting and Air Distribution: Coordinate the initial cleaning and start-up of the HVAC air distribution system, to occur prior to preparatory cleaning and general interior painting.

END OF SECTION 230510

SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Bimetallic-actuated thermometers.
2. Filled-system thermometers.
3. Liquid-in-glass thermometers.
4. Thermowells.
5. Dial-type pressure gages.
6. Gage attachments.
7. Test plugs.
8. Test-plug kits.
9. Ultrasonic, thermal-energy meters.

1.03 ACTION SUBMITTALS

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

B. Wiring Diagrams: For power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage, from manufacturer.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 PRODUCTS

2.01 BIMETALLIC-ACTUATED THERMOMETERS

A. Standard: ASME B40.200.

B. Case: Liquid-filled and sealed type(s); stainless steel with 5-inch nominal diameter.

C. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F.

D. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.

E. Connector Size: 1/2 inch, with ASME B1.1 screw threads.

F. Stem: 0.25 or 0.375 inch in diameter; stainless steel.

G. Window: Plain glass.

H. Ring: Stainless steel.

I. Element: Bimetal coil.

J. Pointer: Dark-colored metal.

K. Accuracy: Plus or minus 1 percent of scale range.

2.02 FILLED-SYSTEM THERMOMETERS

A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:

1. Standard: ASME B40.200.
2. Case: Sealed type, cast aluminum or drawn steel; 5-inch nominal diameter.
3. Element: Bourdon tube or other type of pressure element.
4. Movement: Mechanical, dampening type, with link to pressure element and connection to pointer.
5. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
6. Pointer: Dark-colored metal.
7. Window: Glass.
8. Ring: Metal.
9. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device; with ASME B1.1 screw threads.
10. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

11. Accuracy: Plus or minus 1 percent of scale range.

B. Remote-Mounted, Metal-Case, Vapor-Actuated Thermometers:

1. Standard: ASME B40.200.
2. Case: Sealed type, cast aluminum or drawn steel; 6-inch nominal diameter with back flange and holes for panel mounting.
3. Element: Bourdon tube or other type of pressure element.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
6. Pointer: Dark-colored metal.
7. Window: Glass.
8. Ring: Metal.

9. Connector Type(s): Union joint, back or bottom; with ASME B1.1 screw threads.
10. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.
11. Accuracy: Plus or minus 1 percent of scale range.

2.03 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:

1. Standard: ASME B40.200.
2. Case: Cast aluminum; 6-inch nominal size.
3. Case Form: Back angle or Straight unless otherwise indicated.
4. Tube: Glass with magnifying lens and blue or red organic liquid.
5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
6. Window: Glass.
7. Stem: Aluminum or brass and of length to suit installation.
    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.
8. Connector: 3/4 inch, with ASME B1.1 screw threads.
9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.04 DUCT-THERMOMETER MOUNTING BRACKETS

A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

2.05 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES or CSA.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.06 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Standard: ASME B40.100.
2. Case: Liquid-filled, Sealed, Open-front, pressure relief, or Solid-front, pressure relief type(s); cast aluminum or drawn steel; 6-inch nominal diameter.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Metal.
10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

B. Remote-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Standard: ASME B40.100.
2. Case: Liquid-filled or Sealed type; metal; 6-inch nominal diameter with back flange and holes for panel mounting.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Metal.
10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.07 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston or porous-metal-type surge-dampening device. Include extension for use on insulated piping.

B. Siphons: Loop-shaped section of brass, stainless-steel, steel pipe with NPS 1/4 or NPS 1/2 pipe threads.

C. Valves: Brass ball, Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.08 TEST PLUGS

A. Description: Test-station fitting made for insertion into piping tee fitting.

B. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

C. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.

D. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

E. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.09 TEST-PLUG KITS

A. Furnish one test-plug kit(s) containing two thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

B. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.

C. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.

D. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch diameter dial and probe. Dial range shall be at least 0 to 200 psig.

E. Carrying Case: Metal or plastic, with formed instrument padding.

2.10 THERMAL-ENERGY METERS

A. Ultrasonic, Thermal-Energy Meters:

1. Description: Meter with flow sensor, temperature sensors, transmitter, indicator, and connecting wiring.
2. Flow Sensor: Transit-time ultrasonic type with transmitter.
3. Temperature Sensors: Insertion-type or strap-on transducer.
4. Indicator: Solid-state, integrating-type meter with integral battery pack.

   a. Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units.
   b. Battery Pack: Five-year lithium battery.

5. Accuracy: Plus or minus 1 percent.
6. Display: Visually indicates total fluid volume in gallons and thermal-energy flow in kilowatts per hour or British thermal units.
7. Operating Instructions: Include complete instructions with each thermal-energy meter system.
8. Provide with BACnet connection to report to building automation system.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install thermowells with socket extending a minimum of 2 inches into fluid or a max to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

G. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.

H. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

I. Install remote-mounted pressure gages on panel.

J. Install valve and snubber in piping for each pressure gage for fluids (except steam).

K. Install valve and syphon fitting in piping for each pressure gage for steam.

L. Install test plugs in piping tees.

M. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.

N. Install flowmeter elements in accessible positions in piping systems.

O. Install permanent indicators on walls or brackets in accessible and readable positions.

P. Install connection fittings in accessible locations for attachment to portable indicators.

Q. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.

R. Install thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler.
3. Two inlets and two outlets of each chiller.
4. Inlet and outlet of each hydronic coil in air-handling units.
5. Outside-, return-, supply-, and mixed-air ducts.

S. Install pressure gages in the following locations:

1. Discharge of each pressure-reducing valve.
2. Inlet and outlet of each air handling unit coil, chiller chilled-water, and boiler connection.
3. Suction and discharge of each pump.

3.02 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

B. Connect flowmeter-system elements to meters.

C. Connect flowmeter transmitters to meters.

D. Connect thermal-energy meter transmitters to meters.

3.03 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gages to proper angle for best visibility.

3.04 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 0 to 100 deg F.

B. Scale Range for Heating, Hot-Water Piping: 30 to 240 deg F.

3.05 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 0 to 100 psi and 0 to 230 ft of water.

B. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi and 0 to 230 ft of water.

END OF SECTION

SECTION 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.
3. Iron, single-flange butterfly valves.
4. Iron, grooved-end butterfly valves.
5. Bronze lift check valves.
6. Bronze swing check valves.
7. Iron, plate-type check valves.

B. Related Sections:

1. Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.03 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

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

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

1.04 ACTION SUBMITTALS

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

1.05 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

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

B. Use the following precautions during storage:

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

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

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

A. Refer to HVAC valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Handwheel: For valves other than quarter-turn types.
2. Handlever: For quarter-turn valves NPS 6 and smaller.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
2. Butterfly Valves: With extended neck.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Grooved: With grooves according to AWWA C606.

3. Solder Joint: With sockets according to ASME B16.18.
4. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.02 BRASS BALL VALVES

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

1. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

2.03 BRONZE BALL VALVES

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

1. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

2.04 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

1. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 150 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.

g. Disc: Aluminum bronze.

B. 150 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Aluminum-Bronze Disc:

1. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 150 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: NBR.
f. Stem: One- or two-piece stainless steel.
g. Disc: Aluminum bronze.

C. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Ductile-Iron Disc:

1. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 150 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Nickel-plated or -coated ductile iron.

D. 150 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Ductile-Iron Disc:

1. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 150 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: NBR.
f. Stem: One- or two-piece stainless steel.
g. Disc: Nickel-plated or -coated ductile iron.

E. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:

1. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 150 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Stainless steel.

F. 150 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Stainless-Steel Disc:

1. Description:

   a. Standard: MSS SP-67, Type I.
   b. CWP Rating: 150 psig.
   c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
   d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
   e. Seat: NBR.
   f. Stem: One- or two-piece stainless steel.
   g. Disc: Stainless steel.

2.05 IRON, GROOVED-END BUTTERFLY VALVES

A. 175 CWP, Iron, Grooved-End Butterfly Valves:

1. Description:

   a. Standard: MSS SP-67, Type I.
   b. CWP Rating: 175 psig.
   c. Body Material: Coated, ductile iron.
   d. Stem: Two-piece stainless steel.
   e. Disc: Coated, ductile iron.
   f. Seal: EPDM.

2.06 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Bronze Disc:

1. Description:

   a. Standard: MSS SP-80, Type 1.
   b. CWP Rating: 200 psig.
   c. Body Design: Vertical flow.
   d. Body Material: ASTM B 61 or ASTM B 62, bronze.
   e. Ends: Threaded.
   f. Disc: Bronze.

2.07 BRONZE SWING CHECK VALVES

A. Class 150, Bronze Swing Check Valves with Bronze Disc:

1. Description:

   a. Standard: MSS SP-80, Type 3.
   b. CWP Rating: 300 psig.
   c. Body Design: Horizontal flow.
   d. Body Material: ASTM B 62, bronze.
   e. Ends: Threaded.
   f. Disc: Bronze.

2.08 IRON, PLATE-TYPE CHECK VALVES

A. Class 150, Iron, Dual-Plate Check Valves with Metal Seat:

1. Description:

a. Standard: API 594.
b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
c. NPS 14 to NPS 24, CWP Rating: 250 psig.
d. Body Design: Wafer, spring-loaded plates.
e. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
f. Seat: Bronze.

B. Class 150, Iron, Dual-Plate Check Valves with Resilient Seat:

1. Description:

a. Standard: API 594.
b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
c. NPS 14 to NPS 24, CWP Rating: 250 psig.
d. Body Design: Wafer, spring-loaded plates.
e. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
f. Seat: EPDM or NBR.

PART 3 EXECUTION

3.01 EXAMINATION

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

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

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

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

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

3.02 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

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

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

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

E. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

3.03 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

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

1. Shutoff Service: Ball or butterfly valves.
2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
3. Throttling Service: Calibrated balancing or triple duty valves.
4. Pump-Discharge Check Valves:

   a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
   b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal or resilient-seat check valves.

B. If valves with specified CWP ratings are not available, the same types of valves with higher CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.
7. For Grooved-End Copper Tubing and Steel Piping: Valve ends may be grooved.

3.05 VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two-piece, full port, brass or bronze with brass, bronze, stainless-steel trim.
3. Bronze Swing Check Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM or NBR seat, aluminum-bronze, ductile-iron, or stainless-steel disc.
2. Iron, Grooved-End Butterfly Valves: 175 CWP.
3. Iron, Plate-Type Check Valves: Class 150; single or dual plate; metal resilient seat.

END OF SECTION

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

B. Related Sections:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 230516 "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
3. **Section 230548 "Vibration and Seismic Controls for HVAC"** for vibration isolation devices.
4. Section 233113 "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 ACTION SUBMITTALS

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

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Pipe stands.
4. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
2. Standard: MFMA-4.
3. Channels: Continuous slotted steel channel with inturned lips.
4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
6. Metallic Coating: Hot-dipped galvanized, Mill galvanized, or In-line, hot galvanized.

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
2. Standard: Comply with MFMA-4.
3. Channels: Continuous slotted steel channel with inturned lips.
4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
6. Coating: Zinc or Paint.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength.

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

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

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

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece base unit with plastic roller, for roof installation without membrane penetration.

D. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.8 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

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

E. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

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

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

I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

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

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

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

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

N. Insulated Piping:

1. Attach clamps and spacers to piping.

   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
   e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

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

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.

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

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

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

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
3. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
4. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.

5. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
6. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
7. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
8. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
9. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
10. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

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

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.

7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

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

O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 230548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Housed-spring isolators.
6. Restrained-spring isolators.
7. Housed-restrained-spring isolators.
8. Pipe-riser resilient supports.
9. Resilient pipe guides.
10. Elastomeric hangers.
11. Spring hangers.
12. Snubbers.
13. Restraint channel bracings.
14. Restraint cables.
15. Seismic-restraint accessories.
16. Mechanical anchor bolts.
17. Adhesive anchor bolts.
18. Vibration isolation equipment bases.

1.3 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning & Development (for the State of California).

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component required.

a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES, OSHPD, or an agency acceptable to authorities having jurisdiction.
b. Annotate to indicate application of each product submitted and compliance with requirements.

3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.

1. Include design calculations and details for selecting vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Design Calculations: Calculate static and dynamic loading due to equipment weight, operation, and seismic and wind forces required to select vibration isolators and seismic and wind restraints and for designing vibration isolation bases.

a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.

3. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system was examined for excessive stress and that none exists.
4. Seismic- and Wind-Restraint Details:

a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
d. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES, OSHPD, or an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Qualification Data: For professional engineer and testing agency.

C. Welding certificates.

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are unavailable, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. Unless specifically noted otherwise below, subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Ace Mountings Co., Inc.
    b. California Dynamics Corporation.
    c. Isolation Technology, Inc.
    d. Kinetics Noise Control, Inc.
    e. Mason Industries, Inc.
    f. Vibration Eliminator Co., Inc.
    g. Vibration Isolation.
    h. Vibration Mountings & Controls, Inc.
    i. Or Equal.

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads.

1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
2. Size: Factory or field cut to match requirements of supported equipment.
3. Pad Material: Oil and water resistant with elastomeric properties.
4. Surface Pattern: Smooth, Ribbed, or Waffle pattern.
5. Infused nonwoven cotton or synthetic fibers.
6. Load-bearing metal plates adhered to pads.
7. Sandwich-Core Material: Resilient and elastomeric.

    a. Surface Pattern: Smooth, Ribbed, or Waffle pattern.
    b. Infused nonwoven cotton or synthetic fibers.

2.3 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts.

1. Mounting Plates:

    a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
    b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

2. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

1. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

    a. Housing: Cast-ductile iron or welded steel.
    b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.5 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

5. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.6 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.

   a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
   b. Top housing with attachment and leveling bolt, threaded mounting holes and internal leveling device, or elastomeric pad.

2.7 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint: .

1. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.

   a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
   b. Top plate with elastomeric pad.
   c. Internal leveling bolt that acts as blocking during installation.

2. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.8 HOUSED-RESTRAINED-SPRING ISOLATORS

A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing.

1. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.

a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.9 PIPE-RISER RESILIENT SUPPORT

A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch- thick neoprene.

1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
2. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.10 RESILIENT PIPE GUIDES

A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch- thick neoprene.

1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.11 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods.

1. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
2. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.12 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
8. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.13 SNUBBERS

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

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
3. Maximum 1/4-inch air gap, and minimum 1/4-inch- thick resilient cushion.

2.14 RESTRAINT CHANNEL BRACINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper B-Line, Inc.
2. Hilti, Inc.
3. Mason Industries, Inc.
4. Unistrut.
5. Or Equal.

B. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.15 RESTRAINT CABLES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Kinetics Noise Control, Inc.
2. Loos & Co., Inc.
3. Vibration Mountings & Controls, Inc.
4. Or Equal.

B. Restraint Cables: ASTM A 492 stainless-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.16 SEISMIC-RESTRAINT ACCESSORIES

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

1. Cooper B-Line, Inc.
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.
4. TOLCO.

B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or Reinforcing steel angle clamped to hanger rod.

C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.17 MECHANICAL ANCHOR BOLTS

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

1. Cooper B-Line, Inc.
2. Hilti, Inc.
3. Kinetics Noise Control, Inc.
4. Mason Industries, Inc.

B. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.18 ADHESIVE ANCHOR BOLTS

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

1. Hilti, Inc.
2. Kinetics Noise Control, Inc.

3. Mason Industries, Inc.
4. Or Equal.

B. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.19 VIBRATION ISOLATION EQUIPMENT BASES

A. Steel Rails: Factory-fabricated, welded, structural-steel rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.

   a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Rails shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

B. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

   a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES, OSHPD, or an agency acceptable to authorities having jurisdiction.

B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete.", Section 033053 "Miscellaneous Cast-in-Place Concrete."

B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

C. Equipment Restraints:

1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
3. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES, OSHPD, or an agency acceptable to authorities having jurisdiction that provides required submittals for component.

D. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
3. Brace a change of direction longer than 12 feet.

E. Install cables so they do not bend across edges of adjacent equipment or building structure.

F. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES, OSHPD, or an agency acceptable to authorities having jurisdiction that provides required submittals for component.

G. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

H. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

I. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

J. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 232113 "Hydronic Piping" for piping flexible connections.

3.5 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.

C. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.7 VIBRATION ISOLATION EQUIPMENT BASES INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 030000 " Concrete."

END OF SECTION 230548

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Valve tags.
5. VAV access point label.

1.03 ACTION SUBMITTALS

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

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

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

D. Valve numbering scheme.

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

F. Valve Tag Sheet: For each VAV isolation valve with valve numbers indicated on red-line drawings.

1.04 COORDINATION

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

B. Coordinate installation of identifying devices with locations of access panels and doors.

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

PART 2 PRODUCTS

2.01 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick and having predrilled holes for attachment hardware.
2. Letter Color: White
3. Background Color: Black
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.

B. Label Content: Include equipment's Drawing designation or unique equipment number, drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.02 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

C. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

D. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

E. Fasteners: Stainless-steel rivets or self-tapping screws.

F. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

G. Label Content: Include caution and warning information, plus emergency notification instructions.

2.03 PIPE LABELS

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

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

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

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

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

2.04 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch or Stainless steel, 0.025-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link or beaded chain.

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

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

2.05 VAV ACCESS POINT LABEL

A. Access Point Label: Color coded/round dot labels at each vav access point (Indicating location of VAVs, isolation valves, fire dampers, sensors, and other components necessary for maintenance).

1. Tag Material: Vinyl or plastic, color coded, with black (or other contrasting color) text.
2. Size: Label shall be no smaller than ½”. Font type shall be plan, font size shall be large enough to be legible from 5’0’’ A.F.F.

PART 3 EXECUTION

3.01 PREPARATION

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

3.02 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.03 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 25 feet along each run. Reduce intervals to 10 feet in areas of congested piping and equipment.
7.

B. Pipe Label Color Schedule:
1. Comply with ANSI / ASME A13.1.

3.04 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

3.05 VAV ACCESS POINT LABEL

A. Install label on ceiling grid, ceiling tile, or access panel door showing corresponding VAV tag.

B. Labels shall be placed on grid so that the tile “above” the text label is the best ceiling tile to remove for access to the equipment marked by the label. Labels placed on ceiling tile shall be centered on the tile.

C. Label shall be oriented so they can be read from the most likely access point. In the case of a corridor, all labels shall be placed with uniform orientation, allowing maintenance to read all labels in a single path down the hall. For access panels, label shall be placed below the access panel

END OF SECTION

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

    a. Constant-volume air systems (exhaust fan).
    b. Variable-air-volume systems (air handling units, existing and new).

2. Balancing Hydronic Piping Systems:

    a. Variable-flow hydronic systems (chilled and hot water).
    b. Primary-secondary hydronic systems (chilled and hot water).

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. Certified TAB reports.

E. Sample report forms.

F. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.5 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB, or TABB.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB, or TABB.
2. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB, or TABB as a TAB technician.

B. TAB Conference: Meet with Owner on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items:

a. The Contract Documents examination report.
b. The TAB plan.
c. Coordination and cooperation of trades and subcontractors.
d. Coordination of documentation and communication flow.

C. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard TAB contractor's forms approved by Owner.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

G. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

2.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Section 233113 "Metal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine existing terminal control dampers and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

2.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

2.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", ASHRAE 111, NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing", and in this Section.

1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," and Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

2.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

D. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air-handling-unit components.

K. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

2.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.
2. Measure fan static pressures as follows to determine actual static pressure:

a. For AHU fans, measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
b. For exhaust fan, measure static pressure directly at the fan outlet.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

a. Report the cleanliness status of filters and the time static pressures are measured.

4. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
5. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, and any other operating mode to determine the maximum required brake horsepower.

2.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outdoor-air dampers at minimum, and set return--air dampers at a position that simulates full-cooling load.
2. Adjust system static pressure so the entering static pressure for the critical terminal control damper matches the existing static pressure. Measure total system airflow. Adjust to within indicated airflow.
3.

4. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

5. Measure static pressure at the most critical terminal control damper and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical control damper.
6. Record final fan-performance data.

2.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check liquid level in expansion tank.
3. Check makeup water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure.
6. Set system controls so automatic valves are wide open to hydronic coils.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

2.8 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through hydronic coils and proceed as specified below for hydronic systems.

B. Measure water flow at pumps. Use the following procedures:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

   a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from Owner and comply with requirements in Section 232123 "Hydronic Pumps."

2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.

   a. Monitor motor performance during procedures and do not operate motors in overload conditions.

3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 10 percent of design.

C. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

D. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.

E. Set calibrated balancing valves, if installed, at calculated presettings.

F. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

G. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

H. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
3. Record settings and mark balancing devices.

I. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

J. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.

K. Check settings and operation of each safety valve. Record settings.

2.9 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first and then balance the secondary circuits.

2.10 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

2.11 PROCEDURES FOR BOILERS

A. Hydronic Boilers: Measure and record entering- and leaving-water temperatures and water flow.

2.12 PROCEDURES FOR HYDRONIC COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.

3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

2.13 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing air handling units prior to demolition.

1. Measure and record the operating speed, airflow, and static pressure of each fan.
2. Measure and record the entering and leaving air temperatures, entering and leaving chilled water temperatures, and water flow rate.
3. Select the terminal control damper that is most critical to the supply-fan airflow and static pressure. Measure static pressure.
4. Measure motor voltage and amperage. Compare the values to motor nameplate information.
5. Check the condition of filters.
6. Check the condition of coils.
7. Check the operation of the drain pan and condensate-drain trap.
8. Check bearings and other lubricated parts for proper lubrication.
9. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

2.14 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Heating-Water Flow Rate: Plus or minus 10 percent.
4. Cooling-Water Flow Rate: Plus or minus 10 percent.

2.15 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare biweekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

2.16 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches, and bore.
i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

a. Total air flow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Filter static-pressure differential in inches wg.
f. Separate Preheat-coil static-pressure differential in inches wg.
g. Cooling-coil static-pressure differential in inches wg.
h. Heating-coil static-pressure differential in inches wg.
i. Outdoor airflow in cfm.
j. Return airflow in cfm.
k. Outdoor-air damper position.
l. Return-air damper position.
m. Vortex damper position.

F. Hydronic-Coil Test Reports:

1. Coil Data:

a. System identification.

b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch o.c.
f. Make and model number.
g. Face area in sq. ft..
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
e. Return-air, wet- and dry-bulb temperatures in deg F.
f. Entering-air, wet- and dry-bulb temperatures in deg F.
g. Leaving-air, wet- and dry-bulb temperatures in deg F.
h. Water flow rate in gpm.
i. Water pressure differential in feet of head or psig.
j. Entering-water temperature in deg F.
k. Leaving-water temperature in deg F.

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

H. Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft..
g. Indicated air flow rate in cfm.
h. Indicated velocity in fpm.
i. Actual air flow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

I. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm.
g. Water pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump rpm.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):

a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

J. Instrument Calibration Reports:

1. Report Data:

    a. Instrument type and make.
    b. Serial number.
    c. Application.
    d. Dates of use.
    e. Dates of calibration.

2.17 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:

    a. Measure airflow of at least 10 percent of air outlets.
    b. Measure water flow of at least 5 percent of terminals.
    c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
    d. Verify that balancing devices are marked with final balance position.
    e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect / Engineer / Owner.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Architect / Engineer / Owner.
3. Architect / Engineer / Owner shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

2.18 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulating the following duct services:

1. Indoor, concealed supply, return, and outdoor air.
2. Indoor, exposed supply, return, and outdoor air.

B. Related Sections:

1. Section 233113 "Metal Ducts".

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

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

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

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

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 COORDINATION

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

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

1.8 SCHEDULING

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

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. CertainTeed Corp.; SoftTouch Duct Wrap.
    b. Johns Manville; Microlite.
    c. Knauf Insulation; Friendly Feel Duct Wrap.
    d. Manson Insulation Inc.; Alley Wrap.
    e. Owens Corning; SOFTR All-Service Duct Wrap.
    f. Or Equal.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.Eagle Bridges - Marathon Industries; 225.
    b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.Mon-Eco Industries, Inc.; 22-25.
    c. Or Equal.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
    b. Eagle Bridges - Marathon Industries; 225.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.Mon-Eco Industries, Inc.; 22-25.
    d. Or Equal.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
   b. Vimasco Corporation; 749.
   c. Or Equal.

2. Water-Vapor Permeance: ASTM E 96 , Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
   b. Eagle Bridges - Marathon Industries; 550.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
   d. Mon-Eco Industries, Inc.; 55-50.
   e. Vimasco Corporation; WC-1/WC-5.
   f. Or Equal.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.4 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.Eagle Bridges - Marathon Industries; 405.
   b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
   c. Mon-Eco Industries, Inc.; 44-05.
   d. Or Equal.

2. Materials shall be compatible with insulation materials, jackets, and substrates.

3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.6 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

2.7 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. ABI, Ideal Tape Division; 491 AWF FSK.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
c. Compac Corporation; 110 and 111.
d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
e. Or Equal.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.8 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. ITW Insulation Systems; Gerrard Strapping and Seals.

b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
c. Or Equal.

2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) AGM Industries, Inc.; CWP-1.
2) GEMCO; CD.
3) Midwest Fasteners, Inc.; CD.
4) Nelson Stud Welding; TPA, TPC, and TPS.
5) Or Equal.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) AGM Industries, Inc.; CHP-1.
2) GEMCO; Cupped Head Weld Pin.
3) Midwest Fasteners, Inc.; Cupped Head.
4) Nelson Stud Welding; CHP.
5) Or Equal.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
2) GEMCO; Perforated Base.
3) Midwest Fasteners, Inc.; Spindle.
4) Or Equal.

b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
c. Spindle: Aluminum, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.

d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation securely in position indicated when self-locking washer is in place. Comply with the following requirements:

   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

      1) GEMCO; Nylon Hangers.
      2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
      3) Or Equal.

   b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
   c. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, aluminum sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

      1) AGM Industries, Inc.; RC-150.
      2) GEMCO; R-150.
      3) Midwest Fasteners, Inc.; WA-150.
      4) Nelson Stud Welding; Speed Clips.
      5) Or Equal.

   b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

6. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

   a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

      1) GEMCO.
      2) Midwest Fasteners, Inc.
      3) Or Equal.

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

D. Wire: 0.062-inch soft-annealed, galvanized steel.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. C & F Wire.
    b. Or Equal.

PART 3 - EXECUTION

3.1 EXAMINATION

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

    1. Verify that systems to be insulated have been tested and are free of defects.
    2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

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

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces, free of voids throughout the length of ducts and fittings.

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

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

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

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

F. Keep insulation materials dry during application and finishing.

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

H. Install insulation with the least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

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

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

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

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

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

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

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

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

3.5 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from the top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1-inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 FINISHES

A. Do not field paint aluminum or stainless-steel jackets.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

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

3.8 DUCT INSULATION SCHEDULE, GENERAL

A. Ducts Requiring Insulation:

1. All supply, return, and outdoor air.
2. Exhaust between isolation damper and penetration of building exterior.

B. Items Not Insulated:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.
8. Environmental air exhaust where energy recovery wheel is not present.

3.9 INDOOR DUCT INSULATION SCHEDULE

A. Concealed supply, return, and outdoor-air duct and plenum insulation shall be the following:

1. Mineral-Fiber Blanket: 2.2 inches thick and 0.75-lb/cu. ft. nominal density.

B. Exposed supply, return, and outdoor-air duct where indicated on the drawings or Metal Duct Specification to have single wall duct, insulation shall be the following:

1. Mineral-Fiber Blanket: 2.2 inches thick and 0.75-lb/cu. ft. nominal density. Surface of insulation shall be prepared for painting to match adjacent surfaces, coordinate with architectural plans.

END OF SECTION 230713

SECTION 230719 - HVAC PIPING INSULATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes insulating the following HVAC piping systems:

1. Condensate drain piping, indoors and outdoors.
2. Chilled-water piping, indoors and outdoors.
3. Heating hot-water piping, indoors and outdoors.

B. Related Sections:

1. Section 230713 "Duct Insulation."
2. Section 230716 "HVAC Equipment Insulation."
3. Section 230533 “Heat Tracing for HVAC Piping.”

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

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

C. Field quality-control reports.

1.05 QUALITY ASSURANCE

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

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.06 DELIVERY, STORAGE, AND HANDLING

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

1.07 COORDINATION

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

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

C. Coordinate installation and testing of heat tracing.

1.08 SCHEDULING

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

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 PRODUCTS

2.01 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," and "Outdoor, Aboveground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Minimum thermal performance: 0.21 Btu-in/hr-ft2-F at mean rating temperature of 75 deg F.
2. Block Insulation: ASTM C 552, Type I.
3. Special-Shaped Insulation: ASTM C 552, Type III.
4. Board Insulation: ASTM C 552, Type IV.
5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
6. Preformed Pipe Insulation with Factory-Applied ASJ, ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

H. Mineral-Fiber, Preformed Pipe Insulation:

1. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2. Minimum thermal performance: 0.23 Btu-in/hr-ft2-F at mean rating temperature of 75 deg F.

I. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

J. Phenolic:
1. Minimum thermal performance: 0.21 Btu-in/hr-ft2-F at mean rating temperature of 75 deg F.
2. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
3. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
5. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.

a. Preformed Pipe Insulation: ASJ.

2.02 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

1. For all interior (inside the weatherproofing of the building) adhesives applied on site, provide manufacturer documentation that the product meets the VOC content limits SCAQMD Rule 1168.
2. Provide documentation the product has been tested according to CDPH Standard Method v1.2 and complies with the VOC limits per Section 016116 VOLATILE ORGANIC COMPOUND (VOC) CONTENT RESTRICTIONS.

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

1. For all interior (inside the weatherproofing of the building) adhesives applied on site, provide manufacturer documentation that the product meets the VOC content limits SCAQMD Rule 1168.
2. Provide documentation the product has been tested according to CDPH Standard Method v1.2 and complies with the VOC limits per Section 016116 VOLATILE ORGANIC COMPOUND (VOC) CONTENT RESTRICTIONS.

D. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. For all interior (inside the weatherproofing of the building) adhesives applied on site, provide manufacturer documentation that the product meets the VOC content limits SCAQMD Rule 1168.
2. Provide documentation the product has been tested according to CDPH Standard Method v1.2 and complies with the VOC limits per Section 016116 VOLATILE ORGANIC COMPOUND (VOC) CONTENT RESTRICTIONS.

E. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. For all interior (inside the weatherproofing of the building) adhesives applied on site, provide manufacturer documentation that the product meets the VOC content limits SCAQMD Rule 1168.
2. Provide documentation the product has been tested according to CDPH Standard Method v1.2 and complies with the VOC limits per Section 016116 VOLATILE ORGANIC COMPOUND (VOC) CONTENT RESTRICTIONS.

F. ASJ Adhesive, and FSK Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. For all interior (inside the weatherproofing of the building) adhesives applied on site, provide manufacturer documentation that the product meets the VOC content limits SCAQMD Rule 1168.

2. Provide documentation the product has been tested according to CDPH Standard Method v1.2 and complies with the VOC limits per Section 016116 VOLATILE ORGANIC COMPOUND (VOC) CONTENT RESTRICTIONS.

G. PVC Jacket Adhesive: Compatible with PVC jacket.

1. For all interior (inside the weatherproofing of the building) adhesives applied on site, provide manufacturer documentation that the product meets the VOC content limits SCAQMD Rule 1168.
2. Provide documentation the product has been tested according to CDPH Standard Method v1.2 and complies with the VOC limits per Section 016116 VOLATILE ORGANIC COMPOUND (VOC) CONTENT RESTRICTIONS.

2.03 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For all interior (inside the weatherproofing of the building) mastics applied on site, provide manufacturer documentation that the product meets the VOC content limits SCAQMD Rule 1168 and the emissions testing requirements per Section 016116 VOLATILE ORGANIC COMPOUND (VOC) CONTENT RESTRICTIONS.

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
2. Service Temperature Range: 0 to 180 deg F.
3. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
4. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
2. Service Temperature Range: Minus 50 to plus 220 deg F.
3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
4. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: 60 percent by volume and 66 percent by weight.
4. Color: White.

2.04 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For all interior (inside the weatherproofing of the building) lagging adhesives applied on site, provide manufacturer documentation that the product meets the VOC content limits SCAQMD Rule 1168.
2. Provide documentation the product has been tested according to CDPH Standard Method v1.2 and complies with the VOC limits per Section 016116 VOLATILE ORGANIC COMPOUND (VOC) CONTENT RESTRICTIONS.
3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
4. Service Temperature Range: 0 to plus 180 deg F.
5. Color: White.

2.05 SEALANTS

A. Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F.
4. Color: White or gray.
5. For all interior (inside the weatherproofing of the building) sealants applied on site, provide manufacturer documentation that the product meets the VOC content limits SCAQMD Rule 1168.
6. Provide documentation the product has been tested according to CDPH Standard Method v1.2 and complies with the VOC limits per Section 016116 VOLATILE ORGANIC COMPOUND (VOC) CONTENT RESTRICTIONS.

B. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.
5. For all interior (inside the weatherproofing of the building) sealants applied on site, provide manufacturer documentation that the product meets the VOC content limits SCAQMD Rule 1168.
6. Provide documentation the product has been tested according to CDPH Standard Method v1.2 and complies with the VOC limits per Section 016116 VOLATILE ORGANIC COMPOUND (VOC) CONTENT RESTRICTIONS.

C. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.
5. For all interior (inside the weatherproofing of the building) sealants applied on site, provide manufacturer documentation that the product meets the VOC content limits SCAQMD Rule 1168.

6. Provide documentation the product has been tested according to CDPH Standard Method v1.2 and complies with the VOC limits per Section 016116 VOLATILE ORGANIC COMPOUND (VOC) CONTENT RESTRICTIONS.

2.06 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.07 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.
2. Color: White.
3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

C. Metal Jacket:

1. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

a. Sheet and roll stock ready for shop or field sizing.
b. Finish and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper
d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
e. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.

8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.08 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Width: 3 inches.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 2 inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

2.09 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

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

PART 3 EXECUTION

3.01 EXAMINATION

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

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

3.02 PREPARATION

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

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

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

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

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

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

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

G. Keep insulation materials dry during application and finishing.

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

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

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

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

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

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

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

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

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

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.04 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.05 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt

each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.06 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.07 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.08 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.09 INSTALLATION OF PHENOLIC INSULATION

A. General Installation Requirements:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.

B. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets with vapor retarders on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

C. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

E. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation to flanges as specified for flange insulation application.

3.10 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.11 FINISHES

A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

   a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.12 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of

flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

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

3.13 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.14 PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water:

1. All Pipe Sizes: Insulation shall be one of the following:
   a. Flexible Elastomeric: 1 inch thick.

B. Chilled Water:

1. All pipe sizes: Insulation shall be one of the following:

   a. Cellular Glass: 2 inches thick.

   b. Flexible Elastomeric: 2 inches thick.

C. Indoor Heating-Hot-Water Supply and Return:

1. NPS 1-1/4 and Smaller: Insulation shall be one of the following:
   a. Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inches thick.

2. NPS 1-1/2 and Larger: Insulation shall be one of the following:
   a. Mineral-Fiber, Preformed Pipe, Type I or Pipe and Tank Insulation: 2 inches thick.

D. Outdoor Heating-Hot-Water Supply and Return:

   a. Cellular Glass: 1-1/2 inches thick.

   b. Flexible Elastomeric: 1-1/2 inches thick.

3.15 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Exposed:
1. PVC: 20 mils thick.
2. Aluminum, Embossed : 0.016 inch thick.

3.16 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Exposed:
1. Aluminum, Embossed : 0.016 inch thick.

END OF SECTION

SECTION 230800 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.

B. Related Sections:

Section 019113 "General Commissioning Requirements" for general commissioning process requirements.

1.3 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.

D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 INFORMATIONAL SUBMITTALS

A. Certificates of readiness.

B. Pre-Functional Test Checklists and equipment start up reports.

1.5 CONTRACTOR'S RESPONSIBILITIES

A. Perform commissioning tests at the direction of the CxA.

B. Attend construction phase commissioning kick-off meeting.

C. Attend construction phase controls coordination meetings.

D. Attend testing, adjusting, and balancing review and coordination meetings.

E. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

F. Provide information requested by the CxA for final commissioning documentation.

G. Provide measuring instruments and logging devices, calibrated within one year of date of test unless specifications or industry standards require more stringent calibration periods, to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.6 CxA'S RESPONSIBILITIES

A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.

B. Direct commissioning testing.

C. Verify testing, adjusting, and balancing of Work are complete.

D. Organize Contractor provided test data, inspection reports, and certificates in Systems Manual.

1.7 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:
1. Plan for delivery and review of submittals, operation and maintenance manuals, and other documents and reports.
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
5. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.
6. Test and inspection reports and certificates.
7. Corrective action documents.
8. Verification of testing, adjusting, and balancing reports.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Provide a fully executed Certificate of Readiness signed by Contractor, Subcontractors, TAB Agent and BAS provider certifying that HVAC&R Systems, instrumentation and control systems have been completed and calibrated, pre-tested and inspected and that they are operating according to the Contract Documents, and that pretest set points have been recorded. Provide completed Certificate of Readiness to CxA no less than 7 days prior to the scheduled beginning of on-site CxA verification testing.

B. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

C. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

D. Inspect and verify the position of each device and interlock identified on checklists.

E. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

F. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 TESTING, ADJUSTING AND BALANCING VERIFICATION

A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Notify the CxA at least 30 days in advance of testing and balancing Work and provide access for the CxA to witness testing and balancing Work.

C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.

D. The CxA will notify testing, adjusting and balancing Subcontractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.

1. The testing and balancing Subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
2. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting,

and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.

3. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space.

C. Cx Testing of systems and equipment shall include measuring capacities and effectiveness of operational and control functions in addition to or in conjunction with any statutory and regulatory testing required by Authorities Having Jurisdiction over the project and testing required in other Sections of this Project Manual.

D. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

E. The CxA along with the HVAC&R Subcontractor, testing and balancing Subcontractor, and HVAC&R Instrumentation and Control Subcontractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.

F. Tests will be performed using design conditions whenever possible.

G. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

H. The CxA may direct that set points be altered when simulating conditions is not practical.

I. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

J. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

K. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Section 230900 "Instrumentation And Control For HVAC." Assist the CxA with preparation of testing plans.

B. Refrigerant System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

C. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of special exhaust; and other distribution systems, including HVAC&R terminal equipment, dedicated outdoor air delivery and heat recovery equipment and unitary equipment.

D. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.

END OF SECTION 230800

SECTION 232113 - HYDRONIC PIPING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes pipe and fitting materials and joining methods for the following:

1. Hot-water heating piping.
2. Chilled-water piping.
3. Makeup-water piping.
4. Condensate-drain piping.
5. Blowdown-drain piping.
6. Air-vent piping.
7. Safety-valve-inlet and -outlet piping.

1.03 ACTION SUBMITTALS

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

1. Plastic pipe and fittings with solvent cement.
2. RTRP and RTRF with adhesive.
3. Pressure-seal fittings.
4. Chemical treatment.

B. Delegated-Design Submittal:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors and alignment guides and expansion joints and loops.
3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
4. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Other building services.

3. Structural members.

B. Qualification Data: For Installer.

C. Welding certificates.

D. Field quality-control reports.

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

1.05 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers shall be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
2. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP shall be certified by manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.

B. Material shall be certified by NSF International as complying with NSF 14, and ASTM F 2389 or CSA B137.11.

C. Material shall comply with manufacturer’s specifications.

D. Special Engineered products shall be certified by NSF International as complying with NSF 14.

E. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

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

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

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the pressure of the piping system to which it is attached.

2.02 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.

C. DWV Copper Tubing: ASTM B 306, Type DWV.

D. Copper or Bronze Pressure-Seal Fittings:

1. Housing: Copper.
2. O-Rings and Pipe Stops: EPDM.
3. Tools: Manufacturer's special tools.
4. Minimum 200-psig working-pressure rating at 250 deg F.

E. Wrought-Copper Unions: ASME B16.22.

2.03 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

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

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

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

2.04 JOINING MATERIALS

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

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.

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

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

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

E. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

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

2.05 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings:

1. One-piece fitting with one threaded brass or copper insert and one solvent-cement-joint end of material and wall thickness to match plastic pipe material.

B. Plastic-to-Metal Transition Unions:

1. Brass or copper end, solvent-cement-joint end of material and wall thickness to match plastic pipe material, rubber gasket, and threaded union.

2.06 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Description:

a. Standard: ASSE 1079.
b. Pressure Rating: 125 psig minimum at 180 deg F.
c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Description:

a. Standard: ASSE 1079.
b. Factory-fabricated, bolted, companion-flange assembly.
c. Pressure Rating: 125 psig minimum at 180 deg F
d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Description:

a. Nonconducting materials for field assembly of companion flanges.
b. Pressure Rating: 150 psig.
c. Gasket: Neoprene or phenolic.
d. Bolt Sleeves: Phenolic or polyethylene.
e. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Description:

a. Standard: IAPMO PS 66.
b. Electroplated steel nipple, complying with ASTM F 1545.
c. Pressure Rating: 300 psig at 225 deg F.
d. End Connections: Male threaded or grooved.
e. Lining: Inert and noncorrosive, propylene.

2.07 BYPASS CHEMICAL FEEDER

A. Description: Welded steel construction; 125-psig working pressure; 5-gal. capacity; with fill funnel and inlet, outlet, and drain valves.

1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

PART 3 EXECUTION

3.01 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered, brazed, or pressure-seal joints.
2. Schedule 40, Grade B, Type 96 steel pipe; minimum Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

B. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:

1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

C. Chilled-water piping, aboveground, NPS 2 and smaller, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered, brazed, or pressure-seal joints.
2. Schedule 40 steel pipe; minimum Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

D. Chilled-water piping, aboveground, NPS 2-1/2 and larger, shall be the following:

1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

E. Makeup-water piping installed aboveground shall be either of the following:

1. Type L , drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.

F. Makeup-Water Piping Installed Belowground and within Slabs: Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

G. Condensate-Drain Piping: Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

H. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

I. Air-Vent Piping:

1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

J. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.

3.02 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation.

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

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

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

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

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

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

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

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

S. Install shutoff valve immediately upstream of each dielectric fitting.

T. Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.

U. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

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

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

3.03 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.04 HANGERS AND SUPPORTS

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

B. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Exterior and penthouse hangers, supports, and hardware shall be type 304 stainless steel.

D. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

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

1. NPS 3/4: Maximum span, 7 feet.
2. NPS 1: Maximum span, 7 feet.
3. NPS 1-1/2: Maximum span, 9 feet.
4. NPS 2: Maximum span, 10 feet.
5. NPS 2-1/2: Maximum span, 11 feet.
6. NPS 3 and Larger: Maximum span, 12 feet.

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

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.

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

3.05 PIPE JOINT CONSTRUCTION

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

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

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

H. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.

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

3.06 TERMINAL EQUIPMENT CONNECTIONS

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

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

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

3.07 CHEMICAL TREATMENT

A. Perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the following water characteristics:

1. pH: 9.0 to 10.5.
2. "P" Alkalinity: 100 to 500 ppm.
3. Boron: 100 to 200 ppm.
4. Chemical Oxygen Demand: Maximum of 100 ppm. Revise this value if closed system contains glycol.
5. Corrosion Inhibitor:

   a. Sodium Nitrate: 1000 to 1500 ppm.
   b. Molybdate: 200 to 300 ppm.
   c. Chromate: 200 to 300 ppm.
   d. Sodium Nitrate Plus Molybdate: 100 to 200 ppm each.
   e. Chromate Plus Molybdate: 50 to 100 ppm each.

6. Soluble Copper: Maximum of 0.20 ppm.
7. Tolyiriazole Copper and Yellow Metal Corrosion Inhibitor: Minimum of 10 ppm.

8. Total Suspended Solids: Maximum of 10 ppm.
9. Ammonia: Maximum of 20 ppm.
10. Free Caustic Alkalinity: Maximum of 20 ppm.
11. Microbiological Limits:

    a. Total Aerobic Plate Count: Maximum of 1000 organisms/mL.
    b. Total Anaerobic Plate Count: Maximum of 100 organisms/mL.
    c. Nitrate Reducers: 100 organisms/mL.
    d. Sulfate Reducers: Maximum of zero organisms/mL.
    e. Iron Bacteria: Maximum of zero organisms/mL.

B. Install bypass chemical feeders in each hydronic system where indicated.

1. Install in upright position with top of funnel not more than 48 inches above the floor.
2. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections.
3. Install NPS 3/4 pipe from chemical feeder drain to nearest equipment drain and include a full-size, full-port, ball valve.

C. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.

D. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.

3.08 FIELD QUALITY CONTROL

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

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

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum

yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION

SECTION 232116 - HYDRONIC PIPING SPECIALTIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

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

1. Hot-water heating piping.
2. Chilled-water piping.
3. Makeup-water piping.
4. Condensate-drain piping.

1.03 ACTION SUBMITTALS

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

1. Valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
2. Air-control devices.
3. Hydronic specialties.

1.04 CLOSEOUT SUBMITTALS

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

1.05 QUALITY ASSURANCE

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

1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the minimum working pressures and temperatures of the system in which they serve unless otherwise indicated.

2.02 VALVES

A. Check, Ball, and Butterfly Valves: Comply with requirements specified in Section 230523 "General-Duty Valves for HVAC Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Section 230900 "Instrumentation and Control for HVAC."

C. Plastic Ball Valves:

1. Body: One-, two-, or three-piece CPVC or PVC to match piping.
2. Ball: Full-port CPVC or PVC to match piping.
3. Seats: PTFE.
4. Seals: EPDM.
5. End Connections: Socket, union, or flanged.
6. Handle Style: Tee shape.
7. CWP Rating: Equal to piping service.
8. Maximum Operating Temperature: Equal to piping service.
9. Comply with MSS SP-122.

D. Bronze, Calibrated-Orifice, Balancing Valves:

1. Body: Bronze, ball or plug type with calibrated orifice or venturi.
2. Ball: Brass or stainless steel.
3. Plug: Resin.
4. Seat: PTFE.
5. End Connections: Threaded or socket.
6. Pressure Gage Connections: Integral seals for portable differential pressure meter.
7. Handle Style: Lever, with memory stop to retain set position.
8. CWP Rating: Minimum 125 psig.
9. Maximum Operating Temperature: 250 deg F.

E. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
2. Ball: Brass or stainless steel.
3. Stem Seals: EPDM O-rings.
4. Disc: Glass and carbon-filled PTFE.
5. Seat: PTFE.
6. End Connections: Flanged or grooved.
7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig.

10. Maximum Operating Temperature: 250 deg F.

F. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.

1. Manufacturers: Subject to compliance with requirements.

2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Low inlet-pressure check valve.
8. Inlet Strainer: Stainless steel, removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

G. Diaphragm-Operated Safety Valves: ASME labeled.

1. Body: Bronze or brass.
2. Disc: Glass and carbon-filled PTFE.
3. Seat: Brass.
4. Stem Seals: EPDM O-rings.
5. Diaphragm: EPT.
6. Wetted, Internal Work Parts: Brass and rubber.
7. Inlet Strainer: Stainless Steel, removable without system shutdown.
8. Valve Seat and Stem: Noncorrosive.
9. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

H. Automatic Flow-Control Valves:

1. Body: Brass or ferrous metal.
2. Piston and Spring Assembly: Stainless steel, tamper proof, self-cleaning, and removable.
3. Combination Assemblies: Include bronze or brass-alloy ball valve.
4. Identification Tag: Marked with zone identification, valve number, and flow rate.
5. Size: Same as pipe in which installed.
6. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
7. Minimum CWP Rating: 175 psig.
8. Maximum Operating Temperature: 200 deg F.

2.03 AIR-CONTROL DEVICES

A. Automatic Air Vents:

1. Body: Brass.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS 3/4.
5. Discharge Connection: NPS 1/4.

6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 250 deg F.

B. Centrifugal Air Separators:

1. Tank: Centrifugal type, carbon steel with tangential connections and an internal diffuser constructed to decelerate system flow to maximize air separation. Diameter shall be 3 times nominal inlet/outlet pipe diameter with a minimum volume for sufficient velocity reduction.
2. Strainer: Internal type 304 stainless steel strainer and air separator with 3/16" perforations and 51% open area.
3. Blowdown: Shall have blowdown connection. Provide with appropriate fittings for manual blowdown.
4. Maximum Working Pressure: ASME constructed and stamped for 125 psig at 350°F.
5. Paint: Painted with one shop coat of air dry enamel.

2.04 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: Stainless-steel, 20-mesh strainer, or perforated stainless-steel basket.
4. CWP Rating: 125 psig.

B. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

C. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

D. Spherical, Rubber, Flexible Connectors:

1. Body: Fiber-reinforced rubber body.
2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
3. Performance: Capable of misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

E. Expansion Tanks:

1. Tank Construction: Welded steel.
2. Diaphragm: Heavy duty butyl rubber.
3. Pre-Charge: To system working pressure.
4. Connections: Drain, fill, air charging valve, and system connections.
5. Maximum Working Pressure: 125 psi meeting ASME Section VIII, Division 1 standards.

F. Expansion Fittings: Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping."

PART 3 EXECUTION

3.01 VALVE APPLICATIONS

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

B. Install calibrated-orifice, balancing valves in the return pipe of each cooling unit.

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

D. Install safety valves as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

3.02 HYDRONIC SPECIALTIES INSTALLATION

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

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.

C. Install centrifugal air separators in pump suction. Install drain valve on air separator.

END OF SECTION

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Separately coupled, base-mounted, end-suction centrifugal pumps.
2. Inline circulator pumps.

1.3 SUBMITTALS

A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

B. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages. Provide Wiring Diagrams with power, signal, and control wiring.

C. Operation and Maintenance Data: For pumps to include in operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of hydronic pumps and are based on the specific system indicated.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 END SUCTION SEPARATELY COUPLED PUMPS (BASE MOUNTED):

A. Manufacturer:

1. Contractor shall furnish and install new end suction separately coupled, base mounted centrifugal pumps for chilled and hot water systems as indicated on the drawings. Pumps shall meet types, sizes, capacities, and characteristics as scheduled on the drawings. Basis of design shall be Bell & Gossett with other acceptable manufacturers being Armstrong, Taco, or Peerless, contingent upon compliance with these specifications and the pumps schedules. Pump substitutions shall be provided with connection sizes equal to those scheduled. Pump connections shall not be downsized. Pump substitutions shall not be provided at efficiencies less than those scheduled.

B. Components:

1. The pumps shall be separately coupled, base mounted, single stage, end suction, split case design, in cast iron, bronze fitted construction specifically designed for quiet operation. Suitable standard operations shall be 225F and 175 PSIG working pressure. Working pressures shall not be de-rated at temperatures up to 250F. The pump internals shall be capable of being serviced without disturbing piping connections, electrical motor connections or pump to motor alignment.
2. The pumps shall be composed of three separable components: a motor, bearing assembly, and pump end (wet end). The motor shaft shall be connected to the pump shaft via a replaceable flexible coupler.
3. A bearing assembly shall support the shaft via two heavy-duty regreaseable ball bearings. Bearing assembly shall be replaceable without disturbing the system piping and shall have foot support at the coupling end. Pump bearings shall be regreaseable without removal of the bearings from the bearing assembly. Thermal expansion of the shaft toward the impeller shall be prevented via an inboard thrust bearing.
4. The bearing assembly shall have a solid SAE1144 steel shaft. A non-ferrous shaft sleeve shall be employed to completely cover the wetted area under the seal.
5. Pump shall be equipped with an internally flushed mechanical seal assembly installed in an enlarged tapered seal chamber. Application of an internally flushed mechanical seal shall be adequate for seal flushing without requiring external flushing lines. Seal assembly shall have a brass housing, Buna bellows and seat gasket, stainless steel spring, and be of a carbon ceramic design with the carbon face rotating against a stationary ceramic face.

6. Bearing assembly shaft shall connect to a bronze impeller. Impeller shall be both hydraulically and dynamically balanced to ANSI/HI 1.1-1.5-1994, section 1.4.6.1.3, figure 1.106, balance grade G6.3 and keyed to the shaft and secured by a stainless steel locking cap screw or nut.
7. Pump should be designed to allow for true back pull-out allowing access to the pump's working components, without disturbing motor or piping, for ease of maintenance.
8. A center drop-out type coupling, capable of absorbing torsional vibration, shall be employed between the pump and motor. Pumps for variable speed application shall be provided with a suitable coupler sleeve. Coupler shall allow for removal of pump's wetted end without disturbing pump volute or movement of the pump's motor and electrical connections. On variable speed applications the coupler sleeve should be constructed of an EPDM material to maximize performance life.
9. An ANSI and OSHA rated coupler guard shall shield the coupler during operation. Coupler guard shall be dual rated ANSI B15.1, Section 8 and OSHA 1910.219 compliant coupling guard and contain viewing windows for inspection of the coupling. No more than .25 inches of either rotating assembly shall be visible beyond the coupling guard.
10. Pump volute shall be of a cast iron design for heating systems with integrally cast pedestal volute support, rated for 175 PSIG with integral cast iron flanges drilled for 125# ANSI companion flanges. Volute shall include gauge ports at nozzles, and vent and drain ports.
11. Motors shall meet scheduled horsepower, speed, voltage, and enclosure design. Pump and motors shall be factory aligned and shall be realigned after installation by the manufacturer's representative. Motors shall be non-overloading at any point on the pump curve and shall meet NEMA specifications and conform to the standards outlined in EPACT 92. See other Div 23 Specifications for details.
12. Base plate shall be of structural steel or fabricated steel channel configuration fully enclosed at sides and ends, with securely welded cross members and fully open grouting area (for field grouting). The minimum base plate stiffness shall conform to ANSI/HI 1.3.4-1997 for Horizontal Baseplate Design standards.
13. Pump shall be of a maintainable design and for ease of maintenance should use machine fit parts and not press fit components.
14. The pump vibration limits shall conform to Hydraulic Institute ANSI/HI 1.1-1.5-1994, section 1.4.6.1.1 for recommended acceptable unfiltered field vibration limits (as measured per H.I. 1.4.6.5.2, Figure 1.108) for pumps with rolling contact bearings. Pump manufacturer shall be ISO-9001 certified.
15. The seismic capability of the pump shall allow it to withstand a horizontal load of 0.5g, excluding piping and/or fasteners used to anchor the pump to mounting pads or to the floor, without adversely affecting pump operation.
16. Each pump shall be factory tested and name-plated before shipment.
17. Pump shall conform to ANSI/HI 9.6.3.1 standard for Preferred Operating Region (POR) unless otherwise approved by the engineer.
18. Pumps shall include Totally enclosed Fan Cooled (TEFC) motors.

2.2 INLINE CIRCULATOR PUMPS:

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Armstrong Pumps Inc.
2. Flowserve Corporation.
3. Grundfos Pumps Corporation.
4. ITT Corporation; Bell & Gossett.
5. TACO Incorporated.

B. Description: Factory-assembled and -tested, inline circulator pump.

C. Pump Construction:

1. Body: 100 percent lead-free bronze, Stainless steel, or Cast iron.
2. Impeller: Polypropylene, Noryl, or composite
3. Pump Shaft: Ceramic or 316 L Stainless Steel.
4. Bearings. Double-sintered carbon.

D. Motor: ECM.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

   a. Efficiency: Premium efficiency.

E. Capacities and Characteristics: see Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.

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

3.2 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install all pumps in strict accordance with manufacturer’s instructions. Provide service space around pumps as recommended by the pump manufacturer.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Install continuous-thread hanger rods and spring hangers of sufficient size to support pump weight. Vibration isolation devices are specified in Division 23 Section "Vibration Controls for HVAC Piping and Equipment." Fabricate brackets or supports as required. Hanger and support materials are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

E. Set base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.
   1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches (19 to 38 mm) between pump base and foundation for grouting.
   2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

3.3 ALIGNMENT

A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.

B. Comply with pump and coupling manufacturers' written instructions.

C. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

E. Grout pump mounting base full after piping is connected but before pump drive is aligned. After grouting, align pump drive shaft to 5 mils, even if pump is factory aligned, and conduct vibration test.

F. Realignment after installation prior to start up will be performed by the Mechanical Contractor.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install check valve, balancing valve and shutoff valve on discharge side of pumps. Triple duty valve is not acceptable, unless indicated otherwise on PID drawings.

F. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

G. Install electrical connections for power, controls, and devices.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers or suction diffusers on suction piping.
4. Perform the following startup checks for each pump before starting:
    a. Verify bearing lubrication.
    b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    c. Verify that pump is rotating in the correct direction.
5. Prime pump by opening suction valves and closing drains and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps for a period not to exceed 4 hours.

END OF SECTION 232123

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Sealants and gaskets.
5. Hangers and supports.
6. Seismic-restraint devices.

B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

A. Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7. and SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

1. Seismic Hazard Level as stated on contract documents.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 ACTION SUBMITTALS

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

1. Sealants and gaskets.

2. Seismic-restraint devices.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling including the following:

   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.
   d. Access panels.

1.6 QUALITY ASSURANCE

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and

Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Lindab Industries, Inc.
b. McGill AirFlow LLC.
c. SEMCO Incorporated.
d. Sheet Metal Connectors, Inc.
e. Spiral Manufacturing Co., Inc.
f. Eastern Sheet Metal.
g. Hamlin Sheet Metal.
h. Turn Key Duct Systems.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

E. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

F. Factory- or Shop-Applied Antimicrobial Coating:

1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating shall be applied to the exterior surface.
2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
3. Coating containing the antimicrobial compound shall have a hardness of 2H, minimum, when tested according to ASTM D 3363.
4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
5. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.

G. Reinforcement Shapes and Plates: ASTM A 36, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

H. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Sealant: Modified styrene acrylic.
3. Water resistant.
4. Mold and mildew resistant.
5. Maximum Static-Pressure Class: 10-inch wg , positive and negative.
6. Service: Indoor and outdoor.
7. Service Temperature: Minus 40 to plus 200 deg F .
8. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
9. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

10. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg , positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. VOC: Maximum 395 g/L.
10. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
11. Maximum Static-Pressure Class: 10-inch wg , positive or negative.
12. Service: Indoor or outdoor.
13. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.5 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch , plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches .

K. Where ducts pass through non-fire-rated, interior partitions, fill void between duct and opening in wall with fiberglass insulation and sealant for acoustical separation.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
3. Unconditioned Space, Exhaust Ducts: Seal Class C.
4. Unconditioned Space, Return-Air Ducts: Seal Class B.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with requirements indicated in Seismic Specification.

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install cable restraints on ducts that are suspended with vibration isolators.

E. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

F. Drilling for and Setting Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.6 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:
3. Test for leaks before applying external insulation.
4. Give five days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.8 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.9 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

B. Ductwork

Table 1: Recommended Ductwork Seal Levels by Duct Type (2005 ASHRAE Handbook – Fundamentals)

Duct Location	Supply (less than or equal to 2 in-wg)	Supply (greater than to 2 in-wg)	Exhaust	Return
Outdoors	A	A	A	A
Unconditioned Spaces	B	A	B	B
Conditioned Spaces (concealed ductwork)	C	B	B	C
Conditioned Spaces (exposed ductwork)	A	A	B	B

Table 2: Duct Leakage Classification (2005 ASHRAE Handbook – Fundamentals)

Duct Type	Sealed	Unsealed
Metal (flexible excluded) – Round and flat oval	3	30
Metal – Rectangular (less than or equal to 2 in-wg)	12	48
Metal – Rectangular (greater than 2 in-wg)	6	48
Flexible (metal, aluminum)	8	30

C. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.
2. Aluminum Ducts: Aluminum.

D. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

   a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
   b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.

2. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

E. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Spin in.

2. Round Duct : Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity (less than 2 in-wg)1000 fpm or Lower: 90-degree tap.
b. Velocity 1000 to 1500 fpm : Conical tap.
c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Backdraft dampers
2. Manual volume dampers.
3. Fire dampers.
4. Turning vanes.
5. Flexible connectors.
6. Flexible ducts.
7. Duct accessory hardware.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90 .
2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts.

C. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

D. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Air Balance Inc.; a division of Mestek, Inc.
2. American Warming and Ventilating; a division of Mestek, Inc.
3. Cesco Products; a division of Mestek, Inc.
4. Greenheck Fan Corporation.
5. Lloyd Industries, Inc.
6. Nailor Industries Inc.
7. NCA Manufacturing, Inc.
8. Pottorff.
9. Ruskin Company.

2.4 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Air Balance Inc.; a division of Mestek, Inc.
b. American Warming and Ventilating; a division of Mestek, Inc.
c. Flexmaster U.S.A., Inc.
d. McGill AirFlow LLC.
e. Nailor Industries Inc.
f. Pottorff.
g. Ruskin Company.
h. Trox USA Inc.
i. Vent Products Company, Inc.

2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:

a. Frame: Hat-shaped, 0.094-inch- thick, galvanized sheet steel .
b. Mitered and welded corners.
c. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

a. Multiple or single blade.
b. Parallel- or opposed-blade design.
c. Stiffen damper blades for stability.
d. Galvanized -steel, 0.064 inch thick.

6. Blade Axles: Galvanized steel.
7. Tie Bars and Brackets: Galvanized steel.

B. Standard, Aluminum, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Air Balance Inc.; a division of Mestek, Inc.
b. American Warming and Ventilating; a division of Mestek, Inc.
c. McGill AirFlow LLC.
d. Nailor Industries Inc.
e. Pottorff.
f. Ruskin Company.
g. Trox USA Inc.
h. Vent Products Company, Inc.

2. Standard leakage rating , with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:

a. Multiple or single blade.
b. Parallel- or opposed-blade design.
c. Stiffen damper blades for stability.
d. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
e. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.

6. Blade Axles: Galvanized steel.
7. Tie Bars and Brackets: Aluminum.

2.5 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Elgen Manufacturing.
4. METALAIRE, Inc.
5. SEMCO Incorporated.
6. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

E. Vane Construction: Single wall.

F. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.6 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Elgen Manufacturing.
4. Ventfabrics, Inc.
5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

2.7 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Flexmaster U.S.A., Inc.
2. McGill AirFlow LLC.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F.
4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.

C. Insulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg F.
4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.

D. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg F.
4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.

E. Insulated, Flexible Duct: UL 181, Class 0, interlocking spiral of aluminum foil; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.

1. Pressure Rating: 8-inch wg positive or negative.
2. Maximum Air Velocity: 5000 fpm.
3. Temperature Range: Minus 20 to plus 250 deg F.
4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.

F. Flexible Duct Connectors:

1. Clamps: Nylon strap in sizes 3 through 18 inches, to suit duct size.

2. Non-Clamp Connectors: Liquid adhesive plus tape.

2.8 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of Pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts .

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install flexible connectors to connect ducts to equipment.

H. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

I. Connect diffusers to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.

J. Connect flexible ducts to metal ducts with draw bands.

K. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect turning vanes for proper and secure installation.

END OF SECTION 233300

SECTION 233423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Centrifugal roof ventilators.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on sea level.

B. Operating Limits: Classify according to AMCA 99.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.
6. Roof curbs.
7. Fan speed controllers.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated-Design Submittal: For unit hangars and supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Roof framing and support members relative to duct penetrations.
2. Ceiling suspension assembly members.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Belts: One set(s) for each belt-driven unit.

1.8 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.9 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Acme Engineering & Manufacturing Corporation.
2. Aerovent; a division of Twin City Fan Companies, Ltd.
3. Carnes Company.
4. Greenheck Fan Corporation.
5. Hartzell Fan Incorporated.
6. Loren Cook Company.
7. PennBarry.

B. Housing: Removable, spun-aluminum, dome top and outlet baffle ; square, one-piece, aluminum base with venturi inlet cone.

1. Downblast Units: Provide spun-aluminum discharge baffle to direct discharge air downward.
2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
4. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

E. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Self-flashing without a cant strip, with mounting flange .
2. Overall Height: 12 inches .
3. Sound Curb: Curb with sound-absorbing insulation.
4. Pitch Mounting: Manufacture curb for roof slope.
5. Mounting Pedestal: Galvanized steel with removable access panel.
6. Vented Curb: Unlined with louvered vents in vertical sides.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors.

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Enclosure Type: Totally enclosed, fan cooled.

2.3 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Equipment Mounting:

1. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

C. Install units with clearances for service and maintenance.

3.2 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

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

B. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

END OF SECTION 233423

SECTION 233600 - AIR TERMINAL UNITS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Single-duct air terminal units.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.

1. Air terminal units.
2. Liners and adhesives.
3. Sealants and gaskets.
4. Seismic-restraint devices.

B. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.
3. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

C. Delegated-Design Submittal:

1. Materials, fabrication, assembly, and spacing of hangers and supports.
2. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Ceiling suspension assembly members.

2. Size and location of initial access modules for acoustic tile.
3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

B. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Instructions for resetting minimum and maximum air volumes.
2. Instructions for adjusting software set points.

1.06 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.07 QUALITY ASSURANCE

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7.

2.02 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.03 SINGLE-DUCT AIR TERMINAL UNITS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

1. Anemostat Products; a Mestek Company.
2. Carnes.
3. Environmental Technologies, Inc.
4. Krueger.

5. METALAIRE, Inc.
6. Nailor Industries Inc.
7. Price Industries.
8. Titus.
9. Trane; a business of American Standard Companies.
10. Tuttle & Bailey.
11. Or Approved Equal.

B. Configuration: Diverting-damper assembly inside unit casing with control components inside a protective metal shroud.

C. Casing: 0.034-inch steel, single wall.

1. Casing Lining: Adhesive attached, 3/4-inch-thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.

   a. Cover liner with nonporous foil.
   b. Cover liner with nonporous foil and perforated metal.

2. Casing Lining: Adhesive attached, 3/4-inch-thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
3. Air Inlet: Round stub connection for duct attachment.
4. Air Outlet: S-slip and drive connections.
5. Access: Removable panels for access to diverting damper and other parts requiring service, adjustment, or maintenance; with airtight gasket.
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Diverter Assembly: Galvanized-steel gate, with polyethylene linear bearings or Aluminum blade, with nylon-fitted pivot points.

E. Multioutlet Attenuator Section: With two, three, or four 8-inch- diameter collars, each with locking butterfly balancing damper.

F. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

G. Electric Controls: Damper actuator and thermostat.

1. Damper Actuator: 24 V, powered closed, powered open.
2. Thermostat: Wall-mounted electric type with temperature display in Fahrenheit and Celsius, and space temperature set point.
3. Changeover Thermostat: Duct-mounted, field-adjustable, electric type reverses action of zone thermostat when air temperature reaches 70 deg F.

H. Electronic Controls: Bidirectional damper operator and microprocessor-based thermostat. Control devices shall be compatible with temperature controls and shall have the following features:

1. Damper Actuator: 24 V, powered closed, powered open.
2. Thermostat: Wall-mounted electronic type with the following features:

    a. Temperature set-point display in Fahrenheit and Celsius.
    b. Auxiliary switch to energize heating control circuit.
    c. Changeover thermistor to reverse action.

2.04 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Steel Cables: Galvanized steel complying with ASTM A 603.

D. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

E. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

F. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

2.05 SEISMIC-RESTRAINT DEVICES

A. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

B. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.

C. Restraint Cables: ASTM A 603, galvanized-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; with an automatic-locking and clamping device or double-cable clips.

D. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

E. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.06 SOURCE QUALITY CONTROL

A. Factory Tests: Test assembled air terminal units according to ARI 880.

1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

C. Install wall-mounted thermostats.

3.02 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.03 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install hangers and braces designed to support the air terminal units and to restrain against seismic forces required by applicable building codes. Comply with ASCE/SEI 7.

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install cable restraints on air terminal units that are suspended with vibration isolators.

E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.

F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

G. Drilling for and Setting Anchors:

1. Identify position of reinforcing steel and other embedded items before drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Install heavy-duty sleeve anchors with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.04 CONNECTIONS

A. Install piping adjacent to air terminal unit to allow service and maintenance.

B. Hot-Water Piping: In addition to requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.

C. Connect ducts to air terminal units according to Section 233113 "Metal Ducts." Coordinate duct installations and specialty arrangements with Drawings.

D. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."

3.05 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.06 FIELD QUALITY CONTROL

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

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

C. Perform tests and inspections.

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

D. Tests and Inspections:

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Air terminal unit will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.07 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
3. Verify that controls and control enclosure are accessible.
4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified.

3.08 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Rectangular and square ceiling diffusers.
2. Louver face diffusers.
3. Fixed face registers and grilles .
4. Sidewall Registers
5. Slot Diffusers

B. Related Sections:

1. Section 233300 "Air Duct Accessories" for volume-control dampers not integral to diffusers, registers, and grilles.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.

4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, and special moldings.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on drawings or equal.

2.2 See drawings for mechanical schedules.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 233723 - HVAC GRAVITY VENTILATORS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Louvered-penthouse ventilators.

1.03 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design ventilators, including comprehensive engineering analysis by a qualified professional engineer, using structural and seismic performance requirements and design criteria indicated.

B. Structural Performance: Ventilators shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of ventilator components, noise or metal fatigue caused by ventilator blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.

1. Wind Loads: Determine loads based on pressures as indicated on Drawings.

C. Seismic Performance: Ventilators, including attachments to other construction, shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes, without buckling, opening of joints, overstressing of components, failure of connections, or other detrimental effects.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

E. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. For louvered-penthouse ventilators specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. Shop Drawings: For gravity ventilators. Include plans, elevations, sections, details, ventilator attachments to curbs, and curb attachments to roof structure.

1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.

C. Samples: For each exposed product and for each color and texture specified.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each type of louvered-penthouse ventilator indicated, in manufacturer's standard size.

F. Delegated-Design Submittal: For shop-fabricated ventilators indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of shop-fabricated ventilators.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof framing plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members to which roof curbs and ventilators will be attached.
2. Sizes and locations of roof openings.

B. Seismic Qualification Certificates: For ventilators, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Welding certificates.

1.06 QUALITY ASSURANCE

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

1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
2. AWS D1.3, "Structural Welding Code - Sheet Steel."

1.07 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 PRODUCTS

2.01 MATERIALS

A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5 or T-52.

B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming or as otherwise recommended by metal producer for required finish.

C. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 zinc coating, mill phosphatized.

D. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel unless otherwise indicated. Do not use metals that are incompatible with joined materials.

1. Use types and sizes to suit unit installation conditions.
2. Use Phillips flat, hex-head or Phillips pan-head screws for exposed fasteners unless otherwise indicated.

E. Post-Installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors made from stainless-steel components, with capability to sustain without failure a load equal to 4 times the loads imposed for concrete, or 6 times the load imposed for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.02 FABRICATION, GENERAL

A. Factory or shop fabricate gravity ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.

D. Fabricate supports, anchorages, and accessories required for complete assembly.

E. Perform shop welding by AWS-certified procedures and personnel.

2.03 LOUVERED-PENTHOUSE VENTILATORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Acme Engineering & Mfg. Corporation.
2. Aerovent.
3. Carnes.
4. Greenheck Fan Corporation.

5. JencoFan.
6. Loren Cook Company.
7. PennBarry.
8. Or Approved Equal.

B. Construction: All-welded assembly with 4-inch or 6-inch-deep louvers, mitered corners, and aluminum or galvanized-steel sheet roof with mineral-fiber insulation and vapor barrier.

C. Frame and Blade Material and Nominal Thickness: Extruded aluminum, of thickness required to comply with structural performance requirements, but not less than 0.080 inch for frames and 0.080 inch for blades with condensate deflectors.

1. AMCA Seal: Mark units with the AMCA Certified Ratings Seal.
2. Exterior Corners: Prefabricated corner units with mitered and welded blades and with fully recessed mullions at corners.

D. Frame and Blade Material and Nominal Thickness: Galvanized-steel sheet, of thickness required to comply with structural performance requirements, but not less than 0.052 inch for frames and 0.052 inch for blades with condensate deflectors.

1. AMCA Seal: Mark units with the AMCA Certified Ratings Seal.
2. Exterior Corners: Prefabricated corner units with mitered and welded blades and with fully recessed mullions at corners.

E. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch- thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.

1. Configuration: Built-in cant and mounting flange.

F. Bird Screening: Flattened, expanded aluminum, 3/4 by 0.050 inch thick.

G. Insect Screening: Aluminum, 18-by-16 mesh, 0.012-inch or Stainless-steel, 18-by-18 mesh, 0.009-inch wire.

H. Galvanized-Steel Sheet Finish:

1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.
2. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.
3. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat and an overall minimum dry film thickness of 2 mils.

   a. Color and Gloss: As selected by Architect from manufacturer's full range.

I. Accessories:

1. Dampers:

   a. Location: Penthouse neck.

b. Control: Motorized.

J. Capacities and Characteristics:

1. Refer to schedule on drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.

B. Install gravity ventilators with clearances for service and maintenance.

C. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

D. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Section 079200 "Joint Sealants" for sealants applied during installation.

E. Label gravity ventilators according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

F. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

G. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

3.02 CONNECTIONS

A. Duct installation and connection requirements are specified in Section 233113 "Metal Ducts". Drawings indicate general arrangement of ducts and duct accessories.

3.03 ADJUSTING

A. Adjust damper linkages for proper damper operation.

END OF SECTION

SECTION 237313 - MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Variable-air-volume, multi-zone air-handling units.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design vibration isolation and seismic-restraint details, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Casing panels shall be self-supporting and capable of withstanding 133 percent of internal static pressures indicated, without panel joints exceeding a deflection of L/200 where "L" is the unsupported span length within completed casings.

C. Seismic Performance: Air-handling units shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.4 ACTION SUBMITTALS

A. Product Data: For each air-handling unit indicated.

1. Unit dimensions and weight.
2. Cabinet material, metal thickness, finishes, insulation, and accessories.
3. Fans:
    a. Certified fan-performance curves with system operating conditions indicated.
    b. Certified fan-sound power ratings.
    c. Fan construction and accessories.
    d. Motor ratings, electrical characteristics, and motor accessories.
4. Certified coil-performance ratings with system operating conditions indicated.
5. Dampers, including housings, linkages, and operators.
6. Filters with performance characteristics.

B. Delegated-Design Submittal: For vibration isolation and seismic restraints indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Mechanical-room layout and relationships between components and adjacent structural and mechanical elements.
2. Support location, type, and weight.
3. Field measurements.

B. Seismic Qualification Certificates: For air-handling units, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Source quality-control reports.

D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set for each air-handling unit.
2. Gaskets: One set for each access door.
3. Fan Belts: One set for each air-handling unit fan.

1.8 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.

D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

E. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

F. Comply with NFPA 70.

1.9 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Carrier Corporation; a member of the United Technologies Corporation Family.
2. Trane; American Standard Inc.
3. YORK International Corporation.
4. Or equal.

2.2 UNIT CASINGS

A. General Fabrication Requirements for Casings:

1. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
2. Casing Joints: Sheet metal screws or pop rivets.
3. Sealing: Seal all joints with water-resistant sealant.
4. Factory Finish for Galvanized-Steel Casings: Apply manufacturer's standard primer immediately after cleaning and pretreating.

5. Factory Finish for Galvanized-Steel Casings: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on enamel finish, consisting of prime coat and thermosetting topcoat.
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

B. Casing Insulation and Adhesive:

1. Materials: ASTM C 1071.
2. Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of section panels downstream from, and including, the cooling-coil section.

    a. Liner Adhesive: Comply with ASTM C 916, Type I.
    b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
    c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service-air velocity.

3. Location and Application: Encased between outside and inside casing.

C. Inspection and Access Panels and Access Doors:

1. Panel and Door Fabrication: Formed and reinforced, single- or double-wall and insulated panels of same materials and thicknesses as casing.
2. Inspection and Access Panels:

    a. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
    b. Gasket: Neoprene, applied around entire perimeters of panel frames.
    c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.

3. Access Doors:

    a. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
    b. Gasket: Neoprene, applied around entire perimeters of panel frames.
    c. Fabricate windows in [fan section]doors of double-glazed, wire-reinforced safety glass with an air space between panes and sealed with interior and exterior rubber seals.
    d. Size: At least 18 inches wide by full height of unit casing up to a maximum height of 60 inches.

4. Locations and Applications:

    a. Fan Section: Inspection and access panels.
    b. Access Section: Doors.
    c. Coil Section: Inspection and access panel.
    d. Damper Section: Inspection and access panels.

e. Filter Section: Inspection and access panels large enough to allow periodic removal and installation of filters.
f. Mixing Section: Doors.
g. Humidifier Section: Doors.

5. Service Light: 100-W vaporproof fixture with switched junction box located adjacent to door.

D. Condensate Drain Pans:

1. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.

a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
b. Depth: A minimum of 2 inches deep.

2. Single-wall, stainless-steel sheet.
3. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on both ends of pan.

a. Minimum Connection Size: NPS 2.

4. Pan-Top Surface Coating: Asphaltic waterproofing compound.
5. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

E. Air-Handling-Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.

1. Seismic Fabrication Requirements: Fabricate mounting base and attachment to air-handling unit sections, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when air-handling unit frame is anchored to building structure.

2.3 FAN, DRIVE, AND MOTOR SECTION

A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.

1. Shafts: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.

a. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

B. Centrifugal Fan Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.

1. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.

2. Horizontal-Flanged, Split Housing: Bolted construction.
3. Housing for Supply Fan: Attach housing to fan-section casing with metal-edged flexible duct connector.
4. Flexible Connector: Factory fabricated with a fabric strip 3-1/2 inches wide attached to 2 strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized-steel sheet or 0.032-inch- thick aluminum sheets; select metal compatible with casing.

    a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.

        1) Fabric Minimum Weight: 26 oz./sq. yd..
        2) Fabric Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
        3) Fabric Service Temperature: Minus 40 to plus 200 deg F.

C. Forward-Curved, Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.

D. Fan Shaft Bearings:

1. Prelubricated and Sealed, Ball Bearings: Self-aligning, pillow-block type with a rated life of 120,000 hours according to ABMA 9.
2. Grease-Lubricated, Tapered-Roller Bearings: Self-aligning, pillow-block type with double-locking collars and 2-piece, cast-iron housing and a rated life of 120,000 hours according to ABMA 11.
3. Grease-Lubricated Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.

E. Belt Drives: Factory mounted, with adjustable alignment and belt tensioning, and with 1.3 service factor based on fan motor.

1. Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
2. Motor Pulleys: Adjustable pitch for use with 5-hp motors and smaller; fixed pitch for use with motors larger than 5 hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.
3. Belts: Oil resistant, nonsparking, and nonstatic; in matched sets for multiple-belt drives.
4. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.1046-inch- thick, 3/4-inch diamond-mesh wire screen, welded to steel angle frame; prime coated.

F. Discharge Dampers: Heavy-duty steel assembly with channel frame and sealed ball bearings, and blades constructed of two plates formed around and welded to shaft, with blades linked out of air stream to single control lever.

G. Internal Vibration Isolation and Seismic Control: Fans shall be factory mounted with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 1 inch.

1. Seismic Fabrication Requirements: Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section components with reinforcement strong enough to withstand seismic forces defined in

Section 230548 "Vibration and Seismic Controls for HVAC" when fan-mounting frame and air-handling-unit mounting frame are anchored to building structure.

H. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Enclosure Type: Totally enclosed, fan cooled.
2. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. Mount unit-mounted disconnect switches on interior of unit.

I. Variable Frequency Controllers:
1. Provided by Controls Contractor

2.4 COIL SECTION

A. General Requirements for Coil Section:

1. Comply with ARI 410.
2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
3. For multizone units, provide air deflectors and air baffles to balance airflow across coils.
4. Coils shall not act as structural component of unit.
5. Tubes: ASTM B 743 copper, minimum 0.020 inch thick. Mechanically bonded to fins.
6. Fins: Aluminum, minimum 0.006 inch thick.
7. Headers: Seamless copper tube with brazed joints, prime coated with NPT external thread drain and vent tappings.
8. Seismic Fabrication Requirements: Fabricate coil section, internal mounting frame and attachment to coils, and other coil section components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when coil-mounting frame and air-handling-unit mounting frame are anchored to building structure.

2.5 AIR FILTRATION SECTION

A. General Requirements for Air Filtration Section:

1. Comply with NFPA 90A.
2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
3. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

B. Disposable Panel Filters:

1. Factory-fabricated, viscous-coated, flat-panel type.
2. Thickness: 1 inch.

3. Arrestance (ASHRAE 52.1): 80.
4. Merv (ASHRAE 52.2): 5.
5. Media: Interlaced glass fibers sprayed with nonflammable adhesive and antimicrobial agent.
6. Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, hinged, and with pull and retaining handles.

2.6 DAMPERS

A. General Requirements for Dampers: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 2 percent of air quantity at 2000-fpm face velocity through damper and 4-inch wg pressure differential.

B. Damper Operators: Comply with requirements in Section 230900 "Instrumentation and Control for HVAC."

C. Electronic Damper Operators:

1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
2. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
3. Operator Motors:

   a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   b. Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
   c. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
6. Size dampers for running torque calculated as follows:

   a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
   b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
   c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft of damper.
   d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
   e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
   f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.

7. Coupling: V-bolt and V-shaped, toothed cradle.
8. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
9. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.

10. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
11. Temperature Rating: Minus 22 to plus 122 deg F.

D. Outdoor- and Return-Air Dampers (separate components from AHU): Low-leakage, double-skin, airfoil-blade, extruded-aluminum dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed-blade arrangement with cadmium-plated steel operating rods rotating in sintered bronze or nylon bearings mounted in a single extruded-aluminum frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 5 cfm/sq. ft. at 1-inch wg and 9 cfm/sq. ft. at 4-inch wg.

2.7 CAPACITIES AND CHARACTERISTICS

A. Refer to drawings.

2.8 SOURCE QUALITY CONTROL

A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.

B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."

C. Water Coils: Factory tested to 300 psig according to ARI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

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

3.2 INSTALLATION

A. Equipment Mounting:
1. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

C. Do not operate fan system until filters are in place. Replace temporary filters used during construction and testing, with new, clean filters.

D. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air-handling unit to allow service and maintenance.

C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using NPS 1-1/4, ASTM B 88, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Hot- and Chilled-Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

F. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

3.4 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.

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

C. Tests and Inspections:

1. Leak Test: After installation, fill water coils with water, and test coils and connections for leaks.
2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Automatic-Roll-Filter Operational Test: Operate filters to demonstrate compliance with requirements. Test for leakage of unfiltered air while system is operating.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that zone dampers fully open and close for each zone.
7. Verify that face-and-bypass dampers provide full face flow.
8. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
9. Comb coil fins for parallel orientation.
10. Verify that proper thermal-overload protection is installed for electric coils.
11. Install new, clean filters.
12. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.6 ADJUSTING

A. Adjust damper for proper damper operation.

B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.7 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 237313

SECTION 238219 - FAN COIL UNITS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes fan-coil units and accessories.

1.03 DEFINITIONS

A. BAS: Building automation system.

1.04 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For each type of fan-coil unit indicated.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Ceiling suspension components.
2. Structural members to which fan-coil units will be attached.
3. Method of attaching hangers to building structure.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.

d. Sprinklers.
e. Access panels.

6. Perimeter moldings for exposed or partially exposed cabinets.

B. Manufacturer Seismic Qualification Certification: Submit certification that fan-coil units, accessories, and components will withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC." Include the following:

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

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control test reports.

D. Warranty: Special warranty specified in this Section.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fan-coil units to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

1.07 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan-Coil-Unit Filters: Furnish one spare filters for each filter installed.
2. Fan Belts: Furnish one spare fan belts for each unit installed (if applicable).

1.08 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.09 COORDINATION

A. Coordinate layout and installation of fan-coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

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

B. In the Fan-Coil-Unit Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
3. Basis-of-Design Product: The design for each fan-coil unit is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.02 FAN-COIL UNITS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or a comparable product by one of the following:

1. Multi-Aqua
2. Carrier Corporation
3. Daikin.
4. Engineered Air Ltd.
5. McQuay International.
6. Trane.
7. YORK International Corporation.
8. Or Approved Equal.

B. Description: Factory-packaged and -tested units rated according to ARI 440, ASHRAE 33, and UL 1995.

C. Coil Section Insulation: 1/2-inch thick, foil-covered, closed-cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.

1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Main and Auxiliary Drain Pans: Stainless steel. Fabricate pans and drain connections to comply with ASHRAE 62.1.

E. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Washable Foam: 70 percent arrestance and 3 MERV.
2. Glass Fiber Treated with Adhesive: 80 percent arrestance and 5 MERV.
3. Pleated Cotton-Polyester Media: 90 percent arrestance and 7 MERV.

F. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

G. Fan and Motor Board: Removable.

1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
3. Wiring Termination: Connect motor to chassis wiring with plug connection.

H. Factory, Hydronic Piping Package: ASTM B 88, Type L copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.

I. Basic Unit Controls:

1. Control voltage transformer.
2. Wall-mounting thermostat with the following features:
   a. Heat-cool-off switch.
   b. Fan on-auto switch.
   c. Fan-speed switch.
   d. Automatic changeover.
   e. Adjustable deadband.
   f. Exposed set point.
   g. Exposed indication.
   h. Degree F indication.
3. Unoccupied-period-override push button.
4. Data entry and access port.

a. Input data includes room temperature set points and occupied and unoccupied periods.
b. Output data includes room temperature, supply-air temperature, entering-water temperature, operating mode, and status.

J. Terminal Controller:

1. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
2. Unoccupied Period Override Operation: Two hours.
3. Unit Supply-Air Fan Operation:

a. Occupied Periods: Fan runs continuously.
b. Unoccupied Periods: Fan cycles to maintain room setback temperature.

4. Hydronic-Cooling-Coil Operation:

a. Occupied Periods: Modulate control valve to maintain room temperature.
b. Unoccupied Periods: Close control valve.

5. Controller shall have volatile-memory backup.

K. BAS Interface Requirements:

1. Interface relay for scheduled operation.
2. Interface relay to provide indication of fault at the central workstation.
3. Provide BACnet interface for central BAS workstation for the following functions:

a. Adjust set points.
b. Fan-coil-unit start, stop, and operating status.
c. Data inquiry, including supply- and room-air temperature.
d. Occupied and unoccupied schedules.

L. Electrical Connection: Factory wire motors and controls for a single electrical connection.

M. Capacities and Characteristics:
a. Refer to schedules in drawings.

2.03 FAN-COIL UNITS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or a comparable product by one of the following:

1. Carrier Corporation.
2. Daikin.
3. MultiAqua.
4. McQuay International.
5. Trane.
6. YORK International Corporation.
7. Or Approved Equal.

B. Description: Factory-packaged and -tested units rated according to ARI 440, ASHRAE 33, and UL 1995.

C. Coil Section Insulation: 1/2-inch thick foil-faced glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.

1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Drain Pans: Stainless steel. Fabricate pans and drain connections to comply with ASHRAE 62.1.

E. Chassis: Galvanized steel where exposed to moisture, with baked-enamel finish and removable access panels.

F. Cabinets: Steel with baked-enamel finish in manufacturer's standard paint color.

1. Dampers: Galvanized steel with extruded-vinyl blade seals, flexible-metal jamb seals, and interlocking linkage.

G. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Washable Foam: 70 percent arrestance and 3 MERV.
2. Glass Fiber Treated with Adhesive: 80 percent arrestance and 5 MERV.
3. Pleated Cotton-Polyester Media: 90 percent arrestance and 7 MERV.

H. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.

I. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.

J. Belt-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the cabinet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.

1. Motors: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

K. Factory, Hydronic Piping Package: ASTM B 88, Type L copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.

L. Control devices and operational sequence are specified in Section 230548 "Vibration and Seismic Controls for HVAC."

M. Basic Unit Controls:

1. Control voltage transformer.
2. Wall-mounting thermostat with the following features.

   a. Heat-cool-off switch.

b. Fan on-auto switch.
c. Fan-speed switch.
d. Automatic changeover.
e. Adjustable deadband.
f. Exposed set point.
g. Exposed indication.
h. Degree F indication.

3. Unoccupied-period-override push button.
4. Data entry and access port.

a. Input data includes room temperature set points and occupied and unoccupied periods.
b. Output data includes room temperature, supply-air temperature, entering-water temperature, operating mode, and status.

N. Terminal Controller:

1. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
2. Unoccupied Period Override Operation: Two hours.
3. Unit Supply-Air Fan Operation:

a. Occupied Periods: Fan runs continuously.
b. Unoccupied Periods: Fan cycles to maintain room setback temperature.

4. Hydronic-Cooling-Coil Operation:

a. Occupied Periods: Modulate control valve to maintain room temperature.
b. Unoccupied Periods: Close control valve.

5. Heating-Coil Operation:

a. Occupied Periods: Modulate control valve to provide heating if room temperature falls below thermostat set point.
b. Unoccupied Periods: Start fan and modulate control valve if room temperature falls below setback temperature.

O. BAS Interface Requirements:

1. Interface relay for scheduled operation.
2. Interface relay to provide indication of fault at the central workstation.
3. Provide BACnet interface for central BAS workstation for the following functions:

a. Adjust set points.
b. Fan-coil-unit start, stop, and operating status.
c. Data inquiry including supply- and room-air temperature.
d. Occupied and unoccupied schedules.

P. Electrical Connection: Factory wire motors and controls for a single electrical connection.

Q. Capacities and Characteristics:

a. Refer to schedule in drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before fan-coil-unit installation.

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

3.02 INSTALLATION

A. Install fan-coil units level and plumb.

B. Install fan-coil units to comply with NFPA 90A.

C. Suspend fan-coil units from structure with elastomeric hangers. Vibration isolators are specified in Section 230548 "Vibration and Seismic Controls for HVAC."

D. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above finished floor.

E. Install new filters in each fan-coil unit within two weeks after Substantial Completion.

3.03 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:

1. Install piping adjacent to machine to allow service and maintenance.
2. Connect piping to fan-coil-unit factory hydronic piping package. Install piping package if shipped loose.
3. Connect condensate drain to indirect waste.

    a. Install condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.

B. Connect supply and return ducts to fan-coil units with flexible duct connectors specified in Section 233300 "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.04 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.05 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan-coil units. Refer to Section 017900 "Demonstration and Training."

END OF SECTION

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 IMPOSED REGULATIONS

A. Applicable provisions of the State and Local Codes and of the following codes and standards in addition to those listed elsewhere in the specifications are hereby imposed on a general basis for electrical work: codes and standards listed on the electrical drawings.

1.2 SCOPE OF WORK

A. Provide all labor, materials, equipment and supervision to construct complete and operable electrical systems as indicated on the drawings and specified herein. All materials and equipment used shall be new, undamaged and free from any defects.

1.3 RELATED DOCUMENTS AND OTHER INFORMATION

A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the portions of work specified in each and every Section of this Division, individually and collectively.

1.4 EXISTING SERVICES AND FACILITIES

A. Damage to Existing Services: Existing services and facilities damaged by the Contractor through negligence or through use of faulty materials or workmanship shall be promptly repaired, replaced, or otherwise restored to previous conditions by the Contractor without additional cost to the Owner.

B. Interruption of Services: Interruptions of services necessary for connection to or modification of existing systems or facilities shall occur only at prearranged times approved by the Owner. Interruptions shall only occur after the provision of all temporary work and the availability of adequate labor and materials will assure that the duration of the interruption will not exceed the time agreed upon.

C. Removed Materials: Existing materials made unnecessary by the new installation shall be stored on site. They shall remain the property of the Owner and shall be stored at a location and in a manner as directed by the Owner. If classified by the Owner's authorized representative as unsuitable for further use, the material shall become the property of the Contractor and shall be removed from the site at no additional cost to the owner.

1.5 PRODUCT WARRANTIES

A. Provide manufacturer's standard printed commitment in reference to a specific product and normal application, stating that certain acts of restitution will be performed for the Purchaser or Owner by the manufacturer, when and if the product fails within certain operational conditions and time limits. Where the warranty requirements of a specific specification section exceed the manufacturer's standard warranty, the more stringent requirements will apply and modified manufacturer's warranty shall be provided. In no case shall the manufacturer's warranty be less than one (1) year.

1.6 PRODUCT SUBSTITUTIONS

A. General: Materials specified by manufacturer's name shall be used unless prior approval of an alternate is given by addenda. Requests for substitutions must be received in the office of the Architect at least 10 days prior to opening of bids.

1.7 ELECTRICAL DRAWINGS

A. Electrical contract drawings are diagrammatic and indicate the general arrangement of electrical equipment. Do not scale electrical plans. Obtain all dimensions from the Architect's dimensioned drawings and field measurements. The Contractor shall review Architectural plans for door swings and built-in equipment; conditions indicated on those plans shall govern for this work.

B. Coordinate installation of electrical equipment with the structural and mechanical equipment and access thereto. Coordinate exterior electrical work with civil and landscaping work.

C. Discrepancies shown on different drawings, between drawings and specifications or between documents and field conditions shall be installed to provide the better quality or greater quantity of work; or, comply with the more stringent requirement; either or both in accordance with the A/E’s interpretation.

1.8 SYSTEMS REQUIRING ROUGH-IN

A. Rough-in shall consist of all outlet boxes/raceway systems/supports and sleeves required for the installation of cables/devices by other Divisions and by the Owner. It shall be the responsibility of this Contractor to determine the requirements by reviewing the contract documents and meeting with the Superintendent of the trade involved and Owner’s representative to review submittal data, shop drawings, etc.

B. Sealing of all sleeves, to meet the fire rating of the assembly, whether active or not, is work of this Division.

1.9 SUBMITTALS

A. Refer to section 260510

PART 2 - PRODUCTS

2.1 FIRESTOPPING

A. Refer to Division 07 sections for additional requirements.

B. A firestop system shall be used to seal penetrations of electrical conduits and cables through fire-rated partitions per the NEC. The firestop system shall be qualified by formal performance testing in accordance with ASTM E-814, or UL 1479.

C. The firestop system shall consist of a fire-rated caulk type substance and a high temperature fiber insulation. It shall be permanently flexible, waterproof, non-toxic, smoke and gas tight and have a high adhesion to all solids so damming is not required. Only metal conduit shall be used in conjunction with this system to penetrate fire rated partitions. Install in strict compliance with manufacturer's recommendations. 3M, Hilti, STI or equal

D. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

E. Comply with BICSI TDMM, "Firestopping Systems" Article.

PART 3 - EXECUTION

3.1 PRODUCT INSTALLATION, GENERAL

A. Except where more stringent requirements are indicated, comply with the product manufacturer's installation instructions and recommendations, including handling, anchorage, assembly, connections, cleaning and testing, charging, lubrication, startup, test operation and shut-down of operating equipment. Consult with manufacturer's technical experts, for specific instructions on unique product conditions and unforeseen problems.

B. Protection and Identification: Deliver products to project properly identified with names, models numbers, types, grades, compliance labels and similar information needed for distinct identifications; adequately packaged or protected to prevent deterioration during shipment, storage and handling. Store in a dry, well ventilated, indoor space, except where prepared and protected by the manufacturer specifically for exterior storage.

C. Permits and Tests: Provide labor, material and equipment to perform all tests required by the governing agencies and submit a record of all tests to the Owner or his representative. Notify the Architect five days in advance of any testing.

D. Install temporary protective covers over equipment enclosures, outlet boxes and similar items after interiors, conductors, devices, etc. are installed, to prevent the entry of construction debris and to protect the installation during finish work performed by others. Do not install device plates, equipment covers or trims until finish work is complete.

E. Clean all equipment, inside and out, upon completion of the work. Scratched or marred surfaces shall be touched-up with touch-up paint furnished by the equipment manufacturer.

F. Replace all equipment and materials that become damaged.

G. No more than three phase conductors, each of opposite phases for a three phase WYE system, shall be combined in a single raceway unless written approval is granted by the engineer or noted otherwise on the construction documents. (For 120 volt and 277 volt receptacle and lighting circuits are no more than 3 circuits unless written approval is granted by the engineer or noted otherwise on the construction documents.)

3.2 LOW VOLTAGE CABLING SEPARATION FROM EMI SOURCES

A. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

B. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
1. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches
2. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches
3. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches

C. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   1. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches
   2. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches
   3. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches

D. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   1. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   2. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches
   3. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches

E. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches

F. Separation between Cables and light fixtures: A minimum of 5 inches

3.3 EQUIPMENT PROTECTION

A. Equipment and materials shall be protected during shipment and storage against physical damage, vermin, dirt, corrosive substances, fumes, moisture, cold and rain.

B. Store equipment indoors in clean dry space with uniform temperature to prevent condensation. Equipment shall include but not be limited to switchgear, switchboards, panelboards, transformers, motor control centers, motor controllers, uninterruptible power systems, enclosures, controllers, circuit protective devices, cables, wire, light fixtures, electronic equipment, and accessories.

C. During installation, equipment shall be protected against entry of foreign matter; and be vacuum-cleaned both inside and outside before testing and operating. Compressed air shall not be used to clean equipment. Remove loose packing and flammable materials from inside equipment.

D. Damaged equipment shall be, as determined by the Engineer, placed in first class operating condition or be returned to the source of supply for repair or replacement.

E. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.

F. Damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

3.4 UTILITY CONNECTIONS

A. Coordinate the connection of the electrical system with the local power company. Comply with the requirements of governing regulations, franchised service companies and controlling agencies. Pay all utility fees and charges.

3.5 ELECTRICAL WORK

A. Electrical work shall be accomplished with all affected circuits or equipment de-energized. When an electrical outage cannot be accomplished in this manner for the required work, the following requirements are mandatory:

1. Electricians must use full protective equipment (i.e., certified and tested insulating material to cover exposed energized electrical components, certified and tested insulated tools, etc.) while working on energized systems in accordance with NFPA 70E.

2. Electricians must wear personal protective equipment while working on energized systems in accordance with NFPA 70E.

3. Before initiating any work, a job specific work plan must be developed by the contractor with a peer review conducted and documented by the Contractor. The work plan must include procedures to be used on and near the live electrical equipment, barriers to be installed, safety equipment to be used and exit pathways. This plan is subject to review and comment by the owner.

B. Nothing in the above shall impose any duty on the Architects and Architect’s consultants, nor relieve the General Contractor and its subcontractors of its obligations, duties and responsibilities including but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending and coordinating the Electrical Work in accordance with the Contract Documents and any health or safety precautions required by any regulatory agencies.

END OF SECTION 260500

SECTION 260501 - ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 Not Used

PART 2 - PRODUCTS

2.1 Not Used

PART 3 - EXECUTION

3.1 EXAMINATION

A. Field verify measurements and circuiting arrangements are as shown on Drawings.

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

C. Demolition drawings are based on casual field observation.

D. Report discrepancies to Engineer before disturbing existing installation.

E. Beginning of demolition means installer accepts existing conditions.

3.2 PREPARATION

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

B. Provide temporary wiring and connections to maintain existing systems in service during construction.

C. When work must be performed on energized equipment or circuits, use personnel experienced in such operations, submit verification of compliance with the contractor’s safety procedures to the Architect, and notify the Owner in writing a minimum of 24 hours prior to work.

D. Existing Fire Alarm System: Maintain existing system in service until new system is installed and tested. Disable system only to make switchovers and connections. Minimize outage duration. Notify owner and AHJ before partially or completely disabling system.

E. The existing television, telephone, computer data, intrusion detection and intercom system shall remain operable during construction. Plan and execute the work accordingly. Provide temporary wiring and facilities as may be required.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Maintain electrical service to areas outside of the construction area.

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 electrical devices and equipment serving utilization equipment that has been removed.

H. Disconnect and remove abandoned luminaries. Remove brackets, stems, hangers, and other accessories.

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

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

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

L. All demolished ballasts and lamps shall be recycled.

M. Remove all abandoned conductors and cables within the construction area.

N. Support all existing communication cables within the construction area.

O. Provide fire stopping for all existing communication conduit fire rated wall penetrations within the construction area.

3.4 CONSTRUCTION PHASING

A. Plan and execute the work in accordance with the construction phasing indicated on the Architectural plans. Test and certify all systems, by phase of construction, so that "partial occupancy" can be obtained.

3.5 REUSE OF EXISTING MATERIALS

A. Where new devices are to replace existing, it shall be permissible to reuse existing outlet boxes and branch circuit conduits. It shall be the responsibility of the Contractor to ensure that existing outlet boxes and conduits that are reused comply with requirements for new.

B. The reuse of conduits (not remaining in place), conductors, and devices is not permitted.

3.6 CUTTING AND PATCHING

A. Structural Limitations: Do not cut structural framing, walls, floors, decks, and other members intended to withstand stress, except with the Engineer’s written authorization. Authorization will be granted only when there is no other reasonable method for completing the electrical work, and where the proposed cutting clearly does not materially weaken the structure.

B. Cutting Concrete: Where authorized, cut openings through concrete (for conduit penetrations and similar services) by core drilling or sawing. Do not cut by hammer-driven chisel or drill. Prior to cutting of existing concrete walls, floors, or ceilings x-ray existing concrete to locate existing hidden utilities.

C. Other Work: Do not endanger or damage other work through the procedures and process of cutting to accommodate electrical work. Review the proposed cutting with the Installer of the work to be cut, and comply with his recommendations to minimize damage. Where necessary, engage the original Installer or other specialists to execute the cutting in the recommended manner.

D. Patching: Where patching is required to restore other work, because of cutting or other damage inflicted during the installation of electrical work, execute the patching in the manner recommended by the original Installer. Restore the other work in every respect, including the elimination of visual defects in exposed finished, as judged by the Engineer. Engage the original Installer to complete patching of various categories of work including: concrete and masonry finishing, waterproofing and roofing, exposed wall finishes, etc.

3.7 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.

3.8 LABELING

A. Provide typed circuit directory showing revised circuiting arrangement.

B. Provide and install a new engraved nameplate for all electrical panels that have been modified during construction. Refer to the panelboard specification section for labeling requirements.

END OF SECTION 260501

SECTION 260510 – ELECTRICAL SUBMITTALS

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with the applicable requirements of the Division 1 specifications (013300) and the requirements of this Division of the specifications.

1.2 SUBMITTALS

A. Submit for review by the Engineer Architect a schedule with engineering data of materials and equipment to be incorporated in the work. Submittals shall be supported by descriptive materials, i.e., catalog sheets, product data sheets, diagrams, performance curves and charts published by the manufacturer, warranties, etc., to show conformance to Specifications and Plan requirements; model numbers alone shall not be acceptable. Data submitted for review shall contain all information to indicate compliance with Contract Documents. Complete electrical characteristics shall be provided for all equipment. Submittals for lighting fixtures shall include Photometric Data. The Engineer reserves the right to require samples of any equipment to be submitted for review.

B. The purpose of shop drawing review is to demonstrate to the Architect that the Contractor understands the design concept. The Architect's review of such drawings, schedules, or cuts shall not relieve the Contractor from responsibility for deviations from the drawings or specifications unless he has, in writing, called the Architect's attention to such deviation at the time of submission, and received written permission from the Architect for such deviations.

C. Where cut sheets include an entire product family, mark all specific items to be utilized for this project on equipment cut sheets. Generic cut sheets with no indication of which items on the cut sheet shall be used will be rejected.

D. Response to Submittals: Shop drawings shall be returned by the Electrical Engineer with the following classifications:

1. "No Exceptions Taken": No corrections, no marks. Contractor shall submit copies for distribution

2. "Make Corrections Noted": A few minor corrections. Items may be ordered as marked up without further resubmission. Submit copies for distribution.

3. "Amend and Resubmit": Minor corrections. Item may be ordered at the Contractor's risk. Contractor shall resubmit drawings with corrections noted.

4. "Rejected - Resubmit": Major corrections or not in accordance with the contract documents. No items shall be ordered. Contractor shall correct and resubmit drawings.

E. Prior Approvals and Shop Drawings must be hand delivered, received by mail, or email.

F. Equipment and materials requiring submittals:
1. Section 260500 – Common Work Results for Electrical
   a. Product Warranties
   b. Firestopping Materials
   c. Firestopping Installation Drawings for each conduit penetration, cable in metal

sleeve penetration and blank metal sleeve penetration for each type of wall/floor construction encountered

2. Section 260511 – Electrical Work Closeout
   a. Record Drawings
   b. Record Manuals
   c. Close out submittals

3. Section 260512 – Electrical Coordination

   a. Electrical Coordination Drawings

4. Section 260519 – Low-Voltage Electrical Conductors and Cables
   a. Splice Kits
   b.
   c. Wire
   d. Field Quality Control Test Reports

5. Section 260526 – Grounding and Bonding for Electrical Systems
   a. Grounding Connections
   b. Ground Wire

6. Section 260529 – Hangers and Supports for Electrical Systems
   a. Product Data

7. Section 260533 – Raceway and Boxes for Electrical Systems
   a. Raceway
   b. Boxes
   c. Floor Boxes
   d. Surface Metallic/Nonmetallic Raceway

8. Section 260548 – Vibration and Seismic Controls for Electrical Systems
   a. Submit seismic force level (Fp) calculations from applicable building code.
   b. Submit pre-approved restraint selections and installation details
   c. Restraint selection and installation details shall be sealed by a professionally licensed engineer experienced in seismic restraint design.
   d. Submit manufacturer's product data on strut channels including, but not limited to, types, materials, finishes, gauge thickness, and hole patterns. For each different strut cross-section, submit cross sectional properties including Section Modulus (Sx) and Moment of Inertia (Ix).
   e. Field reports

9. Section 260553 – Identification for Electrical Systems
    a. Product data for all labeling products
    b. Samples of device nameplates

10. Section 260574 – Short Circuit, Overcurrent Protection, Arc Flash Hazard Analysis
    a. Provide study per specification.

11. Section 260923 – Lighting Control Devices
    a. Lighting Contactors
    b. Lighting Control Panels
    c. Photo Cells.
    d. Enclosures
    e. Dimensional Data
    f. Wiring Diagrams
    g. Time Clock
    h. Zone Control Diagram

12. Section 262200 – Low Voltage Transformers
    a. Transformers
    b. Enclosures
    c. Dimensional Data
    d. Impedance (%Z)
    e. Temperature Rating
    f. Winding Material

13. Section 262400 –Panelboards
    a. Circuit Directory
    b. Circuit Breaker trip curves
    c. Shunt-Trip Breakers
    d. Short Circuit Current Rating
    e. Device nameplate data.

14. Section 262726 – Wiring Devices
    a. Product data
    b. Device Plates
    c. Weatherproof Covers
    d. Special Purpose Receptacles
    e. Dimmer Switches
    f. Occupancy Sensors
    g. Occupancy Sensor Wiring Diagrams
    h. Occupancy Sensor Layout Drawings showing location and orientation of each

sensor
i. Device and device plate colors

15. Section 262813 – Fuses
    a. Fuses

16. Section 262816 – Enclosed Switches and Circuit Breakers
    a. Product data
    b. Enclosures
    c. Dimensional Data
    d. Control Wiring Diagrams
    e. Accessories
    f. Short Circuit Current Rating
    g. Test reports
    h. Indicate on the submittal the name of the load served by each device submitted

17. Section 265100 – Lighting
    a. Lighting Fixtures
    b. Lamps
    c. Emergency Ballasts
    d. Color Samples

18. Section 271500 – Communications Horizontal Cabling
    a. Cabling administration drawings and printouts including labeling information.
    b. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
    c. Field quality-control reports.
    d. Cables
    e. Jacks
    f. Outlets
    g. Faceplates
    h. Faceplates colors
    i. Termination blocks
    j. Patch panels
    k. Equipment enclosures
    l. Racks
    m. UPS units
    n. TVSS and plug strip units
    o. Cable supports
    p. Cable management devices
    q. Cable - Nominal OD, Minimum bending radius, Maximum pulling tension.
    r. Shop Drawings:
    s. Qualification Data: For Installer
    t. Field quality-control reports.
    u. Communications Backboard and Rack Layout Diagrams
    v. Lightning Arrestors
    w. Patch cords

19. Section 276410 – Radio Frequency (RF) Based Signal Booster Systems (In-Building Radio enhancement System) (DAS)
    a. Product Data: For each type of product indicated.

b. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
c. Antenna size, location and wind support restraints.
d. Functional Block Diagram: Show single-line interconnections between components for the distribution system. Show cable types and sizes.
e. Wiring Diagrams: For power, signal, and control wiring and transmission cable, include cross connects, taps, and other connections cords.
f. Design Calculations: Calculate signal attention budget and show calculated line and equipment losses for the system based on the functional block diagram, to show that proposed system layout can be expected to perform up to specification. Calculate signal strength from sources to endpoints. Allowable losses between components and user interface shall be used to determine size and type of cable.
g. Coordination Drawings: Include dimensioned plan and elevation views of components and enclosures. Show access and workspace requirements.
h. Field quality-control reports.
i. Operation and Maintenance Data: For headend and distribution system to include in emergency, operation and maintenance manuals.
j. Splitters

20. Section 283100 – Fire Detection and Alarm
    a. Surge Protection
    b. HVAC/Kitchen Hood/Egress Door/Elevator Recall Control Wiring Diagrams
    c. Battery calculations.
    d. Voltage drop calculations
    e. Installer’s qualifications.
    f. Conduit fill calculations.
    g. Manufacturer's detailed data sheet for each control unit, initiating device, and notification appliance.
    h. Device layout drawings with proposed conduit routing. Drawings must be prepared using AutoCAD Release 2017 or newer.
    i. System riser diagram.
    j. List of all devices on each signaling line circuit, with spare capacity indicated.
    k. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72
    l. Warranty
    m. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
    n. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
    o. Submission to Authority Having Jurisdiction: In addition to routine submission of the above material, make an identical submission to the authority having jurisdiction. Include copies of shop drawings as required to depict component locations to facilitate review. Upon receipt of comments from the Authority, make resubmissions if required to make clarifications or revisions to obtain approval.
    p. Inspection and Test Reports:
        1) Submit inspection and test plan prior to closeout demonstration
        2) Submit documentation of satisfactory inspections and tests.
        3) Submit NFPA 72 "Inspection and Test Form," filled out.

21. Section 283200 – Two-Way Communication

a. Product Data
b. Wiring diagrams showing typical field wiring connections.
c. System riser diagram

PART 2 - PRODUCTS

2.1 Not Used.

PART 3 - EXECUTION

3.1 MANUFACTURER'S DATA

A. Include the manufacturer's comprehensive product data sheet and installation instructions. Where operating ranges are shown, mark data to show portion of range required for project application. Where pre-printed data sheet covers more than one distinct product-size, type, material, trim, accessory group or other variations, delete or mark-out portions of the pre-printed data which are not applicable.

3.2 EQUIPMENT LIST

A. Where more than one type of a product is being used (i.e. starters, disconnects, breakers, etc.) provide a list with each submittal correlating the type and size of product to the load served.

3.3 TEST REPORTS

A. Submit test reports which have been signed and dated by the firm performing the tests, and prepare in the manner specified in the standard or regulation governing the tests procedure as indicated.

END OF SECTION 260510

SECTION 260511 - ELECTRICAL WORK CLOSEOUT

PART 1 - GENERAL

1.1 SUBMITTALS

A. Refer to section 260510.

1.2 RELATED SECTIONS

A. Refer to section 017839 for additional requirements.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

A. Except where otherwise indicated, electrical drawings prepared by Engineer are diagrammatic in nature and may not show locations accurately for various components of electrical system. Shop drawings, including coordination drawings, prepared by the Contractor show portions of work more accurately to scale and location, and in greater detail. It is recognized that actual layout of installed work may vary substantially from both Contractor drawings and shop drawings.

B. The electrical superintendent shall maintain a white set of contract documents and shop drawings in clean, undamaged condition, for mark-up of actual installations which vary substantially from the work as shown. PDF or digital mark-ups is acceptable alternates Mark-up whatever drawings are most capable of showing installed conditions accurately. However, where shop drawings are marked, record a reference note on appropriate contract drawings. Mark with erasable pencil, and use multiple colors to aid in the distinction between work of separate electrical systems. <u>These documents shall be used for no other purpose</u>. In general, record every substantive installation of electrical work which previously is either not shown or shown inaccurately, but in any case record the following:

1. Post all addenda prior to beginning work.
2. Underground feeder conduits, both interior and exterior, drawn to scale and fully dimensioned.
3. Work concealed behind or within other work, in a non-accessible arrangement.
4. Mains and branches of wiring systems, with panelboards and control devices located and numbered, with concealed splices located, and with devices requiring maintenance located.
5. Scope of each change order (C.O.), noting C.O. number.

C. Upon each visit by the Architect/Engineer, the Contractor shall demonstrate that the record documents are being kept current, as specified hereinbefore.

2.2 RECORD MANUALS

A. Record manuals shall include the following:

1. Manufacturer’s operation and maintenance manuals for:
    a. Light Fixtures
    b. Loadcenters, Panelboards and Circuit Breakers
    c. Surge Protection Devices
    d. Fire Alarm System

e. Switchboards
f. Motor Starters
g. VFD
h. Emergency Power Generators
i. Transfer switches
j. Generator fuel tanks
k. Electrical Meters
l. Lightning Protection System
m. UPS systems
n. Two way communication systems
o. Power Conditioners
p. Lighting Control Systems

2. Shop drawings, revised to reflect all review comments, supplemented with the installation instructions shipped with equipment.
3. One copy of all panelboard directories.
4. All field test Reports
5. Electrical Contractor's Warranty
6. Fire alarm set of floor plans showing actual installed locations of components, conduit, and zones.
7. Fire Alarm "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.

B. Submit record manuals in quantities and in the format prescribed in the Division 1 specifications.

C. Submit copies of all Maintenance contracts including:
1. VFD drives.
2. Generator Systems.
3. Fire Alarm Systems.
4. UPS systems
5. Two way communication systems
6. Power Conditioners

2.3 CLOSEOUT SUBMITTALS

A. Software and Firmware Operational Documentation:
1. Software operating and upgrade manuals.
2. Program Software Backup: On USB drive, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

PART 3 - EXECUTION

3.1 SITE VISITS

A. At all construction observations by the Architect/Engineer, the Contractor shall demonstrate to the Architect/ Engineer that all work is complete in accordance with the contract documents and that all systems have been tested and are fully operational. The Contractor shall furnish the personnel, tools and equipment required to inspect and test all systems.

3.2 TRAINING

A. Train Owner's personnel on the operation and maintenance of the following systems:
   1. Fire Alarm System - 4 hours
   2. Lighting Control Systems – 8 hours

B. Training shall not be conducted until system has been tested by the Contractor and is 100% operational. Refer to the individual specification sections for additional requirements.

END OF SECTION 260511

SECTION 260512 - ELECTRICAL COORDINATION

PART 1 - GENERAL

1.1 SUBMITTALS

A. Refer to section 260510.

PART 2 - PRODUCTS

2.1 ELECTRICAL WORK SCHEDULE

A. After the award of contract, the Contractor shall prepare a detailed schedule (aka milestone chart) using “Microsoft Project” software or equivalent. The Contractor Project Schedule (CPS) shall indicate detailed activities for the projected life of the project. The CPS shall consist of detailed activities and their restraining relationships. It will also detail manpower usage throughout the project.

B. Electrical Work Schedule: Provide a Gantt chart for review by the Engineer and Owner at least 10-days prior to beginning work. The chart shall have color-coding to distinguish between demolition and renovation tasks as well as any other specific tasks. The Gantt chart shall include the following items:

1. Date of on-site arrival of electrical equipment and accessories required for system installation.
2. Estimated dates and duration of all service outage times.
3. Estimated start date and completion date for the demolition.
4. Estimated dates and duration of required work access to areas that are not in the current phase of work.

2.2 ELECTRICAL COORDINATION DRAWINGS

A. Electrical Rooms: Provide layouts of all electrical rooms using the dimensions of equipment actually furnished. Locate all ducts and piping entering or crossing these spaces.

B. Feeders over 100 Amps : The routing of main feeders is not shown on the drawings. Actual routing shall be determined by the contractor in accordance with the specifications and shall be coordinated with work by other trades. For underground lines, show all utility crossings.

C. Drawing Format: Drawings shall be prepared at a scale of no less than 1/16"=1'-0" for feeder routes and 1/4"=1'-0" for electrical rooms/equipment yards. Drawing shall be titled to define Project Name, Drawing subject and date prepared. Drawings are to be prepared in AutoCAD 2007 or compatible software.

2.3 EQUIPMENT REQUIRING ELECTRICAL SERVICE

A. Provide electrical connections for all electrically driven equipment. <u>Final connections are electrical work</u>, except as otherwise noted. Obtain a copy of the shop drawings of equipment. Review shop drawings to verify electrical characteristics and to determine rough-in requirements, final connection requirements, location of disconnect switch, etc. Notify the General Contractor if the information received is ambiguous or incomplete. Keep a copy of these shop drawings at the project site throughout the course of construction.

B. Equipment to be connected includes, but is not limited to the following:

1. Fire Alarm System
2. Elevators

C. The design of circuits for electrically driven equipment is based on the product of one manufacturer and may not be representative of all acceptable manufacturers. If equipment furnished has differing characteristics, make necessary adjustments to circuit components at no additional cost to the Owner, subject to the approval of the Engineer.

D. Provide motor starters and disconnects for all mechanical equipment unless provided by the mechanical contractor.

PART 3 - EXECUTION

3.1 COORDINATION OF MECHANICAL INSTALLATION:

A. Attachment Number 1 shall be filled out and returned with shop drawing submittals. The intent of Attachment Number 1 is to ensure that the electrical requirements for equipment have been reviewed and coordinated by the Contractor. No electrical equipment shall be ordered, nor shall rough-in begin, before this coordination has taken place. This document shall be returned appropriately marked whether or not any changes are deemed to be necessary by the contractor.

ATTACHMENT NO. 1

SHOP DRAWING COORDINATION AFFIDAVIT

I, the undersigned, certify that I have reviewed the equipment shop drawings for electrically driven equipment and that the accompanying electrical shop drawings reflect the requirements of the actual equipment to be furnished for use on this project. The following deviations from design drawings were required to serve the furnished equipment:

ITEM	CKT.DESIG.		BKR.SIZE		CONDUIT/WIRE		DISC.SIZE		STARTER	
	New	Old	New	Old	New	Old	New	Old	New	Old

NOTE: If no deviations are required please indicate by circling the appropriate answer above your signature.

PROJECT: ______________________________ DEVIATIONS: Yes / No

COMPANY:____

TITLE: _____________________ SIGNATURE: ________________________

TELEPHONE: __________________DATE:______________________________

IT IS THE RESPONSIBILITY OF THE DIVISION 26 CONTRACTOR TO OBTAIN SHOP DRAWING INFORMATION FROM OTHER TRADES. FAILURE TO PERFORM THE WORK REQUIRED BY THIS AFFIDAVIT, PRIOR TO ORDERING MATERIALS OR ROUGHING-IN, MAY RESULT IN IMPROPER CONNECTIONS BEING PROVIDED. THE EXPENSE OF CORRECTIVE MEASURES, IF REQUIRED, SHALL BE BORNE BY THE CONTRACTOR.

NOTE:
PANELBOARD SHOP DRAWINGS WILL NOT BE REVIEWED UNTIL THE ELECTRICAL CONTRACTOR COMPLETES AND SUBMITS THIS AFFIDAVIT TO THE ELECTRICAL ENGINEER.

END OF SECTION 260512

SECTION 260519 – LOW-VOLTAGE ELECTRICAL CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the requirements for the following:
   1. Wire and cable for 600 volts and less.
   2. Wiring connectors and connections.

1.2 SUBMITTALS

A. Refer to section 260510.

1.3 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.4 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Contracting; National Electrical Contractors Association; current edition.

B. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; current edition.

C. NFPA 70 - National Electrical Code; National Fire Protection Association, current edition.

PART 2 - PRODUCTS

2.1 WIRING REQUIREMENTS

A. Concealed Dry Interior Locations: Use only THHN-2, THWN-2 or XHHW-2 wire in raceway.

B. Exposed Dry Interior Locations: Use only THHN-2, THWN-2, or XHHW-2 in raceway.

C. Above Accessible Ceilings: Use only THHN-2, THWN-2, or XHHW-2 in raceway.

D. Wet or Damp Interior Locations: Use only THWN-2 or XHHW-2 in raceway.

E. Exterior locations (above or below grade) THWN-2, XHHW-2 or USE in raceway.

F. Use conductors not smaller than 12 AWG for power and lighting circuits.

G. Use conductors not smaller than 14 AWG for control circuits.

H. Metal Clad (MC) cable can be used for 20 Amp branch circuits, when installed in concealed indoor locations. and not used for home runs.

2.2 BUILDING WIRE

A. Conductor: Copper.

B. Insulation Voltage Rating: 600 volts.

C. Temperature Rating: 90°C.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Pull all conductors into raceway at same time.

B. Use suitable wire pulling lubricant for building wire 4 AWG and larger. Do not exceed manufacturers recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.

D. Neatly train and lace wiring inside boxes, equipment, and panelboards.

E. Clean conductor surfaces before installing lugs and connectors.

F. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

G. Use split bolt connectors or compression fittings for splices and taps on conductors 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.

H. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.

I. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

J. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values or UL 486A and UL 486B.

K. Identify and color code wire and cable under provisions of Section 26 05 53. Identify each conductor with its circuit number or other designation indicated.

L. For each electrical connection/termination, provide a complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire nuts, and other materials necessary to complete splices and terminations. Torque all connections according to installation instructions.

M. Motor connections shall be made with compression connectors forming a bolted in-line or stub-type connection.

N. Splicing of feeder conductors shall not be acceptable, unless specifically indicated on the drawing. Where splicing of feeder conductors is indicated, splices shall be made using compression type butt splice.

O. All splices made underground or in the pipe basements shall be rated suitable for water immersion.

P. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

Q. All MC cable shall be installed perpendicular or parallel to building structure and supports at intervals of 5 feet or less.

R. Cable ties shall not be used to support MC cables.

3.2 LABELING

A. Color Coding
1. Color shall be green for grounding conductors and green with yellow stripe for isolated grounding conductors.
2. The color of the circuit conductors shall be as follows:

120/208 volt, 3-phase	Phase A - Black Phase B - Red Phase C - Blue Neutral - White
277/480 volt, 3-phase:	Phase A - Brown Phase B - Orange Phase C - Yellow Neutral - Gray

3.3 FIELD QUALITY CONTROL

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

B. Perform inspections and tests listed in NETA STD ATS, Section 7.3.2.

END OF SECTION 260519

SECTION 260526 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Grounding and bonding components.

B. Provide all components necessary to complete the grounding system(s) consisting of:
   1. Existing and new metal underground water pipe.
   2. Metal frame of the building.
   3. Steel water storage tank and supports.
   4. Concrete-encased electrode.

1.2 SUBMITTALS

A. Refer to section 260510.

1.3 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.4 REFERENCES

A. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; current edition.

B. NFPA 70 - National Electrical Code; National Fire Protection Association; current edition.

C. NFPA 99 - Standard for Health Care Facilities; National Fire Protection Association; current edition.

D. IEEE Standard 142 "Green Book" – Recommended Practices for Grounding of industrial and Commercial Power Systems; current edition.

1.5 PERFORMANCE REQUIREMENTS

A. Maximum grounding system resistance: 15 ohms.

B. Services at power company interface points shall comply with the power company ground resistance requirements.

PART 2 - PRODUCTS

2.1 ELECTRODES

A. Sectionalized steel with copper-welded exterior, 3/4" dia. x 10'. One 10-foot section shall be required at each ground rod location, unless as otherwise directed in this specification.

2.2 CONDUCTORS

A. Bonding Jumper Braid: Copper braided tape, sized for application.

B. Electrical Grounding conductors: Unless otherwise indicated, provide bare or green insulated stranded copper electrical grounding conductors sized according to NEC or as shown or specified. Provide green insulated for conductors sized No. 10 AWG and smaller.

2.3 GROUND CONNECTIONS

A. Below Grade: Exothermic-welded type connectors.

B. Above Grade:
1. Bonding Jumpers: compression type connectors, using zinc-plated fasteners and external tooth lock washers.
2. Ground Busbars: Two-hole compression type lugs using tin-plated copper or copper alloy bolts and nuts.
3. Rack and Cabinet Ground Bars: one-hole compression-type lugs using zinc-plated or copper alloy fasteners.

C. Install exothermic connectors and terminals as recommended by the connector and terminal manufacturer for intended applications.

D. Bolted clamp will not be accepted between grounding rods and ground conductors.

2.4 EQUIPMENT RACK AND CABINET GROUND BARS

A. Provide solid copper ground bars designed for mounting on the framework of open or cabinet-enclosed equipment racks with minimum dimensions of 3/8 inch x ¾ inch unless noted otherwise.

B. Busbar Connectors: Cast silicon bronze, solderless, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch (15.8- or 25.4-mm) centers for a two-bolt connection to the busbar.

C. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors.

D. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA/EIA-568-B.1 and TIA/EIA-568-B.2 when grounding screened, balanced, twisted-pair cables.

E. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

2.5 GROUND TERMINAL BLOCKS

A. At any equipment mounting location (e.g. backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide screw lug-type terminal blocks.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify existing conditions prior to beginning work.

B. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.2 ELECTRICAL AND COMMUNICATION ROOM GROUNDING

A. Building Earth Ground Busbars: Provide ground busbar hardware at each electrical and communication room and connect to pigtail extensions of the building grounding ring.

3.3 LIGHTNING PROTECTION SYSTEM

A. Bond the lightning protection system to the electrical grounding electrode system.

3.4 CONDUCTIVE PIPING

A. Bond all conductive piping systems (excluding fuel gas piping), interior and exterior, to the building to the grounding electrode system. Bonding connections shall be made as close as practical to the equipment ground bus.

B. Install braided type bonding jumpers with ground clamps on water meter piping to electrically bypass meter where the main is metallic on both sides of the meter. Install clamp-on connectors only on thoroughly cleaned metal contact surfaces, to ensure electrical conductivity and circuit integrity.

3.5 CORROSION INHIBITORS

A. When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

B. Where concrete penetration is necessary, non-metallic conduit shall be cast flush with the points of concrete entrance and exit so as to provide an opening for the ground wire and the opening shall be sealed with a suitable compound after installation of the ground wire.

3.6 MEDIUM-VOLTAGE EQUIPMENT AND CIRCUITS

A. Switchgear: Provide a bare grounding electrode conductor from the switchgear ground bus to the grounding electrode system.

B. Duct Banks and Manholes: Provide an insulated equipment grounding conductor in each duct containing medium or high voltage conductors, sized per NEC except that minimum size shall be 2 AWG. Bond the equipment grounding conductors to the switchgear ground bus, to all manhole hardware and ground rods, to the cable shielding grounding provisions of medium or high voltage cable splices and terminations, and equipment enclosures.

C. Pad Mounted Transformers:
1. Provide a driven ground rod and bond with a grounding electrode conductor to the transformer grounding pad metal steel.
2. Ground the secondary neutral.

D. Lightning Arresters: Connect lightning arresters to the equipment ground bus or ground rods as applicable.

E. Outdoor Metallic Fences Around Electrical Equipment: Fences shall be grounded with a ground rod at each fixed gate post and at each corner post. Attach a 4 AWG copper conductor, by exothermic weld to the ground rods and extend underground to the immediate vicinity of fence post. Lace the conductor vertically into 12 inches of fence mesh and fasten by two approved bronze compression fittings, one to bond wire to post and the other to bond wire to fence. Each gate section shall be bonded to its gatepost by a 1/8 by one inch flexible braided copper strap and ground post clamps. Clamps shall be of the anti-electrolysis type.

F. Metallic Conduit: Metallic conduits which terminate without mechanical connection to an electrical equipment housing by means of locknut and bushings or adapters, shall be provided with grounding bushings. Connect bushings with a bare grounding conductor to the equipment ground bus.

3.7 SECONDARY EQUIPMENT AND CIRCUITS

A. Switchgear, Panelboards, Disconnects, Switchboards, Unit Substations, and Motor Control Centers; Connect metallic conduits, which terminate without mechanical connection to the housing, by grounding bushings and grounding conductor to the equipment ground bus.

B. Feeders and Branch Circuits: Install equipment grounding conductors with all feeders and power and lighting branch circuits, sized in accordance with Article 250 of NFPA 70.

C. Boxes, Cabinets, Enclosures, and Panelboards:
1. Bond the equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes (except for special grounding systems for intensive care units and other critical units shown).
2. Provide lugs in each box and enclosure for equipment grounding conductor termination.
3. Provide ground bars in panelboards, bolted to the housing, with sufficient lugs to terminate the equipment grounding conductors.

D. Motors and Starters: Provide lugs in motor terminal box and starter housing or motor control center compartment to terminate equipment grounding conductors.

E. Receptacles shall not be grounded through their mounting screws. Ground with a jumper from the receptacle green ground terminal to the device box ground screw and the branch circuit equipment grounding conductor.

F. Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the equipment grounding conductor.

G. Metallic Conduit: Metallic conduits which terminate without mechanical connection to an electrical equipment housing by means of locknut and bushings or adapters, shall be provided with grounding bushings. Connect bushings with a bare grounding conductor to the equipment ground bus.

3.8 HOSPITALS

A. Panelboard Bonding: The equipment grounding terminal buses of the normal and critical branch circuit panelboards serving the same individual patient vicinity shall be bonded together with an insulated continuous copper conductor not less than 10 AWG.

B. In patient care areas, bond the gases and suction piping, at the outlets, directly to the room or patient ground bus.

C. Provide grounding and bonding in patient care areas to meet requirements of NFPA 99 and NFPA 70.

3.9 INSTALLATION

A. Install ground electrodes at locations indicated. Provide additional electrodes as required to achieve specified resistance to ground.

B. Install nominal 10" diameter x 18" long fiberglass "water valve" type enclosure, with cover, over each ground rod. The top of ground rods shall be 12" below finished grade. The rod and exothermic connection to the grounding electrode conductor shall be accessible from within enclosure. Fill the lower 3" of enclosure with crushed rocks. Top of enclosure shall be flush with finished grade.

C. Make rebar in concrete footing around the perimeter of the building electrically continuous such that the resulting installation consists of a concrete encased electrode per Article 250 of the NEC. Extend No. 1/0 THWN grounding electrode conductors from convenient points along the “ground ring” to the equipment ground system.

D. If it is determined that the rebar cannot be made electrically continuous, install a No 1/0 bare copper conductor in the footing around the perimeter of the building.

E. Provide grounding electrode conductor and connect to reinforcing steel in foundation footing.

F. Bond together metal siding not attached to grounded structure; bond to ground.

G. Bond together reinforcing steel and metal accessories in pool and fountain structures.

3.10 ISOLATED POWER PANEL SYSTEMS

A. Isolation transformers shall not be system grounded.

B. All permanently installed exposed metallic objects or surfaces in the room powered by the isolated power panel shall be permanently grounded to the ground in the ground bus module in the isolated power panel. Grounding conductor shall be No. 10 AWG stranded copper, green insulated conductor not exceeding fifteen feet in length. Conductor insulation shall be cross-linked polyethylene not less than 30 mils thick. Install conductor in metallic conduit from enclosure to point of ground connection. Make connections to metal pipes with U.L. listed ground clamps; connections to flat metallic surfaces shall be with crimp type for no other purpose. Clean all surfaces to be grounded prior to connection.

3.11 ACCESS FLOORS

A. Install ground grid under communication access floors. Construct grid of 2AWG bare copper wire installed on 24 inch centers both ways. Bond each access floor pedestal to grid.

B. Bond together each metallic raceway, pipe, duct and other metal object entering space under access floors; Bond to underfloor ground grid.

C. Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

3.12 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA STD ATS except Section 4.

B. Perform inspections and tests listed in NETA STD ATS, Section 7.13.

C. Upon completion of installation of electrical grounding system, test resistance of each ground rod installation using the "Fall of Potential" method. Ground resistances shall be measured in normally dry conditions not less than 48 hours after rainfall and at low tide. Where tests show resistance to ground is over the specified value, take appropriate action to reduce resistance by driving additional sections of ground rods and then retest to demonstrate compliance. Tests shall be conducted in the presence of the Project Electrical Engineer. Provide forms to record the data as the tests are conducted. Forms shall be signed by the person conducting the test and included with project closeout documents.

D. Test the effectiveness of the grounding system in patient care areas as required by NFPA 99.

END OF SECTION 260526

SECTION 260529 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the requirements for the following:
   1. Conduit and equipment supports.
   2. Anchors and fasteners.

1.2 SUBMITTALS

A. Refer to section 260510.

1.3 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.4 REFERENCE STANDARDS

A. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting; National Electrical Contractors Association; current edition.

PART 2 - PRODUCTS.

2.1 MATERIALS

A. Hangers, Supports, Anchors, and Fasteners - General: Corrosion-resistant materials of size and type adequate to carry the loads of equipment and conduit, including weight of wire in conduit.

B. Supports: Fabricated of structural steel or formed steel members; galvanized.

C. Anchors and Fasteners:
   1. Do not use powder-actuated anchors.
   2. Concrete Structural Elements: Use precast inserts, expansion anchors, or preset inserts.
   3. Steel Structural Elements: Use beam clamps, steel spring clips, steel ramset fasteners, or welded fasteners.
   4. Concrete Surfaces: Use self-drilling anchors or expansion anchors.
   5. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts or hollow wall fasteners.
   6. Solid Masonry Walls: Use expansion anchors or preset inserts.
   7. Sheet Metal: Use sheet metal screws.
   8. Wood Elements: Use wood screws.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install hangers and supports as required to adequately and securely support electrical system components, in a neat and workmanlike manner, as specified in NECA 1.
   1. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.

B. Cutting or Holes:
   1. Locate holes in advance where they are proposed in the structural sections such as ribs or beams. Obtain the approval of the Architect prior to drilling through structural sections.
   2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not allowed, except where permitted by the Architect as required by limited working space.

C. Rigidly weld support members or use hexagon-head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

D. Install surface-mounted cabinets and panelboards with minimum of four anchors.

E. In wet and damp locations use steel channel supports to stand cabinets, disconnects and panelboards 1 inch (25 mm) off wall.

F. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

G. Use stamped steel bridges to fasten flush mounting outlet box between studs.

H. Use adjustable steel channel fasteners for hung ceiling outlet box.

I. Do not fasten boxes to ceiling support wires.

J. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12 inches of box.

K. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

L. Group related conduits; support using conduit rack. Construct rack using steel channel; provide space on each for 25 percent additional conduits

M. Do not support conduit with wire, wire ties, or perforated pipe straps. Remove wire used for temporary supports.

N. Do not attach conduit to ceiling support wires.

END OF SECTION 260529

SECTION 260533 – RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUBMITTALS

A. Refer to section 260510

1.2 QUALITY ASSURANCE

A. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and shown.

1.3 REFERENCE STANDARDS

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

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

C. ANSI C80.5 - American National Standard for Electrical Rigid Aluminum Conduit (ERAC); current edition

D. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting; National Electrical Contractors Association; current edition

E. NECA 101 - Standard for Installing Steel Conduit (Rigid, IMC, EMT); National Electrical Contractors Association; current edition

F. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association; current edition

1.4 DELIVERY, STORAGE, AND HANDLING

A. Accept conduit on site. Inspect for damage

B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

PART 2 - PRODUCTS

2.1 CONDUIT REQUIREMENTS

A. Conduit Size: Comply with NFPA 70.
   1. Minimum Size: 3/4 inch

B. Wet and Damp Locations:
   1. Exterior above ground and in pipe basements: RMC, IMC, or LFMC (LFMC shall be only used with restrictions, see conduit installation)
   2. Exterior below ground: RNC schedule 40
   3. Interior: RMC, IMC, or LFMC (LFMC shall be only used with restrictions, see conduit installation)

4. Interior below grade: RNC schedule 40
5. Where RNC Schedule 40 is installed below grade or under floor slabs, the elbows required to turn the raceway up through the slab shall be RMC.

C. Dry Locations:
1. Concealed: Use EMT or FMC (FMC shall be only used with restrictions, see conduit installation)
2. Exposed: Use EMT or FMC (FMC shall be only used with restrictions, see conduit installation)
3. Interior below grade: RNC schedule 40

D. Area subject to physical damage: RMC, IMC, or LFMC (LFMC shall be only used with restrictions, see conduit installation)
1. "Areas subject to physical damage" shall be defined as the most stringent of the following:
   a. Exposed conduit below eight feet above finished floor.
   b. As interpreted by the authority having jurisdiction (AHJ).

2.2 METAL CONDUIT

A. Rigid Steel Galvanized Conduit (RMC): ANSI C80.1.

B. Intermediate Metal Conduit (IMC): ANSI C80.6.

C. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.
1. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
2. Standard threaded couplings, locknuts, bushings, and elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
3. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
4. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.
5. Bushings: Metallic insulating type, consisting of an insulating insert molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
6. Sealing fittings: Threaded cast iron type. Use continuous drain type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.

2.3 FLEXIBLE METAL CONDUIT

A. FLEXIBLE METAL CONDUIT (FMC) Description: Interlocked steel construction. Flexible metal conduit shall conform to UL 1.

B. Fittings: NEMA FB 1.
1. Conform to UL 514B. Only steel or malleable iron materials are acceptable.
2. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
3. Clamp type, with insulated throat.

2.4 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC) Description: Interlocked steel construction with PVC jacket. Liquid-tight flexible metal conduit: Shall Conform to UL 360.

B. Fittings: UL 514B and ANSI/ NEMA FB1.
   1. Only steel or malleable iron materials are acceptable.
   2. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
   3. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.
   4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.

2.5 ELECTRICAL METALLIC TUBING

A. ELECTRICAL METALLIC TUBING (EMT) Description: ANSI C80.3

B. Fittings and Conduit Bodies: NEMA FB 1; steel compression type.
   1. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
   2. Only steel or malleable iron materials are acceptable.
   3. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
   4. Couplings and connectors: Concrete tight and rain tight, with connectors having insulated throats. Use gland and ring compression type couplings and connectors for conduit sizes 50mm (2 inches) and smaller.
   5. Indent type connectors or couplings are prohibited.

2.6 NONMETALLIC CONDUIT

A. RIGID NONMETALLIC CONDUIT (RNC): Direct burial plastic conduit: Shall conform to UL 651 and UL 651A, heavy wall PVC or high density polyethylene (PE).

B. RNC: NEMA TC 2, schedule 40 PVC

C. Fittings shall meet the requirements of UL 514C and NEMA TC3

D. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.

2.7 EXPANSION AND DEFLECTION COUPLINGS

A. Conform to UL 467 and UL 514B.

B. Accommodate, 0.75 inch deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.

C. Include internal flexible metal braid sized to guarantee conduit ground continuity and fault currents in accordance with UL 467, and the NEC code tables for ground conductors.

D. Jacket: Flexible, corrosion resistant, watertight, moisture and heat resistant molded rubber material with stainless steel jacket clamps.

2.8 CORROSION PROTECTION

A. Corrosion protection for conduits passing through concrete slabs shall be by one of the following means: field-wrapped with 3M Scotchrap No. 50, 2-inch wide (minimum), with a 50 percent overlay, or shall have a factory-applied polyvinyl chloride, plastic resin, or epoxy coating.

2.9 FLOOR BOXES:

A. For slab on grade locations (non-furniture feed applications): Evolution Series floor box by Legrand or comparable product by one of the following, contingent upon compliance with the Contract Documents:
   1. Hubbell Wiring Systems
   2. FSR Inc.

B. For all other locations (non-furniture feed applications): Evolution Series poke-thru device by Legrand or comparable product by one of the following, contingent upon compliance with the Contract Documents:
   1. Hubbell Wiring Systems
   2. FSR Inc.

C. For slab on grade furniture feed locations: Evolution Floor Box dual-service Furniture Feed by Legrand or comparable product by one of the following, contingent on compliance with the contract documents:
   1. Hubbell Wiring Systems
   2. FSR Inc.

D. For all other furniture feed locations: Evolution Series poke-thru device dual-service Furniture Feed by Legrand or comparable product by one of the following, contingent on compliance with the contract documents:
   1. Hubbell Wiring Systems
   2. FSR Inc.

E. All floor boxes and poke-thrus to be recessed service. Flush service boxes are not acceptable.

F. All poke-thrus to be UL listed for installation in a 2-hour fire-rated floor.

G. Provide floor boxes and poke-thrus with all necessary appurtenances to make a fully functioning system and incorporate wiring devices, low-voltage, and A/V connections indicated on plans.

H. Cover to be UL listed for scrub water. Cover to have in-use hinged cable access doors. Finish of cover shall be selected by Architect and shall be compatible with specified floor finish or covering.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify routing and termination locations of conduit prior to rough-in.

B. Conduit routing is shown on drawings in approximate locations unless dimensioned. Route as required to provide a complete wiring system.

3.2 CONDUIT INSTALLATION

A. All fire alarm cable shall be installed in metallic conduit. Coordinate with fire alarm system manufacturer for cable routing and quantities.

B. Install conduit securely, in a neat and workmanlike manner, as specified in NECA 101.

C. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight.

D. Arrange supports to prevent misalignment during wiring installation.

E. Arrange conduit to maintain headroom and present neat appearance.

F. Route exposed conduit parallel and perpendicular to walls.

G. Route conduit installed above accessible ceilings parallel and perpendicular to walls.

H. Route conduit in and under slab from point-to-point.

I. Maintain adequate clearance between conduit and piping.

J. Maintain 12 inch (300 mm) clearance between conduit and surfaces with temperatures exceeding 104 degrees F (40 degrees C).

K. Cut conduit square using saw or pipecutter; de-burr cut ends.

L. Bring conduit to shoulder of fittings; fasten securely.

M. For power conduits install no more than equivalent of three 90 degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use hydraulic one shot bender to fabricate bends in metal conduit larger than 2 inch (50 mm) size.

N. For communication conduits install no more than the equivalent of two 90 degree bends between pull points. Use conduit bodies to make sharp changes in direction, as around beams. Use hydraulic one shot bender to fabricate bends in metal conduit larger than 2 inch (50 mm) size.

O. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.

P. Provide suitable fittings to accommodate expansion and deflection where conduit crosses seismic, control, and expansion joints.

Q. Seal the inside of all conduits where conduit passes below floor or outside of the building.

R. Provide suitable pull string in each empty conduit except sleeves and nipples.

S. Use suitable caps to protect installed conduit against entrance of dirt and moisture.

T. Do not install FMC or LFMC in lengths over 6’.

U. Use LFMC or FMC only to connect to equipment subject to vibration or to suspended light fixtures.

V. Wherever possible, install horizontal raceway runs above water and drain piping. Give the right-of-way in confined spaces to piping that must slope for drainage and to larger HVAC ductwork and similar services that are less conformable than electrical services.

W. Complete the installation of electrical raceways before starting installation of cables within raceways.

X. Raceways shall not be installed exposed in finished spaces. Install concealed in walls, ceilings, below slab-on-grade or embedded in slabs above grade.

3.3 BOX INSTALLATION

A. Boxes for Concealed Conduits:
   1. Flush mounted.
   2. Provide raised covers for boxes to suit the wall or ceiling, construction and finish.

B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling in operations.

C. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.

D. Outlet boxes in the same wall mounted back-to-back are prohibited. A minimum 24 inch, center-to-center lateral spacing shall be maintained between boxes.

E. Minimum size of outlet boxes for ground fault interrupter (GFI) receptacles is 4 inches square by 2-1/8 inches deep, with device covers for the wall material and thickness involved.

F. Clean all debris out of floor boxes.

3.4 IDENTIFICATION

A. Stencil or install phenolic nameplates on covers of the boxes identified on riser diagrams; for example "SIG-FA JB No. 1"

B. On all concealed junction box covers, identify the circuits with black marker. For exposed junction boxes use printed labels.

END OF SECTION 260533

SECTION 260548 – VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUBMITTALS

A. Refer to section 260510.

1.2 QUALITY ASSURANCE

A. Submittals must be signed and sealed shop drawings from a professional engineer licensed in the state that the project is located in. Shop drawings to include project specific details, sketches, product data cut sheets.

B. The contractor shall provide pre-engineered seismic restraint systems to meet total design lateral force requirements for support and restraint of piping, conduit, cable trays and other similar systems and equipment where required by the applicable building code.

C. System Supports/Restraints Manufacturers shall be firms regularly engaged in the manufacture of products of the types specified in this section, whose products have been in satisfactory use in similar service for not less than 5 years.

PART 2 - PRODUCT

2.1 SEISMIC BRACING

A. General:
1. Seismic restraint designer shall coordinate all attachments with the structural engineer of record.
2. Design analysis shall include calculated dead loads, static seismic loads, and capacity of materials utilized for the connection of the equipment or system to the structure.
3. Analysis shall detail anchoring methods, bolt diameter, and embedment depth.
4. All seismic restraint devices shall be designed to accept without failure the forces calculated per the details and notes on the construction documents

B. Friction from gravity loads shall not be considered resistance to seismic forces.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All seismic restraint systems shall be installed in strict accordance with the manufacturer’s seismic restraint guidelines manual and all certified submittal data

B. Installation of seismic restraints shall not cause any change in position of equipment or piping, resulting in stresses or misalignment.

C. No rigid connections between equipment and the building structure shall be made that degrade the noise and vibration-isolation system specified.

D. Do not install any equipment, piping, duct, or conduit that makes rigid connections with the building.

E. Prior to installation, bring to the architect's/engineer's attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.

F. Bracing may occur from flanges of structural beams, upper truss cords of bar joists, cast in place inserts, or wedge-type concrete anchors. Consult structural engineer of record.

G. Overstressing of the building structure shall not occur from overhead support of equipment. Bracing attached to structural members may present additional stresses. The contractor shall submit loads to the structural engineer of record for approval in this event.

H. Brace support rods when necessary to accept compressive loads. Welding of compressive braces to the vertical support rods is not acceptable.

I. Provide reinforced clevis bolts where required.

J. Seismic restraints shall be mechanically attached to the system. Looping restraints around the system is not acceptable.

K. Do not brace a system to two independent structures such as a ceiling and wall.

L. Provide appropriately sized openings in walls, floors, and ceilings for anticipated seismic movement.

3.2 FIELD QUALITY CONTROL

A. Inspect all seismic supports after installation and submit a report from a professional engineer licensed in the state that the project is located in.

END OF SECTION 260548

SECTION 260553 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUBMITTALS

A. Refer to section 260510.

PART 2 - PRODUCTS

2.1 NAMEPLATES AND LABELS

A. Nameplates: Engraved three-layer laminated plastic, black letters on white background unless noted otherwise.

B. Locations:
1. Each electrical distribution and control equipment enclosure.

C. Letter Size:
1. Use 1/4 inch (6 mm) letters for identifying grouped equipment and loads.

D. Labels: Embossed adhesive tape, with 3/16 inch (5 mm) white letters on black background. Use only for identification of individual wall switches, receptacles, and control device stations. Labels shall identify the panel and circuit number (Ex: PANEL: CIRCUIT).

E. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi (48.2 MPa).
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
5. Color: burgundy.

PART 3 - EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive nameplates and labels.

3.2 INSTALLATION

A. Install nameplates and labels parallel to equipment lines.

B. Secure nameplates to equipment front using corrosion resistant screws.

C. Secure nameplates to inside surface of door on panelboard that is recessed in finished locations.

D. Provide name plates on all disconnects, panelboards, switchboards, switchgear, transformers, and motor starters.

E. Provide labels on all receptacles, light switches, and wall mounted occupancy sensors.

END OF SECTION 260553

SECTION 260574 - SHORT CIRCUIT, OVERCURRENT PROTECTION, ARC FLASH HAZARD ANALYSIS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study.

1. Coordination of series-rated devices is permitted where indicated on Drawings.

1.2 SUBMITTALS

A. Refer to section 260510.

1.3 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Registered Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

1.4 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings
5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems
6. IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations

B. American National Standards Institute (ANSI):

1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures

3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
4. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories
5. ANSI C37.5 – Methods for Determining the RMS Value of a Sinusoidal Current Wave and Normal-Frequency Recovery Voltage, and for Simplified Calculation of Fault Currents

C. The National Fire Protection Association (NFPA)
1. NFPA 70 - National Electrical Code, latest edition
   a. NFPA 70E – Standard for Electrical Safety in the Workplace

PART 2 - PRODUCTS

2.1 STUDIES

A. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer. By using the equipment manufacturer the study allows coordination of proper breakers, fuses, and current transformers. The coordination study shall begin with the utility company's feeder protective device and include all of the electrical protective devices down to and include the largest feeder circuit breaker and motor starter in the 480 Volt motor control centers and power distribution panelboards. The study shall also include variable frequency drives, harmonic filters, power factor correction equipment, transformers and protective devices associated with variable frequency drives, emergency and standby generators associated paralleling equipment and distribution switchgear.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

2.2 DATA COLLECTION

A. Contractor shall furnish all field data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to eliminate unnecessary delays and assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. Source combination may include present and future utility supplies, motors, and generators.

C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner or Contractor.

D. Include fault contribution of existing motors in the study, with motors < 50 hp grouped together. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

2.3 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standards 141, latest edition.

B. Transformer design impedances and standard X/R ratios shall be used when test values are not available.

C. Provide the following:
1. Calculation methods and assumptions
2. Selected base per unit quantities
3. One-line diagram of the system being evaluated with available fault at each bus, and interrupting rating of devices noted
4. Source impedance data, including electric utility system and motor fault contribution characteristics
5. Typical calculations
6. Tabulations of calculated quantities
7. Results, conclusions, and recommendations

D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:
1. Electric utility's supply termination point
2. Incoming switchgear
3. Unit substation primary and secondary terminals
4. Low voltage switchgear
5. Motor control centers
6. Standby generators and automatic transfer switches
7. Branch circuit panelboards
8. Other significant locations throughout the system

E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.

F. Protective Device Evaluation:
1. Evaluate equipment and protective devices and compare to short circuit ratings
2. Adequacy of switchgear, motor control centers, and panelboard bus bracing to withstand short-circuit stresses
3. Adequacy of transformer windings to withstand short-circuit stresses
4. Cable and busway sizes for ability to withstand short-circuit heating
5. Notify Owner in writing, of existing, circuit protective devices improperly rated for the calculated available fault current

2.4 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves shall be graphically displayed on log-log scale paper.

B. Include on each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.

D. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the curve sheets, where applicable:
1. Electric utility's protective device
2. Medium voltage equipment relays
3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
5. Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters
6. Conductor damage curves
7. Ground fault protective devices, as applicable
8. Pertinent motor starting characteristics and motor damage points
9. Pertinent generator short-circuit decrement curve and generator damage point
10. Other system load protective devices for the largest branch circuit and the largest feeder circuit breaker in each motor control center

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.5 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.

B. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Alternative methods shall be presented in the proposal.

C. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

D. The Arc-Flash Hazard Analysis shall include all MV, 575v, & 480v locations and significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA.

E. Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm2.

F. The Arc Flash Hazard analysis shall include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume a minimum motor load. Conversely, the maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

G. Arc flash computation shall include both line and load side of main breaker calculations, where necessary.

H. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2.

2.6 REPORT SECTIONS

A. Input Data:
1. Utility three-phase and line-to-ground available contribution with associated X/R ratios
2. Short-circuit reactance of rotating machines with associated X/R ratios
3. Cable type, construction, size, # per phase, length, impedance and conduit type
4. Bus duct type, size, length, and impedance
5. Transformer primary & secondary voltages, winding configurations, kVA rating, impedance, and X/R ratio
6. Reactor inductance and continuous ampere rating
7. Aerial line type, construction, conductor spacing, size, # per phase, and length

B. Short-Circuit Data:
1. Source fault impedance and generator contributions
2. X to R ratios
3. Asymmetry factors
4. Motor contributions
5. Short circuit Kva
6. Symmetrical and asymmetrical fault currents

C. Recommended Protective Device Settings:
1. Phase and Ground Relays:
   a. Current transformer ratio.
   b. Current setting.
   c. Time setting.
   d. Instantaneous setting.
   e. Specialty non-overcurrent device settings.
   f. Recommendations on improved relaying systems, if applicable.
2. Circuit Breakers:
   a. Adjustable pickups and time delays (long time, short time, ground).
   b. Adjustable time-current characteristic.
   c. Adjustable instantaneous pickup.
   d. Recommendations on improved trip systems, if applicable.

D. Incident energy and flash protection boundary calculations:
1. Arcing fault magnitude
2. Device clearing time
3. Duration of arc
4. Arc flash boundary
5. Working distance

6. Incident energy
7. Hazard Risk Category
8. Recommendations for arc flash energy reduction

PART 3 - EXECUTION

3.1 FIELD ADJUSTMENT

A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Notify Architect / Engineer in writing of any required major equipment modifications.

D. Following completion of all studies, acceptance testing and startup by the field engineering service division of the equipment manufacturer, a 2-year warranty shall be provided on all components manufactured by the engineering service parent manufacturing company.

3.2 ARC FLASH WARNING LABELS

A. The vendor shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.

B. The label shall have an orange header with the wording, “WARNING, ARC FLASH HAZARD”, and shall include the following information:
   1. Location designation
   2. Nominal voltage
   3. Flash protection boundary
   4. Hazard risk category
   5. Incident energy
   6. Working distance
   7. Engineering report number, revision number and issue date

C. Labels shall be machine printed, with no field markings

D. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
   1. For each 600, 480 and applicable 208 volt panelboards and disconnects, one arc flash label shall be provided
   2. For each motor control center, one arc flash label shall be provided
   3. For each low voltage switchboard, one arc flash label shall be provided
   4. For each switchgear, one flash label shall be provided
   5. For medium voltage switches one arc flash label shall be provided

E. Labels shall be field installed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

3.3 ARC FLASH TRAINING

A. The equipment vendor shall train personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours). Maintenance procedures in accordance with the requirements of NFPA 70E, Standard For Electrical Safety Requirements For Employee Workplaces, shall be provided in the equipment manuals. The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET).

END OF SECTION 260574

SECTION 260800- COMMISSIONING OF LIGHTING CONTROL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes commissioning process requirements for Lighting Control Systems, assemblies, and equipment.

B. Related Sections:

Section 019113 "General Commissioning Requirements" for general commissioning process requirements.

1.3 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

C. Lighting Control Systems: Lighting Control Systems, Equipment, Safeties, Interfaces and Interlocks with other systems.

D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 INFORMATIONAL SUBMITTALS

A. Certificates of readiness.

B. Pre-Functional Test Checklist and equipment start up reports.

1.5 CONTRACTOR'S RESPONSIBILITIES

A. Perform commissioning tests and provide reports at the direction of the CxA.

B. Attend construction phase controls coordination meetings.

C. Participate in Lighting Control Systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

D. Provide information requested by the CxA for final commissioning documentation.

E. Provide measuring instruments and logging devices, calibrated within one year of date of test unless specifications or industry standards require more stringent calibration periods, to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.6 CxA'S RESPONSIBILITIES

A. Provide Project-specific construction checklists and commissioning process test procedures for actual Lighting Control Systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.

B. Direct commissioning testing.

C. Organize Contractor provided test data, inspection reports, and certificates in Systems Manual.

1.7 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:
1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for Lighting Control Systems, assemblies, equipment, and components to be verified and tested.
4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
5. Certificate of readiness certifying that Lighting Control Systems, subsystems, equipment, and associated controls are ready for testing.
6. Test and inspection reports and certificates.
7. Corrective action documents.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Provide a fully executed Certificate of Readiness signed by Contractor, Subcontractors, and BAS provider certifying that Lighting Control Systems instrumentation and control systems have been completed and calibrated, pre-tested and inspected and that they are operating according to the Contract Documents, and that pretest set points have been recorded. Provide completed Certificate of Readiness to CxA no less than 7 days prior to the scheduled beginning of on-site CxA verification testing.

B. Certify that testing and adjusting procedures have been completed and that testing and adjusting reports have been submitted, discrepancies corrected, and corrective work approved.

C. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

D. Inspect and verify the position of each device and interlock identified on checklists.

E. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

F. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of Lighting Control Systems testing shall include entire Lighting Control Systems installation, from central equipment, lighting control panels, switches, sensors, devices, interfaces and fixtures. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. CxA will witness the test of all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of system controllers and sensors.

D. The specific Electrical Systems Subcontractor shall prepare detailed testing plans, procedures, and checklists for Lighting Control Systems, subsystems, and equipment.

E. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

F. The CxA may direct that set points be altered when simulating conditions is not practical.

G. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

H. If tests cannot be completed because of a deficiency outside the scope of the Lighting Control

Systems system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

I. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

END OF SECTION 260800

SECTION 260923 – LIGHTING CONTROL DEVICES

PART 1 - PART 1 GENERAL

1.1 SUBMITTALS

A. Refer to section 260510.

1.2 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

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

C. Products: Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated

D. UL Approvals: UL listed under UL 916 Energy Management Equipment.

E. FCC Emissions: Compliance with FCC emissions Standards specified in Part 15 Subpart J for Class A application.

1.3 REFERENCE STANDARDS

A. NEMA ICS 4 – Industrial Control and Systems: Terminal Blocks; National Electrical Manufacturers Association; current edition.

B. NFPA 70 - National Electrical Code; National Fire Protection Association, current edition.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Leviton Manufacturing, Inc: www.leviton.com.

B. Lutron Electronics Inc: www.lutron.com

C. Wattstopper Inc: www.wattstopper.com

2.2 RELAY PANELS

A. Cover: Surface or Flush as required, hinged, lockable and shall restrict access to line voltage section.

B. Clock display and keypad shall be mounted on interior cabinet door for easy user access and programming

C. Interior: Barrier for separation of high voltage (class 1) and low voltage (class 2) wiring. It shall include intelligence boards, power supply and control relays. Clock display and keypad shall be mounted on interior cabinet door for easy user access and programming.

D. Panel shall accept a minimum of eight single pole relays. Provide 25% minimum spare relays. Relays shall be individual latching relays with 30 Amp load contacts for ballast (including HID, magnetic or electronic type ballasts), tungsten and general purpose loads. Provide isolated auxiliary contacts for pilot light switching. Relays shall use quick connectors and be individually replaceable to facilitate ease of use.

E. The lighting control panel shall provide a stagger up delay, override push buttons, pilot light outputs, and LED status light indicators for each relay or contactor control channel.

F. The clock shall have a backlight display, user keypad and shall provide a minimum of 8 channels of time or astronomical control. Preprogrammed lighting control scenarios shall include: scheduled on/off, manual on/scheduled off, manual on/automatic switch sweep off, astronomic or photocell on/off and astronomic or photocell control with scheduled on/off. Time clock shall provide up to 42 holidays, automatic daylight savings adjustment, astronomic coordinates by major cities, and help screens. Program memory shall be non-volatile and clock shall retain time keeping during power outages for at least 48 hours.

G. The panel shall have minimum of 8 universal switch inputs that are low voltage, self-configuring and shall not require programming to accept momentary on/ momentary off switch, push button switch (cycling), maintained switch or 24VDC signals from occupancy sensors, photocells or other interfacing devices.

H. After-hour interior lighting shut off control shall provide a full duration override time of 1 to 240 minutes with a warning blink five to 15 minutes prior to shutting the lighting off. An impending shut off will be cancelled and the override period re-initialized through the operation of any assigned switch input.

I. After-hour interior lighting shut off control may be by line voltage power interrupt control to automatic control switches. The lighting control relay panel shall provide a warning blink signal to automatic control switches, thus allowing a five-minute delay prior to shutting off lighting. The lighting shut off event may be cancelled by pressing the automatic control switch push button. The lighting control panel time clock shall provide periodic lighting sweep signals to shut off automatic control switches.

2.3 REMOTE CONTROL SWITCHING RELAYS

A. Description: Heavy duty, two-coil momentary contact type remote control relay.

B. Contacts: Rated 20 amperes at 277 volts and with isolated and non-isolated pilot contacts where indicated.

C. Line Voltage Connections: Clamp type screw terminals.

2.4 CONTACTORS

A. Contactors shall be rated 30A/600V and shall be installed in a NEMA 1 enclosure. Coil voltage shall be 120V, unless noted otherwise. Contactors shall be electrically operated, mechanically held type with coil clearing contacts. Contactors shall be field-convertible for use with maintained-contact (two-wire) or momentary-contact (three-wire) control devices. Provide three-wire control unless noted otherwise.

B. Contactors shall be of the number of poles required to control the circuits indicated, plus a minimum of two spare poles. Where number of circuits controlled exceeds the maximum number of poles available, provide multiple contactors connected in parallel.

C. Provide H-O-A switch in cover of enclosure for contactors serving exterior lighting. Connect switch to operate as indicated on the drawings.

D. Contactors shall have silver alloy double-break contacts and coil clearing contacts for mechanically held contactor and shall require no arcing contacts.

2.5 PHOTOCELLS

A. Photocells shall have the following features:
1. Quick-response, cadmium-sulfide type.
2. A 15 to 30 second, built-in time delay to prevent response to momentary lightning flashes, car headlights or cloud movements.
3. Energizes the system when the north sky light decreases to approximately 1.5 footcandles, and maintains the system energized until the north sky light increases to approximately 3 to 5 foot candles.

2.6 CONTROLS

A. Switches

B. Wiring

PART 3 - EXECUTION

3.1 INSTALLATION

A. Photocell Switch Aiming: Aim switch according to manufacturer’s recommendations. Set adjustable window slide for proper footcandles photocell turn-on.

B. Locate contactors controlling lighting circuits above panels in which circuits originate; locate contactors controlling receptacles above accessible ceiling of room near location of door to room.

C. Neutral and grounding conductors shall be routed through contactor enclosure with associated phase conductor(s) being switched. Group each branch circuit within enclosure using nylon tie straps.

D. Do not splice conductors within contactor enclosure.

E. Provide wiring troughs with terminal strips adjacent to contactors, so that unswitched portions of circuits (i.e. exit lights, etc.) can bypass the contactors. The use of wirenuts within enclosures is not acceptable. Connect contactor enclosure to panelboard and troughs with conduit nipples sized for the total number of branch circuits conductors encountered.

3.2 LABELING

A. All wiring shall be labeled clearly indicating which lighting control panel or device it connects to.

B. Use only properly color-coded, stranded wire as indicated on the drawings.

3.3 DEMONSTRATION

A. Demonstrate proper operation of system.

3.4 FIELD QUALITY CONTROL

A. Perform field inspection, testing, and adjusting in accordance with Section 01 40 00.

B. Inspect each device for defects.

C. Operate each switch and verify proper operation.

3.5 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

B. It shall be the contractor's responsibility to make all proper adjustments to assure owner's satisfaction with the lighting control system.

END OF SECTION 260923

SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUBMITTALS

A. Refer to section 260510.

1.2 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

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

C. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

D. Dry type transformers shall be in accordance with NEMA standards

1.3 REFERENCES

A. NEMA ST 1 - Specialty Transformers (Except General Purpose Type); National Electrical Manufacturers Association; current edition

B. NEMA ST 20 - Dry-Type Transformers for General Applications; National Electrical Manufacturers Association; current edition

C. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; current edition.

D. NFPA 70 - National Electrical Code; National Fire Protection Association; current edition

1.4 DELIVERY, STORAGE, AND HANDLING

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

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers
   1. Eaton Electrical/Cutler-Hammer

2. GE Industrial
3. Square D
4. Siemens

2.2 TWO-WINDING TRANSFORMERS

A. Description: NEMA ST 20, factory-assembled, air-cooled dry type transformers.

B. Primary Voltage: As indicated on plans.

C. Secondary Voltage: As indicated on plans.

D. Insulation system and average winding temperature rise: Class 220 with 150 degrees C rise.

E. Case Temperature: Do not exceed 35 degrees C rise above ambient at warmest point at full load.

F. Winding Taps: minimum of two 2.5 percent below rated voltage, and two 2.5 percent above rated voltage.

G. Sound Levels: comply with NEMA ST 20.; Maximum sound levels shall not exceed the following:

Transformer Rating	Sound Level Rating
0 - 9 KVA	40 dB
10 - 50 KVA	45 dB
51 - 150 KVA	50 dB
151 - 300 KVA	55 dB
301 - 500 KVA	60 dB

H. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

I. Mounting: suitable for wall; floor; trapeze mounting.

J. Coil Conductors: Continuous [copper][aluminum] windings with terminations brazed or welded.

K. Transformer Enclosure: NEMA ST 20.
   1. Indoor - Type 1;
   2. Provide lifting eyes or brackets.

L. Isolate core and coil from enclosure using vibration-absorbing mounts.

M. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise.

N. Electrostatic Shield: Copper, between primary and secondary windings.

O. Transformer impedance value shall be manufacturer's standard for size transformer provided unless noted otherwise.

P. Transformers shall meet the minimum energy efficiency values per DOE 2016 Efficiency.

2.3 SOURCE QUALITY CONTROL

A. Production test each unit according to NEMA ST 20.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set transformers plumb and level.

B. Use flexible conduit, for connections to transformer case. Make conduit connections to side panel of enclosure.

C. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by the manufacturer.

D. Mount floor-mounted transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure. Floor mounted transformers shall be installed on a 4" high (min) concrete pad with 6" minimum overlap on all sides. Anchor transformer to pad.

E. Mount trapeze-mounted transformers as indicated.

F. Installation of transformers shall be such that air circulation around the units is not restricted. Hold 6" off walls.

G. For suspended transformers, coordinate exact placement with sprinkler system installer.

3.2 FIELD QUALITY CONTROL

A. Perform inspections and tests listed in NETA STD ATS, Section 7.2. In addition to the basic requirements of Section 7.2, include the following:
1. Measure the resistance of each winding at each tap connection.
2. Overpotential test on all high- and low-voltage windings-to-ground.
3. Infrared testing on transformer and terminations.

3.3 ADJUSTING

A. Measure primary and secondary voltages and make appropriate tap adjustments.

END OF SECTION 26 22 00

SECTION 262400 –PANELBOARDS

PART 1 - GENERAL

1.1 SUBMITTALS

A. See section 260510.

1.2 QUALITY ASSURANCE

A. Where switchboards or panelboards are used as service entrance equipment, they shall comply with all NEC and UL requirements for service entrance and a UL service entrance label shall be provided.

B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting; National Electrical Contractors Association; current edition.

B. NEMA PB 1 - Panelboards; National Electrical Manufacturers Association; current edition.

C. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; National Electrical Manufacturers Association; current edition.

D. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; current edition.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Eaton Electrical/Cutler-Hammer

B. GE Industrial

C. Square D

D. Siemens

2.2 SWITCHBOARDS

A. Provide factory-assembled, front accessible dead-front, metal-enclosed, free-standing switchboards.

B. Unless shown otherwise, switchboard shall consist of separate sections for termination/metering, main breaker and distribution.

C. The bus shall be copper with 98 percent conductivity.

D. Vertical bus shall be the full height of the switchboard.

E. Horizontal bus shall be fully sized for entire length of switchboard, and shall have provisions for future extension (bus stabs). The complete assembly shall be listed for 100% rating.

F. Provide full sized copper with 98 percent conductivity neutral bus.

G. Provide copper with 98 percent conductivity ground bus rated not less than 25% of main bus or as required by the NEC, whichever is greater.

2.3 SWITCHBOARD METERING

A. Provide Square D Power Logic Circuit Monitor ION9000, complete with current transformers and interconnecting wiring, all rated for 1% accuracy. Unit shall be factory installed and tested. Flush mount meter in termination compartment. Equivalent metering by Westinghouse, G.E. or Siemens are acceptable.

B. Connect the branch circuit breaker meters to the central meter and provide an ethernet access to the meter. Connect the meter (including all branch circuit breaker meters) to the building Energy Management System.

C. Power Circuit Monitoring and Control System: The Power Circuit Monitor shall be a multi-functional, digital, data acquisition and control device. The Power Circuit Monitor shall be metered over 50 values and extensive Min/Max data can be viewed on the LED display. Each Circuit Monitor shall offer true RMS metering and communications standard. Provide 0.2% accuracy true RMS metering and other powerful features such as automatic relay control, waveform capture, on-board event and data logging, and programmable logic for special applications like custom data logging and control function. On-board memory can be expanded to add 512 K or 1024K. Provide input/output modules, status inputs, a pulse output, relay outputs and analog inputs and outputs.

1. Power Circuit Monitor shall be
    a. Certified ANSI C12.16 revenue accuracy
    b. True RMS Metering through the 31st harmonic
    c. High accuracy: 0.2% on current and voltage
    d. Power quality readings displayed: THD and K-Factor
    e. Harmonic Analysis Data through 63rd harmonic
    f. Automatic Alarm/Relay control
    g. On-board event and data logging
    h. Waveform capture
    i. UL listed, CSA Approved, CE Marketing, NOM Approved
    j. MV-90 compatible

D. Recording Demand Meter: Usable as totalizing relay or as indicating and recording maximum-demand meter with 15-minute interval. Meter shall count and control a succession of pulses entering two channels. House in drawout, back-connected case arranged for semiflush mounting.

2.4 PANELBOARDS

A. Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard.

B. Panelboard Bus: Copper (98% conductivity).

C. Provide copper ground bus in each panelboard

D. Enclosure: Interior - NEMA 1, Exterior locations – gasketed NEMA 4X, Kitchen - Stainless NEMA 1

E. Cabinet Front: Flush cabinet front with concealed trim clamps, concealed hinge, metal directory frame, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel. Paint all hallway panels to match wall finish.

F. All panelboards shall be hinged “door in door” type with:
   1. Interior hinged door with hand operated latch or latches as required to provide access to circuit breaker operating handles only, not to energized ports.
   2. Outer hinged door shall be securely mounted to the panelboard box with factory bolts, screws, clips or other fasteners requiring a tool for entry, hand operated latches are not acceptable.
   3. Push inner and outer doors shall open left to right.

G. All panelboard shall have bolt-on style breakers.

H. Provisions for future breakers shall be fully bussed complete with all necessary mounting hardware.

2.5 CIRCUIT BREAKERS

A. For circuit breakers 1200 amps and over (or capable of being adjusted to 1200 amps and over) – Provide a means of arc energy reduction per NEC 240.87.

B. For Circuit breakers 1000 Amps and over – Provide low voltage AC power circuit breaker, with fixed mounting, stored energy and solid state trip devices.
   1. Provide individual adjustable solid-state elements as an integral part of the solid-state trip devices for complete system selective coordination. All breakers shall have LSI settings. All breakers shall have LSIG settings for 277/480V distribution.
   2. Position indicator: Provide an indicator visible from the front of the unit to indicate whether the breaker is open or closed.
   3. Trip button: Provide a mechanical trip button accessible from the front of the door to trip the breaker.
   4. Padlocking: Include provisions for padlocking the breaker in the open position.

5. Operation: Unless otherwise shown on the drawings, breakers 1600 ampere frame size and less may be manually operated. Breakers larger than 1600 amperes frame size shall be electrically operated.
6. Trip devices shall have the following features:
   a. Trip device in each pole.
   b. Metering, voltage, current memory and LCD display
   c. Mechanically and electrically trip free.
   d. Long time element with adjustable pick-up and selective maximum, intermediate, and minimum time delay bands.
   e. Short time element with adjustable pick-up and selective maximum, intermediate, and minimum time delay bands.
   f. Ground fault element with adjustable pick-up and selective maximum, intermediate and minimum time delay bands.
   g. Maintenance setting option to reduce Arc Flash hazards.

C. For circuit breakers over 200 amps – Provide adjustable trip molded case, solid state adjustable trip type circuit breakers.
   1. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip). (where indicated)
   2. Ground-Fault Protection: Integrally mountedrelay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator. (where indicated)
   3. Shunt Trip: 24 V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage. (where indicated)
   4. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay. (where indicated)
   5. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts. (where indicated)
   6. Trip units shall have field adjustable tripping characteristics as follows:
      a. Ampere setting (continuous).
      b. Long time band.
      c. Short time trip point.
      d. Short time delay.
      e. Instantaneous trip point.

D. For all circuit breakers 200 amps and smaller – Provide molded case circuit breakers: Thermal magnetic trip circuit breakers.
   1. Type SWD for lighting circuits.
   2. Type HACR for air conditioning equipment circuits.
   3. Class A ground fault interrupter circuit breakers where scheduled.
   4. Do not use tandem circuit breakers.
   5. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration for all residential applications.
   6. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip). (where indicated)

E. Circuit breakers serving elevators shall have adjustable long-time setting and shall be provided with a shunt trip coil rated for 120V operation. Breaker shall also have a set of

Form C contacts. Connect shunt trip coil to operate as indicated on the drawings.

F. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

G. Circuit breakers serving fire alarm devices shall be provided with a red fire alarm circuit breaker lockout kit that permanently identifies circuit as “FIRE ALARM”.

H. Circuit breakers serving emergency communication devices (e.g. emergency communication, area of refuge, two way communication) shall be provided with a circuit breaker locking device and be permanently identified as “EMERGENCY COMMUNICATIONS”.

2.6 CONTROL WIRING

A. Control wiring shall be 600 volt class B stranded SIS. Install all control wiring complete at the factory adequately bundled and protected. Wiring across hinges and between shipping units shall be Class C stranded. Size in accordance with NEC. Provide control circuit fuses. Provide integral power supply in switchgear for control power.

2.7 SHORT CIRCUIT CURRENT RATING:

A. Devices which achieve the level of fault protection indicated by means of "series" or "integrated" rating shall not be acceptable unless specifically indicated on the drawings. All panelboards shall be fully rated.

B. Minimum SSCR

1. 208 Volt Panelboards: Minimum 10,000 amperes rms symmetrical unless noted otherwise on plans.
2. 480 Volt Panelboards: Minimum 22,000 amperes rms symmetrical unless noted otherwise on plans.
3. Match existing equipment short circuit current ratings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards in accordance with NEMA PB 1.1 and NECA 1.

B. Install panelboards plumb. Install recessed panelboards flush with wall finishes.

C. Height: 6 feet (1800 mm) to top of panelboard; install panelboards taller than 6 feet (1800 mm) with bottom no more than 4 inches (100 mm) above floor.

D. Provide filler plates for unused spaces in panelboards.

E. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.

F. Provide engraved plastic nameplates on all switchboard and panelboards.

G. Provide spare conduits out of each recessed panelboard to an accessible location above ceiling. Identify each as SPARE.
   1. Minimum spare conduits: 6 empty 1 inch conduits.

H. Ground and bond panelboard and switchboard enclosure according to Section 260526.

I. Do not splice conductors in panelboard or switchboard enclosure.

J. Install switchboard on 4" high concrete pad with 6" minimum overlap on all sides. Bolt switchboard to pad in all four corners, minimum.

K. Each section of two section panels shall contain only those conductors which originate in that section. Do not use panel as a wireway.

L. Piggy-back or tandem type breakers shall not be used.

M. Multi-pole breakers shall be common trip, with a single handle.

3.2 FIELD QUALITY CONTROL

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

B. Perform inspections and tests listed in NETA STD ATS, Section 7.5 for switches, Section 7.6 for circuit breakers.

3.3 ADJUSTING

A. Touch-up scratched or marred surfaces to match original finish.

B. Clean all debris from panel interiors.

3.4 LABELING

A. Provide nameplates on all electrical panels that new circuits are modified or installed. Indicate the following information:
   1. Panel name
   2. Panel fed from
   3. Normal (Black with white letters), Emergency Critical (Orange with black letters), Emergency Equipment (Green with black letters), or Emergency Life safety (Yellow with black letters)
   4. Voltage, phase, wire
   5. Available fault circuit (main only)
   6. Date installed

B. Provide a typed legend for all modified or new electrical panels. Update the panel board schedules after load balancing.

C. Identify load served and location by room names assigned by user, not by room numbers on floor plans. Note spares and spaces as such.

D. For switchboards, provide laminated plastic nameplate for main and for each feeder circuit. Nameplates shall be secured to switchboard with two screws.

E. Provide a laminated 11x17 one line diagram in the main electrical room mounted to the wall or main electrical panel.

F. Provide ARC flash identification per NFPA 70E.

3.5 CLEARANCE AND WORKSPACE

A. Maintain workspace and clearances as required by the NEC for the voltage encountered. No pipes or ducts shall pass above the outline of the panelboard. It shall be the responsibility of this Contractor to make sure that other trades do not encroach on this space.

END OF SECTION 262400

SECTION 262726 – WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the requirements for the following:
1. Receptacles.
2. Device plates.
3. Wall switches.
4. Wall dimmers.
5. Occupancy Sensors
6. Motion Sensors

1.2 SUBMITTALS

A. Refer to section 260510.

1.3 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

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

C. Products: Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.4 OCCUPANCY SENSOR DRAWING

A. Drawing Format: Drawings shall be prepared at a scale of no less than 1/16"=1'-0". Drawing shall be titled to define Project Name, Drawing subject and date prepared. Drawings are to be prepared in AutoCAD 2017 or compatible software.

1.5 REFERENCE STANDARDS

A. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting; National Electrical Contractors Association; current edition.

B. NEMA WD 1 - General Color Requirements for Wiring Devices; National Electrical Manufacturers Association; current edition).

C. NEMA WD 6 - Wiring Device -- Dimensional Requirements; National Electrical Manufacturers Association; current edition.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Acceptable manufacturers, contingent upon compliance with the contract documents, are as listed below. Bidders shall carefully review the requirements listed in the technical specifications and only submit products that are equal or better. Equal products by other manufacturers are acceptable providing substitutions are submitted in accordance with requirements listed in the front end specifications and approved by the A/E. Bidders shall carefully review the front end documents and submit all information required to allow the A/E the ability to make a fully informed decision.
   1. Cooper Wiring Devices
   2. GE Industrial
   3. Leviton Manufacturing, Inc
   4. Hubbell, Inc
   5. Lutron Electronics Inc
   6. Wattstopper Inc
   7. Schneider Electric
   8. Legrand – Pass & Seymour
   9. C.W. Cole & Company
   10. Acuity Brands Lighting, Inc

2.2 RECEPTACLES

A. Receptacles: Fed spec listed complying with NEMA WD 6 and WD 1.
   1. Device Body: color by architect plastic, or Red for emergency power devices.
   2. Configuration: NEMA WD 6, type as specified and indicated.
   3. Type 5-20.

B. Residential Receptacles: Tamper-resistant receptacle
   1. Device Body: color by architect.
   2. Type 5-20 or 5-15

C. Educational and Child Care Facility Receptacles: Tamper-resistant receptacle
   1. Device Body: color by architect.
   2. Type 5-20 or 5-15

D. GFCI Receptacles: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements. Feed through GFCI devices shall not be used. GFCI devices shall contain self-testing feature with power lockout if self-test fails.

E. Special Purpose Receptacles: Provide heavy-duty type as indicated on the drawings.

F. Provide duplex receptacles with two integral USB power charges (3 Amps total capacity) where indicated on the drawings.

G. Wet Location: A receptacle installed in a wet location shall be GFCI listed weather-resistant type.

2.3 WALL PLATES

A. Cover Plates: Provide one piece wall plates for wiring devices, with ganging and cutouts as required. Provide blank wall plates for all un-used outlet boxes. Provide with metal screws for securing plates to devices, screw heads colored to match finish of plate. All plates shall be standard size, smooth stainless steel.

B. Weatherproof Cover Plates: All devices installed outdoors and indoor devices specifically indicated, shall be provided with weatherproof covers. Covers shall be of the type that maintains weatherproof integrity when in-use and not in-use. Covers shall be listed and identified as "extra duty" type.

2.4 WALL SWITCHES

A. Wall Switches: Heavy Duty, AC only general-use snap switch, complying with NEMA WD 6 and WD 1.
   1. Body and Handle: color by architect plastic with toggle handle, or red for emergency power devices.
   2. Locator Light: Lighted handle type switch; red color handle.
   3. Ratings: Match branch circuit and load characteristics.
   4. Switch shall be rated for the horse power of the motor served.

B. Switch Types: Single pole, double pole, 3-way, and 4-way.

2.5 WALL DIMMERS

A. Electronic Wall Dimmers: Coordinate with electronic dimming ballast requirements.
   1. Body and Handle: plastic with slide adjuster.

B. Incandescent Wall Dimmers:
   1. Body and Handle: plastic with slide adjuster.
   2. Rating: Dimmer ratings shall be at least 125% of circuit load. De-rate ganged installations as recommended by the Manufacturer.

2.6 OCCUPANCY SENSORS

A. Wall switch sensors: Passive Infrared type.
   1. Capable of detection of occupancy at desktop level up to 300 sqft, and gross motion up to 1000 sqft with 180 degree coverage capability.
   2. Rating: Sensor rating shall be at least 125% of the connected load.
   3. Sensor shall utilize Zero Crossing Circuitry.
   4. Sensor shall have no leakage current to load, and voltage drop protection.
   5. Sensor shall provide high immunity to false triggering from RFI and EMI.
   6. Sensor shall be capable of operating normally with electronic ballasts, PL lamp systems and rated motor loads.
   7. Sensor shall utilize automatically adjustable time delay and sensitivity settings.
   8. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to the cycling of air conditioner or heating fans.
   9. A bypass manual override shall be provided on each sensor.
   10. An integral photo cell with adjustable light level shall be provided
   11. All sensors shall have UL rated, 94V-0 plastic enclosures.

B. Ceiling Sensors: Dual Technology type.
1. Rating: Sensor rating shall be at least 125% of the connected load.
2. Sensor shall be ceiling mounted in such a way as to minimize coverage in unwanted areas.
3. Sensor shall consist of passive infrared and ultrasonic technologies for occupancy detection. Products that react to noise or ambient sound shall not be considered.
4. Passive Infrared Sensor shall provide high immunity to false triggering from RFI and EMI.
5. Ultrasonic Sensor shall adjust the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout the controlled space.
6. Sensor shall be capable of operating normally with electronic ballasts, PL lamp systems and rated motor loads.
7. Sensor shall utilize automatically adjustable time delay and sensitivity settings.
8. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to the cycling of air conditioner or heating fans.
9. A bypass manual override shall be provided on each sensor.
10. All sensors shall have UL rated, 94V-0 plastic enclosures.

C. Circuit Control Hardware – Where required.
1. Control Unit: Self-contained unit consisting internally of isolated load switching relay(s) and transformer to provide low-voltage power.
2. Control Unit shall provide power to a minimum of two sensors.
3. Relay Contacts shall have ratings as required for connected load.

2.7 MOTION SENSORS

A. Exterior Motion Sensors shall have the following features:
1. Rated for covered exterior applications.
2. A 1 minute built-in time delay.
3. Sensor shall utilize a sensitivity adjustment for wind in trees.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that outlet boxes are installed at proper height.

B. Verify that wall openings are neatly cut and will be completely covered by wall plates.

C. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean debris from outlet boxes.

3.3 INSTALLATION

A. Install securely, in a neat and workmanlike manner, as specified in NECA 1.

B. Install devices plumb and level.

C. Do NOT utilize back wiring on any wiring device.

D. Install receptacles with grounding pole on top.

E. Do not install receptacles within 6” of the edge of sinks.

F. Connect wiring device ground terminal to outlet box with bonding jumper.

G. All receptacles installed as listed below shall be GFCI type.
   1. Receptacles installed outdoors.
   2. Receptacles installed within six feet of sinks.
   3. Receptacles designated for electric drinking fountains.
   4. Receptacles designated for vending machines.
   5. Any other receptacles specifically indicated on the drawings.
   6. Receptacles installed in residential mechanical rooms.

H. Install decorative plates in finished areas.

I. Connect wiring devices by wrapping conductor around screw terminal.

J. Provide engraved stainless steel wall plates that indicate the branch circuit to which the associated device is connected. Use 1/8” high black letters.

K. Install switches with OFF position down.

L. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.

M. Do not share neutral conductor on load side of dimmers.

3.4 FIELD QUALITY CONTROL

A. Perform all field inspection, testing, and adjusting specified in NETA STD ATS.

B. Inspect each wiring device for defects.

C. Verify that each receptacle device is energized.

D. Test each receptacle device for proper polarity.

E. Test each GFCI receptacle device for proper operation.

F. Operate each wall switch with circuit energized and verify proper operation.

G. Test each occupancy sensor and verify settings are appropriate for associated space.

3.5 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

B. It shall be the contractor's responsibility to locate and aim occupancy sensors in the correct location required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas per the manufacturer's recommendations. Rooms shall have ninety (90) to one hundred (100) percent coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room(s). The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms which are to be provided with sensors. The contractor shall provide additional sensors if required to properly and completely cover the respective room.

C. Proper judgment must be exercised in executing the installation so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components. The contractor shall also provide, at the owner's facility, the training necessary to familiarize the owner's personnel with the operation, use, adjustment, and problem solving diagnosis of the occupancy sensing devices and systems.

3.6 CLEANING

A. It is anticipated that painting and other finish work may occur after device installation. Device plates shall not be installed until these activities are completed. Protect device and conductors by installing molded plastic cover.

B. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION 262726

SECTION 262813 – FUSES

PART 1 - GENERAL

1.1 SUBMITTALS

A. Refer to Section 260510.

1.2 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Cooper Bussmann

2.2 FUSES – GENERAL

A. Dimensions and Performance: NEMA FU 1, Class as specified or indicated.

B. Voltage: Rating suitable for circuit phase-to-phase voltage.

C. Provide class R5 time delay fused for all motor applications.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fuses with label oriented such that manufacturer, type, and size are easily read.

B. Provide a spare fuse cabinet and stock with one fuse puller for each size fuse installed and provide 10% spare fuses or a minimum of 3 for each size installed. Install fuse cabinet in main electrical room.

END OF SECTION 262813

SECTION 262816 – ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUBMITTALS

A. Refer to section 260510.

1.2 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

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

C. Products: Furnish products listed and classified by Underwriters Laboratories Inc.; or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.

1.3 REFERENCES

A. NEMA FU 1 - Low Voltage Cartridge Fuses; National Electrical Manufacturers Association; current edition.

B. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum); National Electrical Manufacturers Association; current edition.

C. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; current edition.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers
1. Eaton Electrical/Cutler-Hammer
2. GE Industrial
3. Square D
4. Siemens

2.2 NON-FUSIBLE SWITCH

A. Non-fusible Switch Assemblies: NEMA KS 1, Type HD enclosed load interrupter knife switch.
1. Externally operable handle interlocked to prevent opening front cover with switch in ON position.
2. Handle lockable in OFF position.

2.3 FUSIBLE SWITCH

A. Fusible Switch Assemblies: NEMA KS 1, Type HD enclosed load interrupter knife switch.
   1. Externally operable handle interlocked to prevent opening front cover with switch in ON position.
   2. Handle lockable in OFF position.
   3. Fuse clips: Designed to accommodate NEMA FU1, Class R or J fuse

B. Fusible switches serving elevators shall be provided with a set of Form C contacts.

2.4 MOLDED CASE CIRCUIT BREAKERS

A. Molded Case Circuit Breakers for circuit breakers smaller than 200 amps: UL listed for the following service conditions: Temperature: 40 degrees C. Provide HACR rated breakers where they serve HVAC equipment.

B. Field-Adjustable Trip Circuit Breakers: Provide circuit breakers with frame sizes 200 amperes and larger with mechanism for adjusting long time and short time current

C. Circuit breakers serving elevators shall have adjustable long-time setting. Breaker shall also have a set of Form C contacts.

2.5 ENCLOSURES

A. Enclosures: NEMA KS 1.
   1. Interior Dry Locations: Type 1.
   2. Exterior Locations: NEMA 4X stainless steel.
   3. Kitchen and locations subjected to hose down: gasketed, stainless steel, NEMA 4X Rated.

2.6 ACCESSORIES

A. Shunt Trip Device: 120; volts, AC; provide where indicated.
   24; volts, DC; provide where indicated.

B. Undervoltage Trip Device: 120; volts, AC; provide where indicated

C. Auxiliary NO and NC contact: 120; volts, AC; provide where indicated

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with Manufacturer's instructions.

B. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

C. All switches associated with outdoor equipment shall be located as close to the equipment as possible (when equipment is in a service yard, switches shall also be in the service yard) and mounted such that the top of the switch is no more than 6'-6" above grade. All switches associated with equipment mounted above a lay-in ceiling shall also be located above the lay-in ceiling.

D. Coordinate safety and disconnect switch installation with surrounding equipment to provide unobstructed access to the switch (4 foot clearance) and to insure that the switch is within sight of the controller or driven equipment.

3.2 FIELD QUALITY CONTROL

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

B. Perform inspections and tests listed in NETA STD ATS, Section 7.5.

C. Touch-up scratched or marred surfaces to match original finish.

D. Clean all debris from enclosure interiors.

E. Test all shunt trip and under voltage trip units.

3.3 LABELING

A. Provide nameplates on all switch enclosures wherein new circuits are modified or installed. Indicate the following information:
1. Equipment Switch Serves.
2. Branch Circuit.
3. Normal (Black with white letters), Emergency Critical (Orange with black letters), Emergency Equipment (Green with black letters), or Emergency Life safety (Yellow with black letters)
4. Voltage, phase, wire, short circuit current rating
5. Date installed

3.4 CLEARANCE AND WORKSPACE

A. Maintain workspace and clearances as required by the NEC for the voltage encountered. No pipes or ducts shall pass above the outline of the switch enclosure. It shall be the responsibility of this Contractor to make sure that other trades do not encroach on this space.

END OF SECTION 262816

SECTION 265100 – LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the requirements for the following:
1. Interior luminaires and accessories.
2. Emergency lighting units.
3. Exit signs.
4. Luminaire accessories.

1.2 SUBMITTALS

A. Refer to section 260510.

1.3 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70 and NFPA 101.

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

C. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.4 REFERENCE STANDARDS

A. ANSI C78.379 - American National Standard for Electric Lamps -- Reflector Lamps -- Classification of Beam Patterns; current edition.

B. ANSI C78.377 – American National Standard for Electric Lamps – Specifications for the Chromaticity of Solid State Lighting Products.

C. IESNA LM-63 - ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information; current edition.

D. IESNA LM-79-08 – Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products.

E. IESNA LM-80-08 – Approved Method: Measuring Lumen Maintenance of LED Light Sources.

F. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems; National Electrical Contractors Association; current edition.

G. NEMA WD 6 - Wiring Devices - Dimensional Requirements; National Electrical Manufacturers Association; current edition.

H. NFPA 70 - National Electrical Code; National Fire Protection Association, current edition.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of design is as scheduled on drawings. Acceptable manufacturers, contingent upon compliance with the contract documents, are as follows: Manufacturer A, Manufacturer B, Manufacturer C. Equal products by other manufacturers are acceptable providing substitutions are submitted in accordance with requirements listed elsewhere in the Bid Documents and approved by the A/E.

B. Prior Approved Equal Manufacturer(s) are listed in lighting fixture schedule on drawings.

C. LM-79 reports must be submitted with all proposed LED substitutions from Basis of Design, regardless of whether manufacturer is listed as an approved equal.

2.2 LUMINAIRES

A. Furnish products as indicated in Schedule on plans.

2.3 EMERGENCY LED DRIVERS

A. Regardless of catalogue number shown in fixture schedule, all fixtures indicated to be emergency type shall be provided with emergency type driver battery packs conforming to the following:

1. <u>Fixture Using Integral Emergency Driver/Battery Pack</u>: Provide emergency driver installed within the fixture. The charging light and test switch shall be accessible/visible from below. Driver/Battery must be capable of operating fixture at 75% of fixture lumens for a minimum of 90 minutes. Drivers/batteries shall have full 5-year warranty.
2. <u>Fixture Using Remote Emergency Driver/Battery Pack</u>: Provide Iota or Bodine emergency driver/battery pack installed remotely above accessible ceiling. Driver/Battery must be capable of operating fixture at 75% of fixture lumens for a minimum of 90 minutes. Drivers/batteries shall have full 5-year warranty.

B. Integral emergency drivers/batteries shall be factory installed whenever possible.

C. Drivers/batteries installed in fixtures located outdoors or unheated spaces shall be suitable for the ambient temperatures encountered or remotely located in a nearby accessible space.

2.4 EMERGENCY LIGHTING INVERTERS

A. Emergency lighting inverter shall be provided by a Bodine ELI Series inverter or prior approved equal with the following characteristics:

1. The device shall comply with the standards set forth in UL 924, "Emergency Lighting and Power Equipment", and UL Listed for installation for field installation.

Emergency illumination shall exceed the NEC and Life Safety Code (NFPA-LSC) requirements.

2. Upon failure of normal power, the device shall instantly begin providing emergency power to the connected lighting load for a minimum of 90 minutes. The device shall support lumen output at 91% of the lamp's rating throughout the 90-minute duration.
3. The device shall operate at 120 or 277 VAC, 60 Hz and an ambient temperature of 68 degrees F to 86 degrees F.
4. The device shall have self-diagnostics operation in addition to a momentary test switch.
5. The unit shall be provided with a 3-year full coverage warranty and the battery shall have a 3-year warranty.
6. The unit shall have a recharge time of 24 hours and display a charging indicator light.

2.5 EMERGENCY TRANSFER DEVICES

A. Generator (or central inverter) supplied egress lighting shall be provided by using a standard LED fixture equipped with a Bodine GTD generator transfer device or prior approved equal with the following characteristics:
   1. The device shall be capable of bypassing the local wall switch when the auxiliary generator (or central inverter) powers lighting.
   2. The device shall consist of relay switching circuitry and fusing contained in one galvanized steel case.
   3. The device shall operate at 120 or 277 VAC, 60 Hz; shall have all inputs fused to 3 A maximum; shall draw 280 mA and 1.6 Watts during normal operation; and shall comply with the current NEC.
   4. The device shall be UL Listed for installation inside, on top of or remote from the fixture and shall be warranted for a full five years from date of purchase.

B. All Emergency Transfer Devices shall be provided with five full years of warranty from the date of purchase.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fixtures securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting).

B. Install suspended luminaires and exit signs using pendants supported from swivel hangers. Provide pendant length required to suspend luminaire at indicated height.

C. Locate recessed ceiling luminaires as indicated on reflected ceiling plan.

D. Install surface mounted luminaires and exit signs plumb and adjust to align with building lines and with each other. Secure to prevent movement.

E. Install recessed luminaires to permit removal from below.

F. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.

G. Install clips to secure recessed grid-supported luminaires in place.

H. Install wall mounted luminaires, emergency lighting units, and exit signs at height as indicated on Drawings.

I. Install accessories furnished with each luminaire.

J. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

K. Bond products and metal accessories to branch circuit equipment grounding conductor.

L. Install specified lamps in each emergency lighting unit, exit sign, and luminaire.

3.2 FIELD QUALITY CONTROL

A. Perform field inspection in accordance with Section 01 40 00.

B. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

3.3 ADJUSTING

A. Aim and adjust luminaires as indicated.

B. Position exit sign directional arrows as indicated.

3.4 CLEANING

A. Clean electrical parts to remove conductive and deleterious materials.

B. Remove dirt and debris from enclosures.

C. Clean photometric control surfaces as recommended by manufacturer.

D. Clean finishes and touch up damage.

3.5 CLOSEOUT ACTIVITIES

A. Demonstrate luminaire operation for minimum of two hours.

3.6 PROTECTION

A. Replace/Repair luminaires that have failed at Substantial Completion.

END OF SECTION 265100

FOR REFERENCE ONLY – COMMUNICATION HORIZONTAL CABLING TO BE PROVIDED BY OTHERS.

SECTION 270500 - COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. All division 27 work shall, in addition to all division 1 specification sections, comply with all of the requirements in the following specification sections:

260500 Common Work Results for Electrical
260501 Electrical Demolition
260510 Electrical Submittals
260511 Electrical Work Closeout
260512 Electrical Coordination
260519 Low-Voltage Electrical Power Conductors and Cables
260526 Grounding and Bonding for Electrical Systems
260529 Hangers and Supports for Electrical Systems
260533 Raceway and Boxes for Electrical Systems
260548 Vibration and Seismic Controls for Electrical Systems
262726 Wiring Devices

1.2 COORDINATION

A. CCU ITs must approve any deviation from the specifications in this document. All communications, correspondence, and approvals must be conveyed through the official project contacts of record such as the Architect and Construction Manager.

B. All Division 27 Contractor Project Managers shall schedule and conduct a coordination meeting with CCU ITS to confirm and coordinate scope of work requirements prior to commencement of work whether project is new construction, renovation, or retrofit. Project meetings shall be scheduled through the General Contractor, Construction Manager, or CCU Facilities Services depending upon how the project management process is structured in each instance.

C. The Contractor shall submit a work schedule before any work begins. This schedule shall identify the major phases of the installation. The Architect or Construction Manager shall review the schedule with CCU ITS and CCU Facilities representatives, identify inspection requirements based on phasing and request any required modifications to the installation schedule. When the installation plan is finalized and approved, work may begin.

1.3 SUBMITTALS

A. Work shall not proceed without CCU approval of all submitted items.

1.4 QUALITY ASSURANCE

A. Cabling Contractor shall provide with bid an RCDD and Installer-level BICSI Certification. A minimum of one (1) permanent crew member shall be BICSI Installer Level II as well as manufacturer certified. Twenty-five percent (25%) of installation force shall be BICSI Installer Level I. Work crew, not involved in installing cable elements (e.g. laborers delivering/moving materials, installing grounding by an electrician, or workers installing pathway elements) do not require BICSI or manufacturer certification or registration.

B. Only installers trained and certified by the proposed manufacturer shall be allowed to terminate and test optical fiber. Others specified above may pull/place optical fiber cable under the supervision of an installer trained and certified by the manufacturer.

1.5 SYSTEM WARRANTY

A. The Contractor shall provide a single manufacturer 25-year system performance warranty covering the installed cabling system against defects in workmanship, components and performance, and follow-up support after project completion. Project must be registered with Commscope prior to start of work. All documentation of the 25-year system performance coverage and 25-year component coverage must be provided to CCU prior to completion of project. During the warranty period, and for non-conformities of which contractor has notice, contractor shall take all necessary and appropriate action; free of charge, to correct any non-conformity with the warranties contained in the manufacturer agreement. During the warranty period, contractor shall provide to CCU, free of costs and charges, all support necessary to ensure that the cabling system meets the requirements specified in this document and performance guarantees provided by the contractors. During the warranty period, contractors shall furnish, or cause to be furnished, all maintenance, service, parts and replacements necessary to maintain the cabling system in good working condition, at no cost to CCU.

B. All deficiencies shall be corrected within a period of forty-eight (48) hours.

END OF SECTION 270500

FOR REFERENCE ONLY – COMMUNICATION HORIZONTAL CABLING TO BE PROVIDED BY OTHERS.

SECTION 271500 – COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. UTP cabling.
2. Cable connecting hardware, patch panels.
3. Telecommunications outlet/connectors.
4. Cabling system identification products.

1.2 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.

C. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

D. EMI: Electromagnetic interference.

E. IDC: Insulation displacement connector.

F. LAN: Local area network.

G. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

H. UTP: Unshielded twisted pair.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

1.4 SUBMITTALS

A. Refer to section 260510.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
   2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
   3. Delete subparagraph below if Contractor performs field quality-control testing.
   4. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications:
   1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 814 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency. All cable must have the following characteristics.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

F. Grounding: Comply with ANSI-J-STD-607-A.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
   1. Test each pair of UTP cable for open and short circuits.

PART 2 - PRODUCTS

2.1 HORIZONTAL CABLING DESCRIPTION

A. The maximum allowable horizontal cable length is 295 feet (90 m).

B. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.
   1. Install per TIA/EIA-B.2-1 “Performance specifications for 4-pair 100 ohm Category 6 cabling.”
   2. Bridged taps and splices shall not be installed in the horizontal cabling.

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1 when tested according to test procedures of this standard.

B. Communication contractor shall be an Commscope Uniprise contractor.

C. The project must be registered with Commscope in order to provide a complete 25 year Extended Product and Application Warranty. Warranty documentation must be provided to owner.

D. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Grounding: Comply with J-STD-607-A.

2.3 UTP CABLE

A. Description: 100-ohm, four-pair UTP, covered with a blue thermoplastic jacket (Commscope).
   1. Comply with ICEA S-90-661 for mechanical properties.
   2. Comply with TIA/EIA-568-B.1 for performance specifications.
   3. Comply with TIA/EIA-568-B.2, Category 6.
   4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

   Communications, Non-Plenum Rated: Type CMP complying with NFPA 262.

2.4 UTP CABLE HARDWARE

A. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

B. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.
   1. Provide 8-position, 8-conductor jacks Commscope part number 760237628 USL600-BLUE. Fill vacant positions with blank insert Commscope part number 1116412-3.
   2. Faceplates shall be white in color. Provide Commscope part number 2111012-3 4 port white faceplate.

C. Patch Cords: Factory-made, four-pair cables in 5’, 7’, and 10’ lengths; terminated with eight-position modular plug at each end.
   1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
   2. Patch cords shall have color-coded boots for circuit identification.
   3. Provide one patch cord for each user end connection plus 10% spare. I.E. One patch cord for each connection in the data rack and one patch cord for each connection at the user end.
   4. Quantity of patch cords shall be divided between the multiple lengths as follows: 5’ = 20 percent, 7’ = 30 percent, and 10’ = 50 percent.

2.5 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with J-STD-607-A.

2.6 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces. Conceal pathways and cables except in unfinished spaces.
   1. Install plenum cable in environmental air spaces, including plenum ceilings.
   2. Comply with requirements in Division 260533 Section "Raceway and Boxes for Electrical Systems."

B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures:
   1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
   2. Install lacing bars and distribution spools.
   3. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:
   1. Comply with TIA/EIA-568-B.1.
   2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
   3. Install 66-style IDC termination hardware unless otherwise indicated.
   4. MUTOA shall not be used as a cross-connect point.
   5. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
   6. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   7. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
   8. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
   9. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
   10. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
   11. In the communications equipment room, install a 10-foot long service loop on each end of cable.

12. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
13. Cables shall be installed in continuous lengths from origin to destination (no splices) unless specifically addressed in this document.
14. Where cable splices are allowed, they shall be in accessible locations and housed in an enclosure intended and suitable for the purpose.
15. If a J-hook or trapeze system is used to support cable bundles all horizontal cables shall be supported at a maximum of four-foot intervals - at no point shall cable(s) rest on acoustic ceiling grids or panels.
16. Horizontal distribution cables shall be bundled in groups of not greater than 40 cables (cable bundle quantities in excess of 40 cables may cause deformation of the bottom cables within the bundle).
17. Panel terminations shall be fed by and individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
18. Cable shall be installed above fire-sprinkler and systems and shall not be attached to the system or any ancillary equipment or hardware.
19. The cabling system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
20. Cables shall not be attached to ceiling grid or lighting support wires.
21. Pulling tension on 4-pair UTP cables shall not exceed 25-pounds for a single cable or cable bundle.
22. Unshielded twisted pair cable shall be installed so that there are no bends less than four times the cables outside diameter (4 X cable O.D.) at any point in the run.
23. Cables shall be identified by a self-adhesive label in accordance the specifications.
24. The cable label shall be applied to the cable behind the faceplate on a sec-tion of cable that can be accessed by removing the cover plate. Cable labels shall not be obscured from view.

C. UTP Cable Installation:
1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
4. Cable shall not rest on or make contact with any other system.

E. Group connecting hardware for cables into separate logical fields.

3.3 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with J-STD-607-A.

C. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.4 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
   1. Administration Class: 4.
   2. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.

B. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.

C. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 4 level of administration, including optional identification requirements of this standard.

D. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

E. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.

F. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet
4. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
5. Uniquely identify and label work area cables extending from the MUTOA to the work area. These cables may not exceed the length stated on the MUTOA label.

G. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.
   1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections
   1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
   2. Visually confirm Category 6, marking of outlets, cover plates, outlet/connectors, and patch panels.
   3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
   4. UTP Performance Tests:
      a. Test for each outlet. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:
         1) Wire map.
         2) Length (physical vs. electrical, and length requirements).
         3) Insertion loss.
         4) Near-end crosstalk (NEXT) loss.
         5) Power sum near-end crosstalk (PSNEXT) loss.
         6) Equal-level far-end crosstalk (ELFEXT).
         7) Power sum equal-level far-end crosstalk (PSELFEXT).
         8) Return loss.
         9) Propagation delay.
         10) Delay skew.

5. Final Verification Tests: Perform verification tests for UTP after the complete communications cabling and workstation outlet/connectors are installed.
   a. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

B. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 271500

SECTION 276410 – RADIO FREQUENCY (RF) BASED SIGNAL BOOSTER SYSTEMS (IN-BUILDING RADIO ENHANCEMENT SYSTEM) (DAS)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The contractor will design full functional signal booster system for the local first responders radio systems and furnish, install and provide a one-year warranty for the system.

1.3 SUBMITTALS

A. Refer to section 260510.

PART 2 - PRODUCTS

2.1 RADIO FREQUENCY (RF) BASED SIGNAL BOOSTER SYSTEMS

A. Completed cabling installations must comply with all applicable code and standards, including the NEC, NFPA, ANSI, NEC, OSHA, EIA, IEEE, R-56, etc. as well as the FC Rules and Regulations, as applicable. Equipment provided must be UL listed and FCC type accepted for this specification application. Compliance to codes and standards must extend to include proper grounding, bonding and surge protection.

B. The contractor shall provide a system that has digital signal strength coverage over 95% area on each floor/level of the equipped building. Provide coverage for all radio frequencies required by the AHJ and local first responders.

C. The system must provide a minimum digital and analog overage of Circuit Merit (CM) 3, with a reliability factor of 95%. A Coverage Acceptance Test must be executed prior to final acceptance of an installed system. Coverage acceptance testing must be based on audio quality performance in evenly spaced test grids in the defined service areas. A minimum of 20 tests will be taken for floor/level. Total number of test grids will be determined by the Owner, based on the size of the space per floor/level.

D. The original Proof of Performance report must be submitted to the Engineer, and a copy of the Proof of Performance report must be affixed to its associated equipment.

E. Design and appearance will be of "finished" construction. i.e. must be concealed and/or unobtrusive. Surface raceway and/or exposed conduit installations are not acceptable.

F. All cabling shall be installed in conduit, unless otherwise noted on the drawings.

G. Brace roof mounted antennas to 165 MPH wind. Antennas shall not be visible from grade. Aim antennas to the local first responder radio repeater antenna.

H. The secondary power source shall consist of one of the following:
   1. A storage battery dedicated to the system with at least 12 hours of 100 percent system operation capacity and arranged in accordance with NFPA 72 (10.6.10) if the building is not equipped with an automatic-starting, engine-driven generator.
   2. An automatic-starting, engine-driven generator serving the dedicated branch circuit or the system with at least 12 hours of 100 percent system operation capacity and storage batteries dedicated to the system with at least 2 hours of 100 percent system operation capacity and arranged in accordance with NFPA 72 (10.6.11.3).

I. In-building radio systems required by this ordinance must provide the following signal strengths: Downlink - Minimum signal strength of -95 dBm throughout the coverage area. Minimum signal strength of -95 dBm received at the public safety Radio System.

J. The signal booster and all other active components shall be listed for the intended purpose. UL 2524 – UL listing, In-building 2-Way Emergency Radio Communication Enhancement Systems.

K. All signal booster components shall be contained in a type-4 approved waterproof cabinet. All enclosures shall be painted red with a locking mechanism.

L. Antenna isolation shall be maintained between the donor antenna and all inside antennas (D.A.S.) to a minimum of 20dB under all operating conditions.

M. To prevent radio interference and degradation of public safety radio systems, signal boosters shall not emit any measurable uplink noise while idle. The signal booster shall contain an automatic uplink noise suppression function.

N. The In-Building Radio system shall include automatic supervisory and trouble signals for malfunctions of the signal booster(s) and power supplies that are annunciated by the fire alarm system. System and Signal booster supervisory signals shall include Antenna Malfunction and Signal booster failure.

O. The In-Building Radio system shall be monitored by a listed fire alarm control unit, or where approved by the fire code official, shall sound an audible signal at a constantly attended 24/7 on-site location.

PART 3 - EXECUTION

3.1 WARRANTY

A. The contactor shall provide a full one-year warranty to cover installation and all components; the warranty must commence upon the Owner's final acceptance of the facility. Under warranty coverage, the successful contactor shall provide same business day response time for system malfunctions.

B. Test fault reporting system for proper operation and reporting of system faults.

C. All as-builts shall be submitted to the owner at completion, which shall include cable system layout, along with product information sheets.

D. Test the system and submit signal strength heat maps showing compliance with requirements.

E. Provide a functional test of the system for the AHJ.

END OF SECTION 276410

SECTION 280500 – COMMON WORK RESULTS FOR SAFETY AND SECURITY

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. All division 28 work shall, in addition to all division 1 specification sections, comply with all of the requirements in the following specification sections:

260500 Common Work Results for Electrical
260501 Electrical Demolition
260510 Electrical Submittals
260511 Electrical Work Closeout
260512 Electrical Coordination
260519 Low-Voltage Electrical Conductors and Cables
260526 Grounding and Bonding for Electrical Systems
260529 Hangers and Supports for Electrical Systems
260533 Raceway and Boxes for Electrical Systems
260548 Vibration and Seismic Controls for Electrical Systems
260553 Identification for Electrical Systems
262726 Wiring Devices

END OF SECTION 280500

SECTION 283100 - FIRE DETECTION, ALARM, AND EMERGENCY COMMUNICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Heat detectors.
5. Notification appliances.
6. Device guards.
7. Remote annunciator.
8. Addressable interface device.
9. Digital alarm communicator transmitter.
10. Voice Evacuation & Emergency Communication Panel.
11. Radio alarm transmitter.
12. Network communications.

1.3 DEFINITIONS

A. EMT: Electrical Metallic Tubing.

B. FACP: Fire Alarm Control Panel.

C. HLI: High Level Interface.

D. NICET: National Institute for Certification in Engineering Technologies.

E. PC: Personal computer.

1.4 ACTION SUBMITTALS

A. See submittals section 260510 Electrical Submittals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level III technician.

C. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

1.6 PROJECT CONDITIONS

A. Perform a full test of the existing system prior to starting work. Document any equipment or components not functioning as designed.

B. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:
1. Do not proceed with interruption of fire-alarm service without Owner's written permission.
2. Provide a fire watch whenever the building fire alarm system is impaired.

C. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.7 SEQUENCING AND SCHEDULING

A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service, and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.

B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within one year of substantial completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Source Limitations for Fire-Alarm and Emergency Communication System and Components: Components shall be compatible with, and operate as an extension of, existing Brooks Stadium and campus system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.

B. The fire alarm system shall be a non-coded, UL-certified addressable fire alarm system, with voice evacuation/emergency communication annunciation system.

C. All components provided shall be UL listed for use with the fire alarm voice evacuation/emergency communication annunciation system.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:

1. Manual stations.
2. Heat detectors.
3. Smoke detectors.
4. Duct smoke detectors.
5. Automatic sprinkler system water flow.
6. Fire-extinguishing system operation.
7. Dry system pressure flow switch.
8. Fire pump running.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances, including voice evacuation notices.
2. Identify alarm and specific initiating device at fire-alarm control unit, connected network control panels, and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station at the CCU Department of Public Safety Dispatch Center.
4. Activate voice/alarm communication system.
5. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
6. Recall elevators to primary or alternate recall floors.
7. Record events in the system memory.
8. Indicate device in alarm on the remote annunciator.
9. Release automatic door hold opens.
10. Activate emergency shutoffs for gas and fuel supplies.
11. Close fire smoke dampers.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.
2. Elevator shunt-trip supervision.
3. Loss of communication with any panel on the network.
4. User disabling of zones or individual devices.
5. Fire pump running.
6. Fire-pump loss of power.
7. Fire-pump power phase reversal.
8. Independent fire-detection and -suppression systems.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
4. Loss of primary power at fire-alarm control unit.
5. Ground or a single break in internal circuits of fire-alarm control unit.
6. Abnormal ac voltage at fire-alarm control unit.
7. Break in standby battery circuitry.
8. Failure of battery charging.

9. Abnormal position of any switch at fire-alarm control unit or annunciator.
10. Voice signal amplifier failure.

E. System Supervisory Signal Actions:

1. Initiate notification appliances.
2. Identify specific device initiating the event at fire-alarm control unit, connected network control panels, and remote annunciators.
3. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.
4. Transmit system status to building management system.
5. Display system status on graphic annunciator.

2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.4 EXISTING FIRE-ALARM CONTROL UNIT

A. Existing Honeywell Firelite Fire Alarm System with a new Sircom Voice Evacuation/Emergency Communication System. Confirm all the following properties are met by the existing fire alarm system. Provide a Cooper Waves over IP connected to the CCU Department of Public Safety Dispatch Center’s ALERiTY System.

Provide a wireless IP based radio and antenna system to receive and transmit emergency communication alerts. Connect this radio to an antenna system and to the IPC communicator. This system shall be connected to the CCU Department of Public Safety Dispatch Center’s ALERiTY System and shall have the following minimum components.

1. Omnidirectional antenna on from installed within 90’ of the wireless IP radio and within direct line of sight with the MNS antenna. Coordinate this antenna location in the field with the engineer and the CCU fire marshal. Antenna shall be braced to withstand 130 mph winds with a 1.3 gust factor.
2. Provide a surge protector on the antenna cable and bond the antenna with the building lightning protection system .

B. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.

   a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
   b. Include a real-time clock for time annotation of events on the event recorder and printer.
   c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.

d. The FACP shall be listed for connection to a central-station signaling system service.
e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.
f. Provide UL listed interface unit capable of displaying text messages from voice evacuation/emergency communication captioning system.

2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.

C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

D. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:

1. Pathway Class Designations: NFPA 72, Class B.
2. Pathway Survivability: Level 1.

E. Notification-Appliance Circuit:

1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
2. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

F. Elevator Recall:

1. Elevator recall shall be initiated only by one of the following alarm-initiating devices:

a. Elevator lobby detectors except the lobby detector on the designated floor.
b. Smoke detector in elevator machine room.
c. Smoke detectors in elevator hoistway.

2. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.
3. Heat Detectors in the elevator shaft and elevator machine room shall shut down the elevator via shunt trip circuit breaker. Provide a time delay to allow the elevator to reach the elevator recall floor and open doors.

G. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to CCU’s remote central alarm station.

H. Voice/Alarm Signaling Service:

1. Amplifiers shall comply with UL 1711.
a. Programmable tone and message sequence selection.

b. Programmed with CCU’s standard pre-recorded messages for fire alarm and massnotification.
c. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of fire-alarm control unit.

I. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals, supervisory and digital alarm communicator transmitters and digital alarm radio transmitters shall be powered by 24-V dc source.

1. Alarm current draw of entire fire-alarm and emergency communication shall not exceed 80 percent of the power-supply module rating.

J. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed lead-acid or nickel cadmium.

K. Battery Booster Panel and Amplifier Booster Panel: Provide one battery booster panel and one amplifier booster panel, at minimum, on every floor. Provide 25% spare capacity in the amplifier booster panel and the battery booster panel. Calculations shall assume that the speakers are at their maximum tap settings and strobes are at their designed candela level.

L. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.5 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box. Basis of Design is Firelite BG-12LX keyed common to fire alarm panel.

1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Station Reset: Key switch.

2.6 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be two-wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.

5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.

B. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).

3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
6. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.
7. Test and reset keys shall be provided for all duct mounted smoke detectors. Install the test and reset units 48” AFF and label unit or damper served.

2.7 HEAT DETECTORS

A. General Requirements for Heat Detectors: Comply with UL 521.

1. Temperature sensors shall test for and communicate the sensitivity range of the device.

B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.

1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.8 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Any location that requires a strobe for the alarm notification shall be installed as a combination speaker strobe device.

B. General Requirements for Notification Appliances: Individually address, connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

C. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "ALERT" is engraved in minimum 1-inch- high letters on the lens.

1. Rated Light Output:
   a. 15/30/75/110 cd, selectable in the field.
2. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
3. Flashing shall be in a temporal pattern, synchronized with other units.
4. Strobe Leads: Factory connected to screw terminals.
5. Mounting Faceplate: Factory finished, white.
6. Provide voltage drop calculations that show 1.5dB or less power loss on the speaker circuits.

D. Voice/Tone Notification Appliances:

1. Comply with UL 1480.
2. Speakers for Voice Notification: Locate speakers for voice notification to provide the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
3. High-Range Units: Rated 2 to 15 W.
4. Low-Range Units: Rated 1 to 2 W.
5. Mounting: Semi-recessed.
6. Mounting Faceplate: Factory finished, white.
7. Matching Transformers: Tap range matched to acoustical environment of speaker location.
8. Speakers shall have field selectable taps to adjust volume.
9. Provide voltage drop calculations that show 1.5db or less power loss on the speaker circuits.

2.9 REMOTE ANNUNCIATOR

A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.

1. Mounting: Recessed cabinet with locked enclosure and viewing window, NEMA 250, Type 1. Cabinet shall have manufacturer’s standard light gray finish, or, pending approval of CCU’s Fire Marshal may be painted to match the surrounding wall finish color. Coordinate exact mounting location and cabinet color with CCU Fire Marshal prior to installation.

2. The remote microphone station shall be installed in a NEMA 250, Type 1. Cabinet shall have manufacturer’s standard light gray finish, or, pending approval of CCU’s Fire Marshal may be painted to match the surrounding wall finish color. Coordinate exact mounting location and cabinet color with CCU Fire Marshal prior to installation.

3. Turnover six (6) keys to Owner at Substantial Completion. These encloses shall be keyed to the campus best key system.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.10 ADDRESSABLE INTERFACE DEVICE

A. General:

1. Include address-setting means on the module.
2. Store an internal identifying code for control panel use to identify the module type.
3. Listed for controlling HVAC fan motor controllers.

B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.

C. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall or to circuit-breaker shunt trip for power shutdown.

1. Allow the control panel to switch the relay contacts on command.
2. Have a minimum of two normally open and two normally closed contacts available for field wiring.

D. Control Module:

1. Operate notification devices.
2. Operate solenoids for use in sprinkler service.

2.11 DIGITAL ALARM COMMUNICATOR TRANSMITTER – FIRE ALARM SYSTEM

A. Digital alarm communicator transmitter shall be compatible with the existing remote CCU central station and shall comply with UL 632.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for CCU's existing remote central receiving station at the CCU Department of Public Safety Dispatch Center. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

C. Local functions and display at the digital alarm communicator transmitter shall include the following:

1. Verification that both telephone lines are available.
2. Programming device.
3. LED display.
4. Manual test report function and manual transmission clear indication.
5. Communications failure with the central station or fire-alarm control unit.

D. Digital data transmission shall include the following:

1. Address of the alarm-initiating device.
2. Address of the supervisory signal.
3. Address of the trouble-initiating device.
4. Loss of ac supply.
5. Loss of power.

6. Low battery.
7. Abnormal test signal.
8. Communication bus failure.

E. Secondary Power: Integral rechargeable battery and automatic charger.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.12 VOICE EVACUATION AND EMERGENCY COMMUNICATION PANEL

A. Voice evacuation and emergency communication panel shall be UL listed and comply with NFPA 72 and UL 2572 for message broadcasting.

B. Functional Performance: The operation of any automatic fire detector, initiation device, sprinkler water flow device or manual fire alarm pull station shall automatically sound an alert tone followed by voice instructions for general building evacuation. The signal shall broadcast throughout the building to all paging zones from the voice evacuation and emergency communication panel until the fire alarm control panel is reset, or until the fire emergency personnel interrupt the broadcast with a manual page. On reset the system shall automatically return to normal operating condition. The system shall be configured to allow paging over the Public Address (PA) speakers and fire alarm system notification appliances. The manual live page shall be provided via a remote microphone station located adjacent to the remote fire alarm annunciator panel. The interconnection to the PA system shall be via a Waves Over IP Communicator (IPC 8000).

C. Normal Power Input: 120-V ac.

D. Secondary Power: This system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal AC power in a normal supervisory mode for a period of 24 hours with 15 minutes of alarm operation at the end of this period. The system shall automatically transfer to battery standby upon power failure. All battery charging and re-charging operations shall be automatic.

2.13 RADIO ALARM TRANSMITTER & IPC COMMUNICATOR – EMERGENCY COMMUNICATION SYSTEM

A. Transmitter shall comply with NFPA 1221 and 47 CFR 90.

B. Radio shall be 5.8 Ghz

C. Description: Manufacturer's standard commercial product; factory assembled, wired, and tested; ready for installation and operation.

1. Packaging: A single, modular, NEMA 250, Type 1 metal enclosure with a tamper-resistant flush tumbler lock.
2. Normal Power Input: 120-V ac.
3. Secondary Power: Integral-sealed, rechargeable, 12-V battery and charger. Comply with NFPA 72 requirements for battery capacity; submit calculations.
4. Alarm Interface Devices: Circuit boards, modules, and other auxiliary devices, integral to the transmitter, matching fire-alarm and other system outputs to message-generating inputs of the transmitter that produce required message transmissions.

D. Functional Performance: The IP communicator shall receive a signal from CCU's ALERiTY emergency communication system via the radio alarm transmitter and/or Ethernet network connection and transmit audible and visual messages to the building's Fire Alarm System Notification devices via the Voice Evacuation and Emergency Communication Panel (VECP). Transmitted messages shall include CCU's standard eight (8) pre-recorded messages. The message priority shall be as follows:

1. The in-building emergency communication system is allowed to override a fire alarm evacuation notification for the brief time that the emergency communication signal is broadcast. Once the emergency communication signal is complete the fire alarm signal will continue.
2. The emergency communication system will only be used when there is an imminent threat to life and safety.
3. If at any time a first responder needs to communicate with the building occupants the local microphone in the building will override all fire alarm and emergency communication signals. Once the local microphone is no longer in use, the building fire alarm and/or emergency communication system will continue to alarm.
4. If the building uses the emergency communication system for paging, music, non- emergency communication signals these signals shall not override any fire alarm, emergency communication or local microphone signal.

2.14 NETWORK COMMUNICATIONS

A. Provide network communications for the voice evacuation and emergency communication system according to the manufacturer's written requirements.

B. Provide network communications pathway per manufacturer's written requirements and requirements in NFPA 72 and NFPA 70.

C. Provide integration gateway using BACnet or Modbus for connection to building automation system.

2.15 DEVICE GUARDS

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

1. Factory fabricated and furnished by device manufacturer.
2. Finish: Paint of color to match the protected device.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

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

3.2 EQUIPMENT INSTALLATION

A. Comply with NFPA 72 and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

1. Devices placed in service before all other trades have completed cleanup shall be replaced.
2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

B. Equipment Mounting:

1. Comply with requirements for seismic-restraint devices specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

C. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

D. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

E. Duct Smoke Detectors: Comply with NFPA 72 and IMC. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches long shall be supported at both ends.

1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.

F. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.

G. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.

H. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

I. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling. Install all devices at the same height unless otherwise indicated.

J. Device Location-Indicating Lights: Locate in public space near the device they monitor.

K. Program the emergency communication and voice evacuation panel with CCU’s standard 8 pre-recorded messages.

L. All circuit breakers supplying power to the fire alarm voice evacuation and emergency communication annunciation system shall be painted red and locked in the on position.

M. Provide TVSS surge protection for the incoming power and for all devices that leave the building (AHU interfaces, antennas, duct mounted smoke detectors, exterior strobes/horns).

N. All circuits that provide power to the fire alarm and emergency communication system shall be painted red and locked in the on position.

3.3 PATHWAYS

A. All cabling shall be installed in EMT conduit.

B. The conduit system shall be painted red enamel, or be red anodized conduit, or shall have red covered junction boxes. In areas with exposed conduit in finished spaces, pending approval of the CCU Fire Marshal, the conduit and junction boxes can be painted to match the exposed ceiling spaces if the junction boxes are labeled “Fire Alarm.”

3.4 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches (910 mm) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
1. Smoke dampers in air ducts of designated HVAC duct systems.
2. Electronically locked doors and access gates.
3. Alarm-initiating connection to elevator recall system and components.
4. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
5. Supervisory connections at valve supervisory switches.
6. Supervisory connections at elevator shunt-trip breaker.
7. Data communication circuits for connection to building management system.
8. Data communication circuits for connection to emergency communication system.
9. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
10. Supervisory connections at fire-pump engine control panel.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install framed instructions in a location visible from fire-alarm control unit.

C. Provide embossed adhesive tape with 3/16 inch letters for identification of fire alarm notification and activation devices. Label shall include loop and device number.

3.6 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.7 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction.

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

C. Perform tests and inspections.

D. Perform the following tests and inspections:

1. Visual Inspection: Conduct visual inspection prior to testing.

    a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
    b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3. Audible Appliance Testing:
    a. The fire alarm contractor shall contractor with an independent testing agency to conduct a STI/STIPA test per NFPA 72-2013 Annex D. The testing shall be a quantitative test that uses a signal generator and a testing device that provides a speech intelligibility score for each Acoustically Distinguishable Space (ADS).
    b. Submit a testing plan identifying the proposed ADS's to the Architect/Engineer and CCU Fire Marshal on a marked up floor plan for review and approval prior to testing.
    c. Perform a pre-test of the system during construction and prior to substantial completion. This test will be an unoccupied test. Adjust speaker taps to improve intelligibility and audibility of the system prior to completing the pre-test.
    d. Perform a final test of the system post construction completion and during normal building occupied hours.
    e. Submit all test reports to the Architect/Engineer and CCU Fire Marshal.
4. Test visible appliances for the public operating mode according to manufacturer's written instructions.
5. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

F. Fire-alarm system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

3.8 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.
1. Training Duration: Four (4) hours, minimum.
2. Schedule training with the Owner at least seven (7) days in advance.

END OF SECTION 283111

SECTION 283200 – TWO-WAY COMMUNICATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Two-way Communications vandal resistant and ADA-compliant hands-free speakerphone communications system with Two-way Communication Command unit Master Station.
   2. Equipment furnished under the terms of this specification shall be the standard product of a single manufacturer.

1.2 SUBMITTALS
   1. Refer to section 260510

1.3 QUALITY ASSURANCE

A. The Contractor shall be authorized by the Manufacturer to install the equipment provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers
   1. Cornell
   2. Aiphone
   3. Rath

2.2 COMMUNICATIONS EQUIPMENT

A. System overview:
   1. The communication system consists of Area Station's with battery back-up (24 hours of standby and 2 hours of use upon loss of power) and programmable automatic dialer & a Master Station.

B. Call Station:
   1. Initiate call when button is pressed.
   2. When note answered on site after a preprogrammed time has elapsed, the main panel with call off site to an emergency number specified by the AHJ.
   3. The station shall initiate an alarm at the control panel when the button is pressed.
   4. Face plate shall be stainless steel.
   5. Greater than or equal to 1.5" diameter button:
      a. Capable of being activated from any angle with a minimum of effort.
      b. No other hardware shall protrude from the station as high as the pushbutton.
   6. LED indicator confirms transmission of the "HELP REQUESTED" SIGNAL.

7. Dual audio and visual alarms for the hearing and visually impaired.

C. Command Unit (master)
1. Recessed Mounted
2. Handset for Talk/ Listen
3. Indication of area from which rescue assistance is being requested.
4. Talk & Hold buttons for each area
5. Power Led (red)
6. Battery Back-up w\ light
7. Green Led to indicate outgoing call initiated from any area station
8. Overide button to cancel any outgoing call
9. Audio alert signaling for outgoing call from the area station

2.3 BASIC SYSTEM OPERATION

A. When in use the system shall provide two-way audio communications between the call stations and the base station, and a called outside party. Communication at the Call Station shall be hands-free after initial contact from the Base station or called party, the Base Station will use an ADA compliant volume control handset.

B. When an emergency call is placed by the Call Station, it provides the following indications at the Base Station to assure the caller that the call is being processed. After pressing the “PUSH FOR HELP” call button:
1. Audio and visual confirmation:
a. A “HELP REQUESTED” LED shall illuminate.
b. An alarm shall sound.

C. The Base Station allows Emergency Personnel to check status of each Call Station and to talk with each Call Station on an individual basis or all of them together

D. A lighted green LED labeled “RESCUE SERVICES” indicates that an emergency is in progress.

E. If an emergency call is in progress, by lifting the handset on the Base Station unit you can automatically join the conversation .At this point you can place any or all Call Stations on hold by pushing the hold button corresponding to that unit, which will leave them talking to the called party. Or you can disconnect the called party by pressing the “DISCONNECT TO CALL SERVICES” button, which will leave you talking to the Call Station.

F. If there is no emergency call in progress you can call into any or all Call Station by pressing the corresponding talk button to that unit.

G. By hanging up the Base Station you disconnect from the conversation while leaving the Call Station continuing any ongoing conversation with the called party.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Complete system shall be installed in strict accordance with manufacturer's written instructions.

B. Provide signage per the International Building Code.

C. Mounting height:
   1. Area Station: call button centered 3’-6” AFF.
   2. Base Station: top call button 3’-6” AFF.

D. Wiring:
   1. All wiring shall be in conduit and shall be concealed.

3.2 CIRCUIT BREAKERS

A. Circuit breakers serving two-way communication devices shall be provided with a circuit breaker locking device and be permanently identified as “EMERGENCY COMMUNICATIONS”.

3.3 INSPECTION AND TEST UPON COMPLETION

A. System field wiring diagrams shall be provided to the Contractor by the system Manufacturer prior to installation.

B. Upon completion of the installation:
   1. Four (4) copies of complete operational instructions shall be furnished, complete with record drawings. Instructions shall include part numbers and name, address, and telephone number of parts source.
   2. Contractor shall provide to the Engineer a signed statement that the system has been wired and tested, and functions properly according to the specifications.

C. Nothing herein contained shall be construed to relieve the Contractor from furnishing a complete and acceptable electrical wiring system in all its categories. The Engineer will reject any materials or labor which are or may become detrimental to the accomplishment of the intentions of these specifications.

3.4 IN SERVICE TRAINING

A. The Contractor shall furnish training with the system. This session shall be broken into segments that will facilitate the training of individuals in operating the Master Station as well as the Area Station. Operating manuals and users guides shall be provided at the time of the training.

END OF SECTION 283200

SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and removing site utilities.
7. Retain subparagraph below if erosion- and sedimentation-control measures are not included in Division 01 Section "Temporary Facilities and Controls."
8. Temporary erosion- and sedimentation-control measures.

B. Related Sections:

1. Division 01 Section "Temporary Facilities and Controls" for temporary utility services, construction and support facilities, security and protection facilities, and temporary erosion- and sedimentation-control measures.
2. Division 01 Section "Execution" for field engineering and surveying.

1.3 DEFINITIONS

A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow.

D. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches (50 mm) in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

E. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and indicated on Drawings.

F. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 SUBMITTALS

A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

1. Use sufficiently detailed photographs or videotape.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at Project site.

1.7 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: N/A

C. Salvable Improvements: N/A

D. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

E. Do not commence site clearing operations until temporary erosion- and sedimentation-control measures are in place.

F. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

G. Do not direct vehicle or equipment exhaust towards protection zones.

H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

I. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Division 31 Section "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly identify trees, shrubs, and other vegetation to remain.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

A. General: Protect trees and plants remaining on-site according to requirements in Division 01 Section "Temporary Tree and Plant Protection."

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect.

3.4 EXISTING UTILITIES

A. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.

1. Verify that utilities have been disconnected and capped before proceeding with site clearing.

B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed.

1. Arrange with utility companies to shut off indicated utilities.
2. Owner will arrange to shut off indicated utilities when requested by Contractor.

C. Locate, identify, and disconnect utilities indicated to be abandoned in place.

D. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

E. Excavate for and remove underground utilities indicated to be removed.

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches (450 mm) below exposed subgrade.
3. Use only hand methods for grubbing within protection zones.
4. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches (200 mm), and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth of 6 inches (150 mm) in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches (50 mm) in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Limit height of topsoil stockpiles to 72 inches (1800 mm).
2. Do not stockpile topsoil within protection zones.
3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 311000

SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Preparing subgrades for slabs-on-grade, walks, turf and grasses, and plants.
2. Excavating and backfilling for buildings and structures.
3. Drainage course for concrete slabs-on-grade.
4. Subbase course and base course for asphalt paving.
5. Excavating and backfilling trenches for utilities and pits for buried utility structures.

B. Related Sections:

1. Division 01 Section "Construction Progress Documentation" for recording preexcavation and earth moving progress.
2. Division 01 Section "Temporary Facilities and Controls" for temporary controls, utilities, and support facilities; also for temporary site fencing if not in another Section.
3. Division 03 Section "Cast-in-Place Concrete" for granular course if placed over vapor retarder and beneath the slab-on-grade.
4. Divisions 21, 22, 23, 26, and 33 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures.
5. Division 31 Section "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Bulk Excavation: Excavation more than 10 feet (3 m) in width and more than 30 feet (9 m) in length.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Rock: N/A

I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

J. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

K. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

L. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 SUBMITTALS

A. Product Data: For each type of the following manufactured products required:

1. Geotextiles.
2. Controlled low-strength material, including design mixture.
3. Warning tapes.

B. Samples for Verification: For the following products, in sizes indicated below:

1. Geotextile: 12 by 12 inches (300 by 300 mm).
2. Warning Tape: 12 inches (300 mm) long; of each color.

C. Qualification Data: For qualified testing agency.

D. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:

1. Classification according to ASTM D 2487.
2. Laboratory compaction curve according to ASTM D 698.

E. Seismic survey report from seismic survey agency.

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

G. Co-Permittee Agreement for Storm Water Management: This submittal shall be submitted prior to beginning work.

H. Permits: Coordinate with architect/engineer.

1.5 QUALITY ASSURANCE

A. Blasting: Not allowed

B. Seismic Survey Agency: N/A

C. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

D. Preexcavation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: N/A

C. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth moving operations.

D. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures, specified in Division 31 Section "Site Clearing," are in place.

E. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.

7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

F. Do not direct vehicle or equipment exhaust towards protection zones.

G. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, SC and SM according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 3 inches (75 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

1. Liquid Limit: <35
2. Plasticity Index: <20

C. Unsatisfactory Soils: Soil Classification Groups GC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487 or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch (37.5-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.

I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch (25-mm) sieve and 0 to 5 percent passing a No. 4 (4.75-mm) sieve.

J. Sand: ASTM C 33; fine aggregate.

K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.3 EXPLOSIVES

A. Explosives: Do not use explosives.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:

a. 24 inches (600 mm) outside of concrete forms other than at footings.
b. 12 inches (300 mm) outside of concrete forms at footings.
c. 6 inches (150 mm) outside of minimum required dimensions of concrete cast against grade.
d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
e. 6 inches (150 mm) beneath bottom of concrete slabs-on-grade.
f. 6 inches (150 mm) beneath pipe in trenches, and the greater of 24 inches (600 mm) wider than pipe or 42 inches (1065 mm) wide.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm). If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch (25 mm). Do not disturb bottom of excavations intended as bearing surfaces.

B. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Cut and protect roots according to requirements in Division 01 Section "Temporary Tree and Plant Protection."

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: 12 inches (300 mm) each side of pipe or conduit.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. For pipes and conduit less than 6 inches (150 mm) in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
2. For pipes and conduit 6 inches (150 mm) or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
3. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
4. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trench Bottoms: Excavate trenches 4 inches (100 mm) deeper than bottom of pipe and conduit elevations to allow for bedding course if necessary. Hand-excavate deeper for bells of pipe.

1. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

E. Trenches in Tree- and Plant-Protection Zones:

1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
3. Cut and protect roots according to requirements in Division 01 Section "Temporary Tree and Plant Protection."

3.8 SUBGRADE INSPECTION

A. Notify Architect when excavations have reached required subgrade.

B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes) to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph (5 km/h).
2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi (17.2 MPa), may be used when approved by Architect.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.10 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.12 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches (450 mm) of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Division 03 Section "Cast-in-Place Concrete."

D. Backfill voids with satisfactory soil while removing shoring and bracing.

E. Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch (25 mm) in any dimension, to a height of 12 inches (300 mm) over the pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

F. Place and compact final backfill of satisfactory soil to final subgrade elevation.

G. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.

H. Install warning tape directly above utilities, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.13 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.14 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.

2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches (200 mm) in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:

1. Under structures and building slabs, scarify and recompact top 12 inches (300 mm) of existing subgrade and each layer of backfill or fill soil material at 98 percent and the upper one (1) foot of floor slab and footing area compacted to 100 percent of its maximum dry density.
2. Under vehicular pavements, scarify and recompact top 12 inches (300 mm) of existing subgrade and each layer of backfill or fill soil material at 98 percent of its maximum dry density.
3. Under walkways, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 95 percent.
4. Under turf or unpaved areas, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 85 percent.
5. For utility trenches, compact each layer of initial and final backfill soil material at 90 percent in lawn areas and 95 percent under paved areas.

3.16 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch (25 mm).
2. Walks: Plus or minus 1/2 inch (13 mm).

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch (13 mm) when tested with a 10-foot (3-m) straightedge.

3.17 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:

1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place base course material over subbase course under hot-mix asphalt pavement.
3. Shape subbase course and base course to required crown elevations and cross-slope grades.
4. Place subbase course and base course 6 inches (150 mm) or less in compacted thickness in a single layer.
5. Place subbase course and base course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
6. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

C. Pavement Shoulders: Place shoulders along edges of subbase course and base course to prevent lateral movement. Construct shoulders, at least 12 inches (300 mm) wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.18 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place drainage course 6 inches (150 mm) or less in compacted thickness in a single layer.
3. Place drainage course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.19 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
2. Determine that fill material and maximum lift thickness comply with requirements.

3. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.

B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

E. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:

1. Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. (186 sq. m) or less of paved area or building slab, but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet (30 m) or less of wall length, but no fewer than two tests.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.20 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.21 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 312000

SECTION 31 23 33 - TRENCHING, BACKFILLING AND COMPACTING FOR UTILITY SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Material Classification

B. Excavation

C. Dewatering

D. Backfilling and Compaction

E. Testing

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM)

1. ASTM D422 Particle - size Analysis of Soils

2. ASTM D698 Moisture - Density Relations of Soils and Soil - Aggregate mixtures using 5.5 lb. Rammer and 12 inch Drop.

3. ASTM D1556 Density of soil in place by the Sand - Cone Method

4. ASTM D2167 Density and Unit Weight of soil in place by the Rubber Balloon Method.

5. ASTM D2487 Classification of soils for engineering purposes.

6. ASTM D2488 Description of soils (visual - manual Procedure).

7. ASTM D2922 Density of soil and soil - aggregate in place by nuclear methods.

8. ASTM D3017 Moisture content of soil and soil - aggregate in place by Nuclear Methods.

9. ASTM D4318 Liquid limit of soils.

1.3 JOB CONDITIONS

A. Existing Utilities:

1. Locate existing underground utilities in areas of work.

2. Provide adequate means of support and protection during earthwork operations.

3. Utilities encountered during excavation, uncharted or incorrectly charted shall be kept in operation. Consult Engineer about utility locations.

4. Repair damaged utilities to satisfaction of Engineer at no cost to Owner.

5. Do not interrupt existing utilities serving facilities occupied and used, during occupied hours, unless acceptable temporary utility services have been provided.

6. Provide minimum of 48-hour notice to Engineer, and receive notice to proceed before interrupting any utility.

B. Protection of Persons and Property:

1. Provide adequate barricades, construction signs, and warning lights as required.

2. Protection shall be placed and maintained by the Contractor at his expense during the progress of the construction.

3. Obstructions to traffic, material piles, equipment and pipe, shall be enclosed by fences or barricades and shall be protected by proper lights when the visibility is poor.

4. The rules and regulations of O.S.H.A. and appropriate authorities safety provisions shall be observed.

5. Shoring and Sheeting shall be used if the soil conditions are not substantial to:
   a. Prevent undermining of pavements and slabs.
   b. Prevent movement in bank or slopes.
   c. Prevent movement in vertical wall trenches.

6. Protect satisfactory material from becoming spoiled by water, debris, organic material.

7. A temporary surface shall be placed over the trench top as soon as possible after compaction in traveled areas. The temporary surface shall:
   a. Maintain a smooth surface
   b. Meet grade of adjacent undisturbed surface
   c. Be maintained at Contractor's expense until final restoration

1.4 DEFINITIONS

A. Absorption - The attachment of water molecules to the surfaces of soil particles.

B. Aggregate - Relatively inert granular mineral material such as sand, gravel, slag, crush stone, etc.

1. Fine aggregate - material that will pass a No. 4 screen.

2. Coarse aggregate - material that will not pass a No. 4 screen.

C. Angular aggregate - aggregate that possesses well - defined edges formed at the intersection of roughly planar faces.

D. Base coarse - a layer of specified or selected material of planned thickness constructed in the subgrade or subbase for the purpose of serving one or more functions such as distributing load, providing drainage, minimizing frost action, etc.

E. Backfill - The area above the initial backfill to finish grade or grade specified.

F. Bedding - The section from the top of the foundation to the bottom of the pipe.

G. Clay - fine grained soil or the fine grained portion of soil that can be made to exhibit plasticity (putty like) within a range of water contents, and that exhibits considerable strength when air dry.

H. Cohesionless soils - a soil that when unconfined has little or no strength when air dried and that has little or no cohesion when submerged.

I. Cohesive soils - a soil that when unconfined has considerable strength when air dried and that has significant cohesion when submerged.

J. Compaction - The densification of a soil by means of mechanical manipulation.

K. Differential Settlement - settlement that varies in rate or amount, or both, from place across a structure.

L. Displacement - a change in position of a material point.

M. Ductility - condition in which material can sustain permanent deformation without losing its ability to resist load.

N. Elasticity - property of material that returns to its original form or condition after the applied force is removed.

O. Fineness - a measure of particle size.

P. Fines - portion of soil that passes through a No. 200 U.S. Standard sieve.

Q. Foundation - material below bedding that represents the bottom of trench.

R. Water Table - elevations at which the pressure of the water is zero (0) with respect to the atmospheric pressure.

S. Ground - Water Level - - the level below which the rock and subsoil, to unknown depths, are saturated.

T. Hardpan - a hard impervious layer, composed chiefly of clay, cemented by relatively insoluble materials, that does not become plastic when mixed with water and definitely limits the downward movement of water and roots.

U. Haunching - from the bottom of the pipe to 1/4 of pipe outside diameter above the spring line (3/4 of pipe outside diameter above the pipe bottom).

V. Initial Backfill - from top of haunching section to the bottom of the final backfill.

W. Liquid Limit - the water content corresponding to the arbitrary limit between the liquid and plastic states of consistency of a soil.

X. Moisture Content - the percentage by weight of water contained in the pore space of a rock or soil.

Y. Muck - stone, dirt, debris, or useless material or an organic soil of very soft consistency.

Z. Mud - a mixture of soil and water in a fluid or weakly solid state.

AA. Optimum moisture content - the water content at which a soil can be compacted to a maximum dry unit weight by a given compactive effort.

BB. Plasticity - the property of a soil or rock that allows it to be deformed beyond the point of recovery without cracking or appreciable volume change.

CC. Rock – see definition in Earth Moving Section.

1.5 SUBMITTALS

A. Copies of laboratory and field test reports

PART 2 PRODUCTS

2.1 SATISFACTORY MATERIALS

A. Satisfactory materials are materials designated as such in the Geotechnical report and Earth Moving section provided in the project manual.

2.2 UNSATISFACTORY MATERIALS

A. Unsatisfactory materials shall be materials that are unsatisfactory for their intended use and as designated by soil technicians.

B. Unsatisfactory materials include but are not limited to those materials containing roots and other organic matter, trash, debris, frozen materials and stones larger than 3 inches and materials classified in USCS as OH, OL, CH, and MH.

C. Unsatisfactory materials also include man-made fills, refuse, or backfill from previous construction.

D. Satisfactory materials, which are classified as wet or saturated by ASTM D2488, shall be considered unsatisfactory material unless dried to optimum moisture content.

2.3 UNYIELDING MATERIAL

A. Unyielding material shall consist of rock and gravelly soils with stones greater than 3 inches in any dimension or as defined by the pipe manufacturer, whichever is smaller.

2.4 UNSTABLE MATERIAL

A. Unstable material shall consist of materials unable to properly support the utility pipe, conduit, or appurtenance structure.

2.5 DEGREE OF COMPACTION

A. Degree of compaction shall be expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D-698.

2.6 EMBEDMENT MATERIALS

A. Embedment materials listed herein include a number of processed materials plus the soil classifications listed under the Unified Soil Classification System (USCS) (Method D 2487 and Practice D 2488). These materials are grouped into four broad categories according to their suitability for this application.

1. Class I - Angular, 6 to 40 mm (1/4 to 1-1/2 inch), graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, and crushed shells.

2. Class II - Coarse sands and gravels with maximum particle size of 40 mm (1-1/2 inch), including variously graded sands and gravels containing small percentage of fines, generally granular and non-cohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class.

3. Class III - Fine sand and clay gravels, including fine sands, sand-clay mixtures, and gravel-clay mixtures. Soil Types GM, GC, SM and SC are included in this class.

4. Class IV - Silt, silty clays, and clays, including inorganic clays and silts of medium to high plasticity and liquid limits. Soil Types MH, ML, CH and CL are included in this class.

PART 3 - EXECUTION

3.1 CONSTRUCTION METHODS

A. Construction on site:

1. Confine all operations to the limits of construction.

2. Take precautions to prevent any cave-in of disturbance beyond the construction limits or damage to improvements within the site.

3. Restore damage areas outside of the construction limits to original condition.

4. Fences, shrubbery or other type of surface improvements located in the construction area will require protection during construction or removal and replacement as necessary for trench construction.

5. Organize operations to perform within the construction limits.

B. Protection of Property and Surface Structures:

1. Protect property and surface structures during construction operations. Provide appropriate barricades in any traffic areas to deter traffic from construction areas.

2. Restore fences, poles or other man-made surface improvements that are disturbed to the original conditions. Expense for restoration shall be borne by the Contractor and shall not be an additional cost to Owner.

3. The Contractor at no cost to Owner shall restore damage caused by construction operations to landscape improvements that were not authorized for removal.

3.2 EXCAVATION

A. Excavation shall be performed to the lines and grades indicated.

B. Stockpile:

1. Stockpile material satisfactory for backfilling at a sufficient distance from the trench to avoid overloading and to prevent slides or cave-ins.

2. If construction limits prevent the stockpiling of excavated material adjacent to the banks of the trench transport immediately excavated material to its ultimate destination (backfill or off-site).

3. Provide adequate drainage for the stockpiles and surrounding areas, by means of ditches, dikes, or other approved methods.

4. Grade to prevent surface water from flowing into the excavation.

5. Remove accumulating water from trenches.

6. Protect stockpiles from contamination with unsatisfactory excavated material or other material that may destroy the quality and fitness of the suitable stockpiled material.

7. Satisfactory material that becomes contaminated shall be removed and replaced with satisfactory material from approved sources at no additional cost to the Owner.

8. Excavated material not required or unsatisfactory for backfill shall be completely removed from the site.

9. Avoid obstructing sidewalks and driveways.

10. Leave fire hydrants, valve pit covers, valve boxes, curb stop boxes, or other utility controls unobstructed and accessible.

11. Provide adequate erosion control devices to prevent damage to surrounding construction areas.

C. Excavation for Appurtenances:

1. Leave 12 inches clear between the outer structure surfaces and the face of the excavation or support members.

2. Rock shall be cleaned of loose debris and cut to a firm surface either level, stepped, or serrated.
3. Remove loose disintegrated rock and thin strata.

4. Take care not to disturb the bottom (foundation) of the excavation when placing concrete or masonry.

5. Excavation to the final grade level shall not be made until just before the concrete or masonry is to be placed.

D. Trench Excavation:

1. Excavate to the dimension and depth shown in the plans.

2. Slope or brace trench walls, above the area designated as "initial backfill", to meet OSHA requirements. Vertical side wall shall be maintained below the area designated as "initial backfill".

E. Sheeting, Shoring and Bracing:

1. Open-cut trenches shall be sheeted and braced or otherwise protected as required to protect life, property, or the work and as required by Federal, State, or municipal ordinances.

2. The minimum protection shall conform to the recommendations in O.S.H.A. Safety and Health Standards for Construction.

3. A sand box or trench shield may be used in lieu of sheeting as permitted by O.S.H.A.

4. When close sheeting is used, it shall be so driven as to prevent adjacent soil from entering the trench either below or through such sheeting.

5. Where shoring and bracing are used, the trench width shall be increased accordingly.

6. Sheeting and bracing which have been ordered left in place shall be cut off 18-inches below grade.

7. Trench bracing, except when ordered left in place, may be removed when the backfilling has reached the respective levels of such bracing.

8. Sheeting, except that ordered left in place, may be removed after the backfilling has been completed or has been brought to such an elevation as to permit its safe removal.

F. Trenches With Sloping Sides, Limited:

1. When working conditions and right-of-way permit allow, excavate pipe line trenches with sloping sides, but with the following exceptions:

a. To save site improvements.
b. Adjacent to a structure or building.
c. Violates easement or right-of-way permit.

G. Bottom Preparation:

1. Accurately grade the bottom to provide uniform bearing and bottom quadrant support of each pipe section and to avoid differential settlement.
2. When unstable material is encountered in the bottom of the trench, such material shall be removed to the depth as required to provide acceptable pipe foundation and replaced to the proper grade with Class I material.

3. Over excavation of trench bottom - fill over excavation with an acceptable class of embedment material to at least 12 inch below pipe and compact to a minimum of 98% Standard Proctor Density, ASTM D 698.

3.3 DEWATERING

A. Trenches shall be kept dewatered at all times by bailing sump pumps at the lower end of the trench, by well-pointing or other approved means.

B. Surface water shall be prevented from flowing into trenches by diking, ditching or otherwise directing the flow of surface water.

C. Disposal of water shall be in accordance with local erosion and sediment control regulations. Silty or muddy water shall not be permitted to enter a watercourse, open ditch or storm drain until after flowing through a sediment trap or basin.

D. Running Water:

1. Remove running water from trench before laying pipe.

2. Select the method of water removal.
   a. Use Class I material for pipe bedding which will serve as a trench drain and/or under drain from which the excess water will be pumped via trench side pumps.
   b. Well points.

3. Take necessary precautions to insure that the trench wall will not be removed as a result of the running water.

3.4 BACKFILL AND COMPACTION

A. Backfill shall be placed in layers not exceeding 6 inches loose thickness for hand operated machine compaction, and 8" loose thickness for other than hand operated machines, unless otherwise specified.

1. Each layer shall be compacted to at least 95% maximum density, unless otherwise specified.

2. Compaction shall be tested by ASTM D698.

B. Replacement of Unyielding Material: Unyielding material removed from the bottom of the trench shall be replaced with satisfactory material of class specified for that trench section (Haunching, Initial Backfill, etc.).

C. Replacement of Unstable Material: Unstable material removed from the bottom of the trench or excavated shall be replaced with the specified class of material for that trench section (Haunching, Initial Backfill, etc.).

D. Foundation: Take care to undercut only what is required for bedding and leave foundation undisturbed. In situations where unstable material is encountered below the bedding, it shall be removed to the depth required, replaced with Class I material in 6" layers and compacted to 95% of maximum density.

E. Bedding: shall consist of Class I or Class II materials.

F. Haunching: place in layers of a maximum of 6 inches loose thickness. The haunching shall be brought up evenly on both sides of the pipe for the full length of the pipe. Compaction rates for materials used in Haunching area are as follows:

1. Class I: Requires hand tamped compaction
   a. Care shall be taken to ensure proper pipe support under pipe in haunching areas.

2. Class II and III: 95% maximum density

3. For PVC pipe use Class 1.

G. Initial Backfill:

1. Place in layers of a maximum of 6 inches loose thickness and compacted.

2. When using ductile iron pipe use Class I, Class II, or Class III materials,
   a. At a moisture content that will facilitate compaction,
   b. Be free from stones larger than 2 inches in any dimension or as recommended by pipe manufacturer, whichever is smaller.
   c. If the pipe is coated or wrapped for protection against corrosion, the backfill material shall be free of stones larger than 1 inch in any direction or as recommended by the pipe manufacturer whichever is smaller.
   d. PVC pipe use Class I only

3. Compaction rates
   a. Class I material: hand tamped.
   b. Class II and Class III: 95% maximum density.
   c. Class IV material shall not be used in initial backfill area.

H. Final Backfill: Class II, Class III, or Class IV material. Final backfill shall contain no unsuitable material that includes organic matter, trash, debris, frozen materials and stones larger than 1.5 inches.

1. Turfed or Sodded Areas and Miscellaneous Areas:
   a. Deposit in layers of a maximum of 12-inch loose thickness.
   b. Compact to 90% maximum density.

2. Backfill for Manholes, Catch Basins and other Appurtenances:
   a. Carefully place backfill so that the structure will not be damaged by the shock of falling earth.
   b. Deposit and compact as specified for initial backfill above.
   c. Place as to prevent eccentric loading and excess stress on the pipe or structure.

3. Roadways. Walks, and Parking Areas:
   a. Deposit on lifts not exceeding 6" loose thickness.
   b. Compacted to 100% maximum density.

3.5 TESTING

A. Testing and inspection services: Owner shall engage soil testing and inspection service for quality control testing during trenching and backfilling operation.

B. Determination of Density:

1. Testing facility: an approved commercial testing laboratory shall perform density tests. Approval of testing facilities shall be based on compliance with ASTM E 548.

2. Tests shall be performed in sufficient numbers to ensure that the specified density is being obtained.

3. Field moisture-density relation testing and compaction testing shall be performed at the direction and discretion of the Engineer, but shall not exceed two test locations per week.

4. Laboratory tests for moisture-density relations shall be determined in accordance with ASTM D 698 or ASTM D 1557, as specified in these specifications.

5. Characteristics of backfill material shall be determined in accordance with particle size analysis of soils in accordance with ASTM D 422.

6. Field in-place density shall be determined in accordance with ASTM D 2167.

7. Trenches improperly compacted shall be reopened to the necessary depth, then refilled and compacted to the density specified at no additional cost to the Owner.

3.6 RESTORATION OF PRE-EXISTING CONDITIONS

A. Areas disturbed by operations required under this Section shall be restored as indicated on the Drawings or specified herein and at no cost to Owner.

B. Any disturbance outside the construction area shall be restored to the original condition or satisfaction of Engineer at no cost to the Owner.

C. Paved Areas: Restore to the original conditions conforming to these specifications and drawings.

D. Lawns and Yards: Established greenways on site; sod lawn and replant scrubs.

E. Surfaces Structures: Trees, shrubbery, fences, poles and all other surface structures shall be protected during construction operations unless the Engineer authorizes the removal. Any fences, poles or other manmade surface improvements which are moved or disturbed by the Contractor shall be restored to their original condition at the Contractor's expense. Any trees, shrubbery or other vegetation which are approved or ordered for removal by the Engineer shall be removed completely, including stumps and roots, by the Contractor. The Contractor shall be responsible for damage or claims of damage caused by construction operations to shrubbery or other landscape improvements.

END OF SECTION

SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes exterior cement concrete pavement for the following:

1. Driveways.
2. Curbs and gutters.
3. Walkways.
4. Pads.

B. Related Sections include the following:

1. Division 03 Section "Cast-in-Place Concrete" for general building applications of concrete.
2. Division 31 Section "Earth Moving" for subgrade preparation, grading, and subbase course.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated.

B. Design Mixtures: For each concrete pavement mixture. Include alternate mixture designs when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Samples: 10-lb (4.5-kg) sample of exposed aggregate.

D. Qualification Data: For manufacturer.

E. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:

1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

F. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Admixtures.
4. Curing compounds.
5. Bonding agent or epoxy adhesive.
6. Joint fillers.

G. Field quality-control test reports.

H. On curb and gutter and concrete flumes of less than 1.0 percent gradient, the Contractor shall provide to the Architect/Engineer As Built elevations for curb and gutter and concrete flumes located at the edge of the gutters and edge of flumes at 10’ +- intervals (score joints) to confirm that positive drainage has been established. Only curb and gutter and flumes with positive drainage is acceptable except where gradient is specified to be flat. This information shall be furnished in electronic format and on a hard copy print at 1” 40’ scale.

I. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

B. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.

C. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.

D. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1. Before submitting design mixtures, review concrete pavement mixture design and examine procedures for ensuring quality of concrete materials and concrete pavement construction practices. Require representatives, including the following, of each entity directly concerned with concrete pavement, to attend conference:

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete producer.
d. Concrete pavement subcontractor.

1.6 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

1.7 SOLAR REFLECTIVE INDEX

A. 25 or greater

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
2. Products: Subject to compliance with requirements, provide one of the products specified.
3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.

1. Use flexible or curved forms for curves with a radius 100 feet (30.5 m) or less.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

A. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420); deformed.

C. Joint Dowel Bars: Plain steel bars, ASTM A 615/A 615M, Grade 60 (Grade 420). Cut bars true to length with ends square and free of burrs.

2.4 CONCRETE MATERIALS

A. Cementitious Material: Use one of the following cementitious materials, of the same type, brand, and source throughout the Project:

1. Portland Cement: ASTM C 150, Type I/II

a. Fly Ash: ASTM C 618, Class F.
b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33, Class 4M, 4S, 1N coarse aggregate, uniformly graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar pavement applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 1 inch (25 mm) nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: ASTM C 94/C 94M.

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.5 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.

1. Available Products:

a. Axim Concrete Technologies; Cimfilm.
b. Burke by Edeco; BurkeFilm.
c. ChemMasters; Spray-Film.
d. Conspec Marketing & Manufacturing Co., Inc.; Aquafilm.
e. Dayton Superior Corporation; Sure Film.
f. Euclid Chemical Company (The); Eucobar.
g. Kaufman Products, Inc.; Vapor Aid.
h. Lambert Corporation; Lambco Skin.
i. L&M Construction Chemicals, Inc.; E-Con.
j. MBT Protection and Repair, ChemRex Inc.; Confilm.
k. Meadows, W. R., Inc.; Sealtight Evapre.
l. Metalcrete Industries; Waterhold.
m. Nox-Crete Products Group, Kinsman Corporation; Monofilm.
n. Sika Corporation, Inc.; SikaFilm.
o. Symons Corporation; Finishing Aid.
p. Vexcon Chemicals, Inc.; Certi-Vex EnvioAssist.

E. Clear Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

1. Available Products:

a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
b. Burke by Edoko; Aqua Resin Cure.
c. ChemMasters; Safe-Cure Clear.
d. Conspec Marketing & Manufacturing Co., Inc.; W.B. Resin Cure.
e. Dayton Superior Corporation; Day Chem Rez Cure (J-11-W).
f. Euclid Chemical Company (The); Kurez DR VOX.
g. Kaufman Products, Inc.; Thinfilm 420.
h. Lambert Corporation; Aqua Kure-Clear.
i. L&M Construction Chemicals, Inc.; L&M Cure R.
j. Meadows, W. R., Inc.; 1100 Clear.
k. Nox-Crete Products Group, Kinsman Corporation; Resin Cure E.
l. Symons Corporation; Resi-Chem Clear.
m. Tamms Industries Inc.; Horncure WB 30.
n. Unitex; Hydro Cure 309.
o. Vexcon Chemicals, Inc.; Certi-Vex Enviocure 100.

2.6 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

C. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to requirements, and as follows:

1. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

D. Chemical Surface Retarder: Water-soluble, liquid-set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch (3 to 6 mm).

1. Available Products:

a. Burke by Edeco; True Etch Surface Retarder.
b. ChemMasters; Exposee.
c. Conspec Marketing & Manufacturing Co., Inc.; Delay S.
d. Euclid Chemical Company (The); Surface Retarder S.
e. Kaufman Products, Inc.; Expose.
f. Metalcrete Industries; Surftard.
g. Nox-Crete Products Group, Kinsman Corporation; Crete-Nox TA.
h. Scofield, L. M. Company; Lithotex.
i. Sika Corporation, Inc.; Rugasol-S.
j. Vexcon Chemicals, Inc.; Certi-Vex Envioset.

2.7 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete mixture designs for the trial batch method.

B. Proportion mixtures to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): 4000 psi (27.6 MPa) on driveway, 3000 psi (20.7 MPa) on sidewalk.
2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.50.
3. Slump Limit: 4 inches (100 mm), plus or minus 1 inch (25 mm) or 8” maximum using high range water reducer.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content: 6 percent plus or minus 1.5 percent for 1-inch (25-mm) nominal maximum aggregate size.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing admixture, high-range, water-reducing admixture, high-range, water-reducing and retarding mixture, plasticizing and retarding mixture in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

F. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements as follows:

1. Fly Ash or Pozzolan: 25 percent.
2. Ground Granulated Blast-Furnace Slag: 50 percent.
3. Combined Fly Ash or Pozzolan, and Ground Granulated Blast-Furnace Slag: 50 percent, with fly ash or pozzolan not exceeding 25 percent.

2.8 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 deg F (30 deg C) and 90 deg F (32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For concrete mixes of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For concrete mixes larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph (5 km/h).
2. Proof-roll with a loaded 10-wheel tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes).
3. Subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch (13 mm) require correction according to requirements in Division 31 Section "Earth Moving."

C. Proceed with concrete pavement operations only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.

   1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.

   1. Continue steel reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
   2. Provide tie bars at sides of pavement strips where indicated.
   3. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
   4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
   5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.

   1. Locate expansion joints at intervals of 50 feet (15.25 m), unless otherwise indicated.

2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) below finished surface if joint sealant is indicated.
4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
6. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:
   1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
   2. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.
   3. Scored Joints: On sidewalk score joints at 10’ o/c unless otherwise indicated on drawings. On sidewalks wider than 10’provide a center line scoring. On curb and gutters and concrete flumes score joints shall be at 10’ o/c.

E. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 1/4-inch (6-mm) radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site.

F. Do not add water to fresh concrete after testing.

G. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

H. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

I. Place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay welded wire fabric or fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.

1. Remove and replace concrete that has been placed for more than 15 minutes without being covered by top layer, or use bonding agent if approved by Architect.

J. Screed pavement surfaces with a straightedge and strike off.

K. Commence initial floating using bull floats or darbies to impart an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

L. Curbs and Gutters: When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not approved, remove and replace with formed concrete.

M. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When air temperature has fallen to or is expected to fall below 40 deg F (4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mix designs.

N. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.

3.8 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:

1. Moist Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

a. Water.
b. Continuous water-fog spray.
c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.9 PAVEMENT TOLERANCES

A. Comply with tolerances of ACI 117 and as follows:

1. Elevation: 1/4 inch (6 mm).
2. Thickness: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).

3. Surface: Gap below 10-foot- (3-m-) long, unleveled straightedge not to exceed 1/4 inch (6 mm).
4. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch (25 mm).
5. Vertical Alignment of Tie Bars and Dowels: 1/4 inch (6 mm).
6. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2 inch (13 mm).
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches (6 mm per 300 mm).
8. Joint Spacing: 3 inches (75 mm).
9. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.
10. Joint Width: Plus 1/8 inch (3 mm), no minus.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least 1 composite sample for each 100 cu. yd. (76 cu. m) 5000 sq. ft. (465 sq. m) or fraction thereof of each concrete mix placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39/C 39M; test 1 specimen at 7 days and 2 specimens at 28 days.

    a. A compressive-strength test shall be the average compressive strength from 2 specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mix will be satisfactory if average of any 3 consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).

D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.11 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.

C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

SECTION 329200 - TURF AND GRASSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Seeding.
2. Sodding.

1.2 DEFINITIONS

A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

B. Finish Grade: Elevation of finished surface of planting soil.

C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.

H. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

I. Surface Soil: Whatever soil is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.3 SUBMITTALS

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

B. Certification of grass seed.

1. Certification of each seed mixture for turfgrass sod.

C. Product certificates.

1.4 QUALITY ASSURANCE

A. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

1. Pesticide Applicator: State licensed, commercial.

B. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory.

1. The soil-testing laboratory shall oversee soil sampling.
2. Report suitability of tested soil for turf growth.

a. State recommendations for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
b. Report presence of problem salts, minerals, or heavy metals; if present, provide additional recommendations for corrective action.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.

1.6 MAINTENANCE SERVICE

A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but for not less than the following periods:

1. Sodded Turf: 30 days from date of planting completion.

PART 2 - PRODUCTS

2.1 TURFGRASS SOD

A. Turfgrass Sod: Certified and Approved sod including limitations on thatch, weeds, diseases, nematodes, and insects], complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.

B. Turfgrass Species: Sod of grass species as follows:

1. Centipede

C. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as needed.

D. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, and with a minimum of 99 percent passing through.

E. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

F. Aluminum Sulfate: Commercial grade, unadulterated.

G. Perlite: Horticultural perlite, soil amendment grade.

H. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through.

I. Sand: Clean, washed, natural or manufactured, and free of toxic materials.

J. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.

K. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.2 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1 inch sieve; soluble salt content of 8 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings.

B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture, with a pH range of 3.4 to 4.8.

C. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.

D. Wood Derivatives: Decomposed, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.

E. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.3 FERTILIZERS

A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 20 percent phosphoric acid.

B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.

2.4 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Sphagnum Peat Mulch: Partially decomposed sphagnum peat moss, finely divided or of granular texture, and with a pH range of 3.4 to 4.8.

C. Muck Peat Mulch: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.

D. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1 inch sieve; soluble salt content of 3 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings.

2.5 PESTICIDES

A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

PART 3 - EXECUTION

3.1 TURF AREA PREPARATION

A. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 6 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply fertilizer directly to subgrade before loosening.
2. Thoroughly blend planting soil off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil.
3. Spread planting soil to a depth of 6 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

    a. Reduce elevation of planting soil to allow for soil thickness of sod.

B. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:

1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
2. Loosen surface soil to a depth of at least 6 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 6 inches of soil. Till soil to a homogeneous mixture of fine texture.

    a. Apply fertilizer directly to surface soil before loosening.

3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.

C. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus .5 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.

D. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

E. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.2 SODDING

A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

1. Lay sod across angle of slopes exceeding 1:3.
2. Anchor sod on slopes exceeding 1:6 with steel staples spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.

C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1.5 inches below sod.

3.3 TURF MAINTENANCE

A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

B. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain height appropriate for species without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings.

C. Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

3.4 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect:
   1. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.

B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

END OF SECTION 329200

SECTION 329300 - PLANTS

PART 1 GENERAL

1.1 SECTION INCLUDES, BUT NOT LIMITED TO: Plant materials, mulch, and planting accessories.

1.2 RELATED WORK SPECIFIED ELSEWHERE:

A. Section 329400: Irrigation

B. Section 329200: Turfs and Grasses

1.3 QUALITY ASSURANCE

A. Installer's Qualifications: Planting shall be performed by a single firm specializing and experienced (minimum five years) in landscape work.

B. Codes and Standards: Comply with applicable provisions of the following, except as otherwise indicated or specified:

ANSI Z60.1 "American Standard for Nursery Stock."
Standards of the American Association of Nurserymen.
Federal, State and local regulations.

C. Plant names indicated comply with "Standardized Plant Names" as adopted by the latest edition of the American Joint Committee of Horticulture Nomenclature. Names of varieties not listed in that publication conform generally with names accepted by the nursery trade.

D. Inspection: Architect may inspect plant materials at place of growth and again on site. Architect reserves the right to tag some or all trees at place of growth; coordinate with Architect to allow sufficient opportunity for Architect to tag material.

E. Topsoil Analysis: Provide and pay for the services of an approved testing agency to perform an analysis of topsoil to be used. Analysis shall include a comprehensive description of topsoil, and a listing of types and quantities of soil amendments required for the successful establishment, growth and health of plant materials.

1.4 SUBMITTALS

A. Certification: Submit certification of inspection as required by government authorities. Submit manufacturer's or vendor's certified analysis for soil amendments and fertilizer materials, in accordance with methods established by the Association of Official Agricultural Chemists. Submit other data substantiating that materials comply with specified requirements, including certification that plant material species as delivered to the site comply with those specified.

B. Topsoil Analysis: Submit complete results of analysis.

C. Planting Schedule: Submit proposed planting schedule, indicating dates for completion of landscape work. Once accepted, revise schedule only as approved in writing by the Architect, after documentation of reasons for delays.

D. Maintenance Instructions: Prior to expiration of Contractor's maintenance period, submit typewritten instructions recommending procedures to be followed by Owner for maintenance of landscape work for the year following expiration of Contractor's maintenance period.

1.5 DELIVERY, STORAGE AND HANDLING:

A. Packaged Materials: Delivery packaged materials in original un-opened containers showing weight, name of manufacturer or vendor, and certified analysis. Store in manner to prevent wetting and deterioration.

B. Trees and Shrubs:

1. Provide freshly dug trees and shrubs. Take all precautions customary in good trade practice in preparing plants for moving. Ship with certificates of inspection required by governing authorities. Do not prune prior to delivery. Do not bend or bind-tie trees or shrubs in such a manner as to damage bark, break branches, or destroy natural shape of plant. Provide protective covering during transport. Do not drop stock.

2. Label each tree and at least one shrub of each variety with securely attached waterproof tags bearing legible designation of botanical name.

3. Deliver trees and shrubs after preparations for planting have been completed. If planting is delayed more than 4 hours after delivery, set trees and shrubs in shade, protect from weather and damage, and keep roots moist by covering with mulch or other material acceptable for retaining moisture. Do not remove container-grown stock from containers until time of planting.

1.6 JOB CONDITIONS:

A. Utilities: Locate and avoid damage to all underground utilities. Utilities not necessarily shown on Drawings. Hand excavate adjacent to utility lines. If conflicts between utilities and plantings are encountered, notify Architect for direction before planting.

B. Excavation: When conditions detrimental to plant growth are encountered, such as rubble, adverse drainage conditions, or obstructions, notify Architect for direction before planting.

C. A complete list of plants, including schedule of sizes, quantities, and other requirements is shown on the Drawings. In the event that quantity discrepancies or material omissions occur in the plant materials list, the Planting Plans shall govern. Payment shall be based on actual Planting Plan count.

1.7 PLANT GUARANTEE AND REPLACEMENT: Warrant all plant material, for a period of one year after date of Final Completion, against death and /or unsatisfactory growth.

A. During the warranty period, plants found to be dead shall be immediately removed from site.

B. Plants found to be dead, or in an unhealthy condition doubtful for survival, at the end of the warranty period, shall be removed from the site.

C. Make replacements during the first normal planting season following end of guarantee period. After all replacements have been made, Architect will re-inspect planting for acceptance.

PART 2 - PRODUCTS

2.1 TOPSOIL

A. No topsoil is available from this site. Contractor shall determine the quantity of topsoil needed for this work, and shall provide new topsoil from off-site, local sources, which are naturally well-drained sites where topsoil occurs to a depth of not less than 6". Do not obtain topsoils from bogs or marshes.

B. Topsoil from off-site sources: Natural, fertile, friable, granular, surface soil, characteristic of productive soils in vicinity, uniform in composition and texture, clean and free from subsoil, clay lumps, brush, weeds, stumps, roots, toxic substances, stones and other debris 1 ½" or more in greatest dimension.

2.2 LIGHTWEIGHT INDOOR PLANTER MIX:

A. Provide a Planter mix using the four components listed below that will meet the ASTM standards as follows:

Perma Till 5/16” Expanded Slate	55%*
Coarse Sand	30%
Pine Bark Humus	05%
Compost	10%

*Increase or decrease volume to meet weight requirement

2.3 SOIL AMENDMENTS:

A. Lime: Natural dolomitic limestone containing not less than 85% of total carbonates with a minimum of 30% magnesium carbonates, ground so that not less than 90% passes a 10-mesh sieve and not less than 50% passes a 100-mesh sieve; to be used to pH balance soil, as required.

B. Aluminum Sulfate: Commercial grade, in dry powder form, to be used to pH balance soil as required, and/or to acidify soil for “acid loving” plants.

C. Peat Humus: FS Q-P-166 decomposed peat with no identifiable fibers and with pH range suitable for intended use, free of weeds and seeds.

D. Bonemeal: Commercial, raw, finely ground; 4% nitrogen and 20% phosphoric acid.

E. Superphosphate: Soluble mixture of treated minerals, 20% available phosphoric acid.

F. Sand: Clean, washed sand, free of toxic materials.

G. Vermiculite: Horticultural grade, free of toxic substances.

2.4 PLANTER AND ROOT ZONE COMPONENTS:

A. Root Zone Sand

1. Grain Size Distribution (ASTM C136-95A)

Sieve Size	% Passing
3/8”	100
#4	95-100
#8	85-97
#16	60-80
#30	10-20
#50	5-15
#100	0-5

B. 3/8” - #8 **Perma Till** Rotary Kiln Expanded Slate (5/16”)

1. Only **non-hazardous** fuels such as coal or natural gas may be used to process the slate.
2. ASTM C29 Unit Dry Weight loose (48 lb./cf to 55 lb./cf)

3. ASTM C127 Specific Gravity: 1.45 to 1.60, SSD

4. ASTM C330: ASTM Gradation 3/8” - #8 size

3/8” - #8 (5/16”)

Sieve Size	% Passing
½”	100
3/8”	80-100
#4	5-40
#8	0-20
#16	0-10

5. Absorption (ASTM C127) No more than 12%.

6. The expanded slate must contain **no** clay lumps or any organic impurities.

C. Compost

1. Compost must be derived from poultry or cow manure as the nitrogen source and pine bark as the carbon source. Addition of yard waste to the composting process is not acceptable.

2. The compost must have a minimum thermophillic bioreduction time of four (4) months with aeration management based on temperature monitoring. The compost must be under cover during a minimum curing time of four (4) weeks.

3. Thermophillic temperatures must be sustained at or above 150 degrees Fahrenheit for eight (8) weeks for weed seed and pathogen sterilization.

4. Finished compost must be screened to minus ½”, protected from and free from any outside contaminants during and after screening and curing.

5. The finished compost must fall below the following limits:

Ammonium (NH4-N)	0 PPM
Magnesium (Mg)	70 PPM
Iron (Fe)	3.8 PPM
Manganese (Mn)	1.0 PPM
Copper (Cn)	.10 PPM
Zinc (Zn)	.15 PPM
Soluble salts	5.50 mmho/cm

PH must fall between 6.0 and 7.0

D. Pine Bark Humus

1. Must be aged and fully decomposed pine bark humus screened to minus ½”.

2. The screened bark humus must fall below the following limits:

Ammonium (NH4-N)	20 PPM
Magnesium (Mg)	5.0 PPM
Iron (Fe)	8.0 PPM
Manganese (Mn)	1.0 PPM
Copper (Cn)	.10 PPM
Zinc (Zn)	.15 PPM
Soluble salts	0.50 mmho/cm
PH must fall between	4.0 and 7.0

E. Foam Filler for planter beds: Expanded polystyrene bead board in chunks approximately1” square.

2.5 COMMERCIAL FERTILIZER Complete fertilizer, partially organic, neutral, uniform in composition, dry and free flowing. Fertilizer shall contain not less than 10% total nitrogen (of which 50 percent shall be organic), 10% available phosphoric acid, and 10% soluble potash, unless otherwise recommended by soil test.

2.6 PLANTING MULCH: For planting beds and individual plantings: Organic mulch free from deleterious materials and suitable for top dressing of trees, shrubs, ground covers and other plants. Provide aged, shredded cypress or cedar. Use same mulch type throughout entire project.

2.7 PLANT MATERIALS:

A. Quality: Provide trees, shrubs, ground cover plants, and other plants of quantity, genus, species and variety shown or scheduled for landscape work, and complying with recommendations and requirements of ANSI Z60.1. Provide healthy, vigorous stock, grown in recognized nurseries under climatic conditions similar to those in locality of project, in accordance with good horticultural practice. Plants shall be free of disease, insects, eggs, larvae and defects such as knots, sun-scald, injuries, abrasions, or disfigurements.

B. Size: Stock furnished shall be at least the minimum size indicated. Larger stock is acceptable at no additional cost, and providing that the larger plants are not cut back to size indicated, and providing root balls meet standards specified for the larger material provided.

C. Uniformity: Where formal arrangements of trees are shown, select stock for uniform height, spread, and growth habit to assure symmetry in planting.

D. 'Specimen' Plants: Provide where noted, with a special height, shape or character of growth.

E. Substitutions: If specified landscape material is not obtainable, submit proof of non-availability, together with proposal for use of material with similar characteristics. Architect reserves the right to make the final determination as to what plants do and do not meet the "similar characteristics" requirement.

F. Tree and Shrub Root Condition: Provide plants balled and burlapped (B & B), or at Contractor's option, provide container grown stock subject to specified limitations of ANSI Z60.1 for container grown stock, and upon the condition that plants have been cultivated in containers for a minimum of one year. Bare root plants are not acceptable.

G. Deciduous Trees: Form and branching configuration shall be as recommended by ANSI Z60.1 for species and/or variety specified. Provide single stem trees, except where special forms are shown or listed.

Deciduous Shrubs: Provide shrubs with not less than minimum number of canes required by ANSI Z60.1 for type and height of shrub listed.

H. Coniferous and Broadleafed Evergreens: Provide evergreens with well-balanced form complying with requirements of ANSI Z60.1 for type and height of plant listed. Dimensions indicate minimum spread for spreading and semi-spreading type evergreens, and height for other types.

I. Ground Cover: Provide plants established and well-rooted in removable containers or peat pots (PP), and with not less than minimum number and length of runners required by ANSI Z60.1 for pot size listed.

J. Ornamental Grasses: Provide plants established and well rooted in removable containers.

2.8 MISCELLANEOUS LANDSCAPE MATERIALS

A. Anti-Desiccant: Emulsion type, film-forming agent, designed to permit transpiration but retard excessive loss of moisture from plants. Mix and apply in accordance with manufacturer's instructions.

B. Stakes and Guys: Provide nominal 2" x 2" stakes of sound new hardwood, pressure treated softwood, or cypress, free of knot holes and other defects. At Contractor's alternative option, provide galvanized 16-gauge steel posts, painted dark brown or black. Provide wire ties and guys of 2-strand, twisted, pliable, galvanized iron wire not lighter than 12 ga., with zinc-coated turnbuckles. Provide not less than ½" diameter rubber or plastic hose, cut to required lengths and of uniform black color to protect tree trunks from damage by wires.

PART 3 – EXECUTION

3.1 PREPARATION:

A. Proceed with and complete landscape work as rapidly as portions of site become available. Install materials during normal planting seasons. Planting operations shall not occur when soil is frozen, or saturated, or when temperature extremes or wind conditions make survival of plant material unlikely. Provide continuous maintenance from date of initial planting through end of Contractor's maintenance period(s).

B. Stake locations of trees and individual shrubs, and outline multiple shrub areas, ground cover beds, and flower beds. Secure acceptance of Owner before starting installation. Make adjustments as required.

C. Preparation of Planting Soil.

1. Before mixing, clean topsoil of roots, plants, sod, stones, clay lumps, and any extraneous materials harmful or toxic to plant growth.

2. Amend topsoil as required by topsoil analysis, for the specific plants to be planted.

3. Mix amended topsoil with peat humus at rate of five parts topsoil and one part humus, as measured by volume, for all plantings except ground cover and flowerbeds. Ratio for ground cover and flowerbed planting soil shall be three parts topsoil to one part humus, measured by volume.

4. Fertilizer: Mix in fertilizer at rate of one-half pound per cubic yard of planting soil, unless otherwise recommended by the topsoil analysis. Delay mixing of fertilizer, if planting will not follow mixing of planting soil within three days.

5. Soil Acidifier: In addition to requirements of the topsoils analysis, mix aluminum sulfate in planting soil to be used for all plants who's optimum pH growth is less than 6.8. Delay mixing of aluminum sulfate, if planting will not follow mixing of plant soil within three days.
6. Mix planting soil prior to backfilling, and stockpile at site.

D. Mixing and Placing Roof Top Planter Mix:

1. Mechanically mix the materials to provide a uniform distribution of the components. Mixing shall occur off-site.

2. Inadequate Moisture Content: Do not work planting medium when moisture content is low that dust will form in the air. Apply water, if necessary, to bring planting medium to an optimum moisture content for compacting and planting.

3. Do not work planting medium when the moisture content is high enough that excessive compaction will occur. Aerate planting medium until moisture content is uniformly reduced as necessary to achieve optimum compaction.

4. Final Mixing with Stalite Perma Till Expanded Slate

   a. Saturate the Perma Till Expanded Slate with water and mechanically mix with the soil blend until the slate particles are completely coated.
   b. To avoid soil separation, do not transport the roof top planter mix by truck

more than 100 miles from the construction job site.

c. When stockpiling the finished mix, cover the pile with a plastic tarp to prevent drying out or soil separation from rain.

5. Place planter mix over drainage ballast as detailed.

E. Preparation of Ground Cover, Ornamental Grasses, and Flower Beds:

1. Dig beds to not less than depth noted and/or detailed. Dispose of excavated material off-site.

2. Scarify subgrade of bed areas to minimum depth of 4" using a cultimulcher or similar equipment. Remove sticks, roots, rubbish, other extraneous matter, and stones over 1-1/2" in any dimension.

3. Spread planting soil mixture to depth noted and/or detailed; lightly tamp or roll; match adjacent grades.

F. Excavation for Plant Pits and Trenches:

1. Excavate with vertical sides and with bottom slightly raised at center to provide proper drainage. Scarify subsoil in bottom of excavation to a minimum depth of 4".

2. For both balled and burlapped (B & B) and container grown stock, make excavations at least half again as wide as ball or container diameter. Depth to be equal to ball or container depth, plus allowance for compacted planting soil under ball or container, and allowing for settlement.

3. Dispose of excavated material off-site. Do not mix with planting soil or use as back fill.

4. Fill excavations with water and allow to percolate out before beginning planting.

3.2 INSTALLATION

A. Planting Trees and Shrubs:

1. Set plants upright, plumb and faced to give the best appearance or relationship to each other and adjacent structure.

2. Set balled and burlapped (B & B) stock on layer of compacted planting soil mixture as detailed, in center of pit or trench with top of ball at same elevation to slightly above adjacent finished grades. Remove burlap and ropes from collar of balls; retain on sides and bottoms. Remove all wire from around ball. If ball is wrapped in material other than burlap, completely remove material from around and under ball. When set, place planting soil backfill (roof top planter mix for above grade plantings) around base and sides of ball, and work each layer to settle backfill and eliminate voids and air pockets. When excavation is approximately 2/3-full, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing final layer of backfill.

3. Set container grown stock as specified for balled and burlapped stock, except cut

containers on two sides; remove container and set plant so as not to damage root balls. Where plant shows signs of being rootbound, cleanly cut roots.

4. Dish top of backfill to allow for mulching. Provide saucer mound around plant pit to retain water.

5. Prune, thin out and shape plants in accordance with standard horticultural practice. Prune, but retain required height and spread. Unless otherwise directed by Owner, do not cut tree leaders; remove injured and dead branches. Prune shrubs to retain natural character. Remove and replace excessively or improperly pruned stock.

6. Apply anti-desiccant using power spray to provide an adequate film over trunks, branches, stems, twigs and foliage. If deciduous trees or shrubs are moved in full-leaf, spray with anti-desiccant at nursery before moving and again two weeks after planting.

7. Guy and stake trees immediately after planting. Trees up to 2” caliper shall have two (2) stakes. Trees over 2” caliper shall have three (3) stakes. Multi-stem trees, and coniferous evergreen trees, with heights up to 6’ shall have two (2) stakes; multi-stem trees and coniferous evergreen trees over 6’ in height shall have three (3) stakes.

8. Mulch immediately after planting. Provide minimum, uniform 4" thickness for individual pits and planting beds. Areas of mass plantings shall be mulched entirely within limits of bed.

9. Plant labels to remain on plants until end of warranty period, at which time they shall be removed.

B. Planting Ground Covers, Ornamental Grasses, and Flowers:

1. Space plants as scheduled, or detailed.

2. Remove plants from containers. Dig holes large enough to allow for spreading roots. Backfill with planting soil (roof top planter mix for above grade plantings). Work soil around roots to eliminate air pockets. Water thoroughly after planting, taking care not to cover crowns with wet soil.

3. Immediately mulch entire ground cover beds and ornamental grass. Minimum thickness of mulch to be 3".

C. Flower Beds: Flower plants only are by others. Contractor shall mulch flower beds with 3" thickness of mulch immediately.

3.3 CLEANUP AND PROTECTION:

A. During landscape work, keep pavements clean and work area in an orderly condition. Periodically (maximum weekly) remove from site all excess materials, soil, debris, and equipment.

B. Damage caused to trees, lawns, buildings, street, curbs, walks and other items shall be corrected by whatever means necessary to satisfy the requirements of the Architect, and/or the state, city or county, whichever may have jurisdiction, at no additional cost.

C. Protect landscape work and materials from damage due to operations by other contractors, trades, and trespassers. Maintain protection during installation and Contractor's maintenance period(s). Treat, repair or replace damaged landscape work as directed by the Architect.

3.4 CONTRACTORS' MAINTENANCE

A. Begin maintenance immediately after planting.

B. Maintain trees, shrubs and other plant material continuously, for up to not less than 60 days after Substantial Completion.

C. Maintain trees, shrubs and other plants by pruning, cultivating, refertilizing, weeding, watering, and treatment for insect (and other pest) infestation, as required for healthy growth. Tighten and repair stake and guy supports, and reset trees and shrubs to proper grades and vertical positions. Restore planting saucers and mulch. Reset trees and shrubs to proper grades and vertical position. Spray as required to keep plants free of insects and disease.

3.5 INSPECTIONS

A. The Architect will make the following inspections of completed work upon written request by Contractor:

1. Substantial Completion Inspection(s): When all planting and related work is completed. Warranty period shall begin upon acceptance of work by Landscape Architect.

2. Final Completion Inspection(s): When minimum maintenance period has been completed. Acceptance of work by Owner ends Contractor's maintenance period.

3. Warranty Inspection: At end of warranty period(s).

B. Landscape work may be inspected for acceptance in sections (up to a maximum of two) agreeable to Owner, provided all required work in that section is complete.

C. Where inspected work is not acceptable, replace or remedy rejected work. Remove rejected plants and materials promptly from site. Continue all requirements of contract until re-inspected and accepted by the Architect. The cost of remedial work, continued maintenance, and additional inspections, required by unacceptable work, shall be borne entirely by Contractor.

END OF SECTION – 329300

SECTION 334100 - STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Manholes.
3. Stormwater structures.
4. Pipe outlets.

1.3 SUBMITTALS

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

B. Shop Drawings:

1. Manholes: Include plans, elevations, sections, details, frames, and covers.
2. Stormwater Structures: Include plans, elevations, sections, details, frames, and grates.

C. Field quality-control reports.

D. Record Drawings: The Contractor shall furnish to the Architect/Engineer Record Drawings of the storm drainage system. This information shall be presented electronically using the electronic file of the Grading and Utilities Plan Sheets. <u>Marked-up Construction Document drawings are not acceptable.</u> Record Drawings shall include, but not limited to, the following:

1. Surveyed locations and invert elevations, rims, throats and/or grate elevations of structures.. Also included shall be as-built topography of any detention ponds and outlet structures.

E. Underground Detention system components.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Protect pipe, pipe fittings, and seals from dirt and damage.

B. Handle stormwater structures according to manufacturer's written rigging instructions.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of service.

PART 2 - PRODUCTS

2.1 MATERIALS:

A. Material as specified at Contractor option unless indicated otherwise.

B. Corrugated High Density Polyethylene Pipe (HDPE)
1. Pipe sizes 4” – 10” HDPE: **ADS N-12 ST IB** pipe (per ASTM F2648) shall have a smooth interior and corrugations.

Pipe shall be joined using a bell & spigot joint meeting ASTM F2648. The joint shall be soil-tight and gaskets, when applicable, shall meet the requirements of ASTM F477. Gaskets shall be installed by the pipe manufacturer and covered with a removable wrap to ensure the gasket is free from debris. A joint lubricant supplied by the manufacturer shall be used on the gasket and bell during assembly.

Fittings shall conform to ASTM F 2306. Bell and spigot connections shall utilize a spun-on or welded bell and valley or saddle gasket meeting the soil-tight joint performance requirements of ASTM F 2306.

Material for pipe production shall be an engineered compound of virgin and recycled high density polyethylene conforming with the minimum requirements of cell classification 424420C (ESCR Test Condition B) for 4- through 10-inch (100 to 250 mm) diameters, , as defined and described in the latest version of ASTM D3350, except that carbon black content should not exceed 4%.

Installation shall be in accordance with ASTM D2321 and ADS recommended installation guidelines, with the exception that minimum cover in trafficked areas for 4- through 48-inch (100 to 1200 mm) diameters shall be one foot. (0.3 m) and for 60-inch (1500 mm) diameters, the minimum cover shall be 2 ft. (0.6 m) in single run applications. Backfill for minimum cover situations shall consist of Class 1 (compacted), or Class 2 (minimum 90% SPD) material. Maximum fill heights depend on embedment material and compaction level and should be in accordance with manufacturer’s recommendations.

2. **ADS HP STORM**: Pipe sizes 12”-30” HDPE: 12- through 30-inch (300 to 750 mm) pipe shall have a smooth interior and annular exterior corrugations and meet or exceed ASTM F2736 and AASHTO MP-21-11. Pipe shall be joined with a gasketed integral bell & spigot joint meeting the requirements of ASTM F2736 and F2881, for the respective diameters. 12- through 60-inch (300 to 1500 mm) shall be watertight according to the requirements of ASTM D3212. Spigots shall have gaskets meeting the requirements of ASTM F477. Gasket shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. A joint lubricant available from the manufacturer shall be used on the gasket and bell

during assembly. 12- through 60-inch (300 to 1500 mm) diameters shall have a reinforced bell with a polymer composite band installed by the manufacturer.

Fittings shall conform to ASTM F2736, ASTM F2881 and AASHTO MP-21-11, for the respective diameters. Bell & spigot connections shall utilize a spun-on, welded or integral bell and spigot with gaskets meeting ASTM F477. Bell & spigot fittings joint shall meet the watertight joint performance requirements of ASTM D3212. Corrugated couplings shall be split collar, engaging at least 2 full corrugations.

To assure watertightness, field performance verification may be accomplished by testing in accordance with ASTM F2487. Appropriate safety precautions must be used when field-testing any pipe material. Contact the manufacturer for recommended leakage rates.

Polypropylene compound for pipe and fitting production shall be impact modified copolymer meeting the material requirements of ASTM F2736, Section 4, ASTM F2881, Section 5 and AASHTO MP-21-11, Section 6.1, for the respective diameters.

Installation shall be in accordance with ASTM D2321 and ADS recommended installation guidelines, with the exception that minimum cover in traffic areas for 12- through 48-inch (300 to 1200 mm) diameters shall be one foot. (0.3 m) and for 60-inch (1500 mm) diameters, the minimum cover shall be 2 ft. (0.6 m) in single run applications. Backfill for minimum cover situations shall consist of Class 1, Class 2 (minimum 90% SPD) or Class 3 (minimum 95%) material. Maximum fill heights depend on embedment material and compaction level; please refer to manufacturer's recommendations

2.2 CONCRETE PIPE AND FITTINGS

A. Reinforced-Concrete Sewer Pipe and Fittings Pipe sizes 12"-48": ASTM C 76 (ASTM C 76M).

1. Bell-and-spigot with O-ring gasketed joints.

2. Class III, Wall B or Class IV if cover is less than 18" per SCDOT fill height tables.

2.3 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 inches (1200 mm) minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
4. Base Section: 6-inch (150-mm) minimum thickness for floor slab and 4-inch (102-mm) minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
5. Riser Sections: 4-inch (102-mm) minimum thickness, and lengths to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
7. Joint Sealant: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.

9. Steps: ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm).
10. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch- (102-mm-) minimum width flange and 26-inch- (660-mm-) diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
2. Material: ASTM A 48/A 48M, Class 35 gray iron unless otherwise indicated.

C. Built in Place concrete Brick Manholes: Built in place structures in accordance with SCDOT Standard Specification 719 and in accordance with SCDOT Standard Details.

2.4 STORMWATER STRUCTURES

A. Standard Precast Concrete Stormwater Structures:

1. Description: ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Base Section: 6-inch (150-mm) minimum thickness for floor slab and 4-inch (102-mm) minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
3. Riser Sections: 4-inch (102-mm) minimum thickness, 48-inch (1200-mm) diameter, and lengths to provide depth indicated.
4. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
5. Joint Sealant: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.
6. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
7. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch (150- to 225-mm) total thickness, that match 24-inch- (610-mm-) diameter frame and grate.
8. Steps: ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of catch basin to finished grade is less than 60 inches (1500 mm).

B. Frames and Grates: See Plans

C. Nyloplast Drain Basins: Can be used in pedestrian-traffic areas

1. GENERAL: PVC surface drainage inlets shall include the drain basin type as indicated on the contract drawing and referenced within the contract specifications. The ductile iron grates for each of these fittings are to be considered an integral part of the surface drainage inlet and shall be furnished by the same manufacturer. The surface drainage inlets shall be as manufactured by Nyloplast a division of Advanced Drainage Systems, Inc., or prior approved equal.

2. MATERIALS: The drain basins required for this contract shall be manufactured from PVC pipe stock, utilizing a thermo-molding process to reform the pipe stock to the specified configuration. The drainage pipe connection stubs shall be manufactured from PVC pipe stock and formed to provide a watertight connection with the specified pipe system. This joint tightness shall conform to ASTM D3212 for joints for drain and sewer plastic pipe using flexible elastomeric seals. The flexible elastomeric seals shall conform to ASTM F477. The pipe bell spigot shall be joined to the main body of the drain basin or catch basin. The raw material used to manufacture the pipe stock that is used to manufacture the main body and pipe stubs of the surface drainage inlets shall conform to ASTM D1784 cell class 12454. The grates and frames furnished for all surface drainage inlets shall be ductile iron for sizes 8”, 10”, 12”, 15”, 18”, 24” and 30” and shall be made specifically for each basin so as to provide a round bottom flange that closely matches the diameter of the surface drainage inlet. Grates for drain basins shall be capable of supporting H-20 wheel loading for traffic areas or H-10 loading for pedestrian areas. 12” and 15” square grates will be hinged to the frame using pins. Metal used
in the manufacture of the castings shall conform to ASTM A536 grade 70-50-05 for ductile iron. Grates shall be provided painted black.

3. INSTALLATION: The specified PVC surface drainage inlet shall be installed using conventional flexible pipe backfill materials and procedures. The backfill material shall be crushed stone or other granular material meeting the requirements of class 2 material as defined in ASTM D2321. Bedding and backfill for surface drainage inlets shall be placed and compacted uniformly in accordance with ASTM D2321. The drain basin body will be cut at the time of the final grade. No brick, stone or concrete block will be required to set the grate to the final grade height. For H-20 load rated installations, a concrete ring will be poured under and around the grate and frame. The concrete slab must be designed taking into consideration local soil conditions, traffic loading, and other applicable design factors. For other installation considerations such as migration of fines, ground water, and soft foundations refer to ASTM D2321 guidelines.

2.5 STORMTECH UNDERGROUND DETENTION SYSTEM

A. All installation of the underground Stormtech system components to be in accordance with manufacturer’s instructions and guidelines.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling of Storm Drainage Piping to be in accordance with SCDOT Standard Specification SC-M-714, for the respective type of pipe used with the following exceptions:

1. Backfill compaction testing will be in accordance with Geotechnical Report recommendations.
2. In situ material can be used for backfill if deemed acceptable suitable material by geotechnical testing firm.
2. Video Inspection will be required on the storm installation for all pipe sizes 12” and larger.

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install gravity-flow, nonpressure drainage piping according to SCDOT Specifications.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping according to SCDOT Supplemental Technical Specification SC-M-714, latest edition.

3.4 MANHOLE INSTALLATION

A. General: Install manholes and Catch Basins in accordance with SCDOT Standard Specification Section 719, latest edition.

3.5 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.6 FIELD QUALITY CONTROL

A. Visually inspect 100% of pipe for fractures, cracks, spalling, chips, and breaks during all phases of the installation process. Inspect joints, including tongues and grooves. Inspect installed joints for missing, damaged, or improperly installed joint sealant or gasket. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Defects requiring correction include the following:

   a. Alignment: Less than full diameter of inside of pipe is visible between structures.
   b. Deflection: Flexible piping with deflection that prevents passage of 9-Fin Mandrel.
   c. Crushed, broken, cracked, or otherwise damaged piping.
   d. Infiltration: Water leakage into piping.
   e. Exfiltration: Water leakage from or around piping.

2. Replace defective piping using new materials, and repeat inspections until defects are corrected.

B. Video Inspect Storm drainage after backfill in accordance with SCDOT SC-M-714 and Provide digital copy of video inspection to Engineer.

C. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

1. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (610 mm) of backfill is in place, and again at completion of Project.

3.7 CLEANING

1. Clean interior of piping of dirt and superfluous materials. Flush with water.

END OF SECTION 334100

June 12, 2019

Eddie Richardson
Coastal Carolina University
Facilities Maintenance
P.O. Box 261954
Conway, SC 29528-6054

Re: PEC Job # 21-19-121-AB-I; Coastal Carolina University, Kimbel Library, 376 University Boulevard, Conway, SC – Asbestos Bulk Sampling Report

On May 28, 2019, Phoenix EnviroCorp (PEC) representative Tommie Green (South Carolina Consultant/Project Designer #PD-00123, South Carolina Consultant/Management Planner #MP-00184) performed an asbestos survey on materials specified by the client that may be disturbed during a planned renovation.

The collected samples were placed into individual sample containers, sealed, and assigned a unique identification number at the time of collection. The sample information was logged onto a chain of custody/laboratory request form and submitted to a third party laboratory for analysis.

The completion of this survey included the collection of forty-seven (47) bulk samples. The analysis of these samples was performed by Polarized Light Microscopy (PLM) utilizing dispersion staining techniques. In addition, per South Carolina asbestos regulations, all non-friable organically bound (NOB) materials found to contain less than one percent (<1%) asbestos per PLM analysis are required to be re-analyzed utilizing Transmission Electron Microscopy (TEM) analysis. Any multi-layered samples/ heterogeneous samples analyzed were first separated into sub-samples and analyzed separately per EPA protocol. Positive stop instructions were issued for all homogeneous samples materials that previously tested positive for asbestos content. Upon completion of analysis, a total of ninety (90) samples were analyzed via PLM and ten (10) NOB materials were analyzed via TEM. The results are enclosed in this report.

Asbestos Results

Of the homogeneous materials sampled, the following were found to contain greater than one percent (>1%) asbestos following the required analysis and are considered to be asbestos-containing:

- Mastic on HVAC equipment – located in the 1st and 2nd floor mechanical rooms, etc. **- 2% Chrysotile asbestos**

Of the homogeneous materials sampled, the following were found to contain less than one percent (<1%) asbestos following the required analysis and are considered to be non-asbestos-containing:

- Pipe insulation covering on large (approximately 18”) soft/fiberglass insulated pipes - located in the 1st and 2nd floor mechanical rooms - **None detected**
- Pipe insulation on large (approximately 18”) hard pipes - located in the 2nd floor mechanical rooms (black inner insulation) - **None detected**
- Pipe insulation covering on small (approximately 6”) soft pipes - located in the 1st and 2nd floor mechanical rooms, and the 1st floor water heater room - **None detected**
- Flange covering on large (approximately 18”) soft pipes – located in the 1st and 2nd floor mechanical rooms **- None detected**
- Pipe insulation on hard small (approximately 6”) pipes - located in the 2nd floor mechanical room (white inner insulation) - **None detected**
- Flange insulation on hard large (approximately 18”) pipes – located in the 1st and 2nd floor mechanical rooms **- None detected**
- Elbow insulation on hard large (approximately 18”) pipes – located in the 1st and 2nd floor mechanical rooms – **None detected**
- Batt insulation paper backing – located in the 1st and 2nd floor mechanical rooms – **None detected**
- Duct tape on HVAC equipment – located in the 2nd floor mechanical room, etc. – **None detected**
- Expansion joint on HVAC equipment – located in the 1st and 2nd floor mechanical rooms, etc. – **None detected**
- Drywall/joint compound (two layers) – located in the 1st and 2nd floor mechanical rooms, etc. – **None detected**
- Green ceiling board system – located in the 2nd floor mechanical room, etc. – **None detected**
- Ceiling tiles – located throughout – **None detected**

Conclusions: Tan mastic (approximately 120 SF) on HVAC equipment located in the 1st and 2nd floor mechanical rooms, etc. tested positive for asbestos. See the enclosed photo number 10 to view the positive material

Enclosed in this report are the inspector accreditation, lab accreditation, asbestos analysis forms, Chain of Custody, and photographic documentation.

Should you have any questions, please do not hesitate to call.

Thank you,

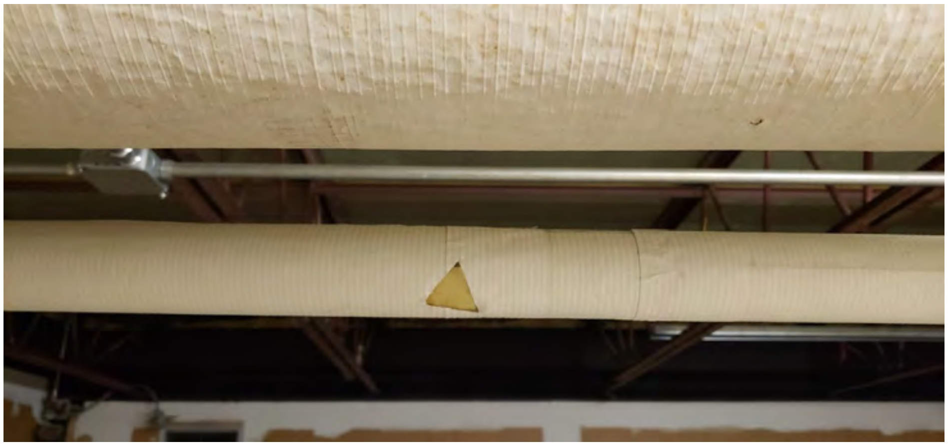
Tommie Green
Asbestos Inspector
SC Consultant Project Designer PD-00123
SC Consultant/Management Planner MP-00184

1


Pipe insulation covereing on large (approximately 18") soft/fiberglass insulated pipes located in the 1st and 2nd floor mechanical rooms

2


Pipe insulation on large (approximately 18") hard pipes - located in the 1st and 2nd floor mechanical rooms (black inner insulation)

3


Pipe insulation covering on small (approximately 6") soft pipes - located in the 1st and 2nd floor mechanical rooms and 1st floor water heater room in the office area

4

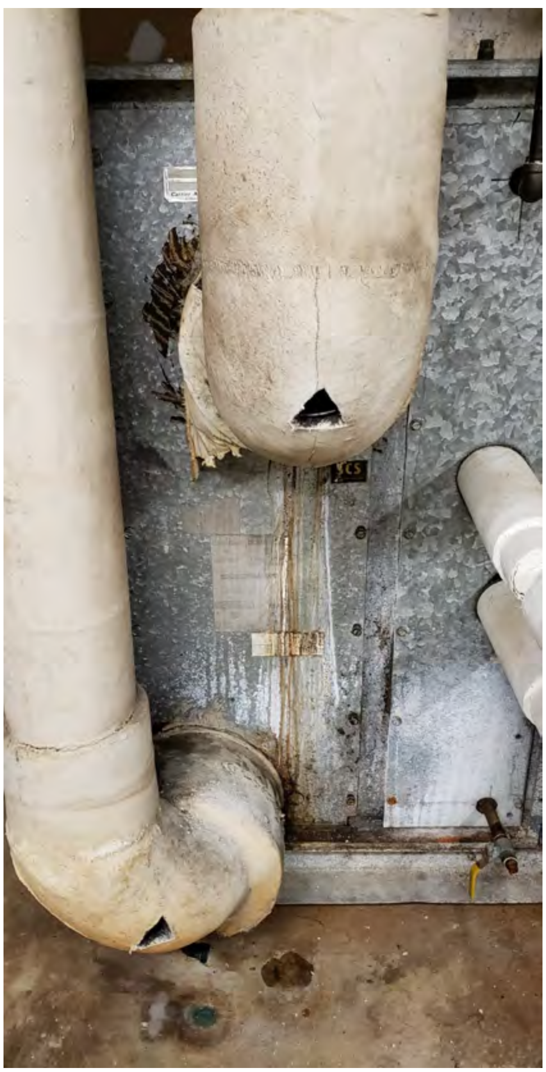

Flange covering on large (approximately 18") soft pipes - located in the 1st and 2nd floor mechanical rooms

5


Pipe insulation on hard small (approximately 6") pipes - located in the 2nd floor mechanical room (white inner insulation)

6


Flange insulation on hard large (approximately 18") pipes - located in the 1st and 2nd floor mechanical rooms

7


Elbow insulation on hard large (approximately 18") pipes - located in the 1st and 2nd floor mechanical rooms

8

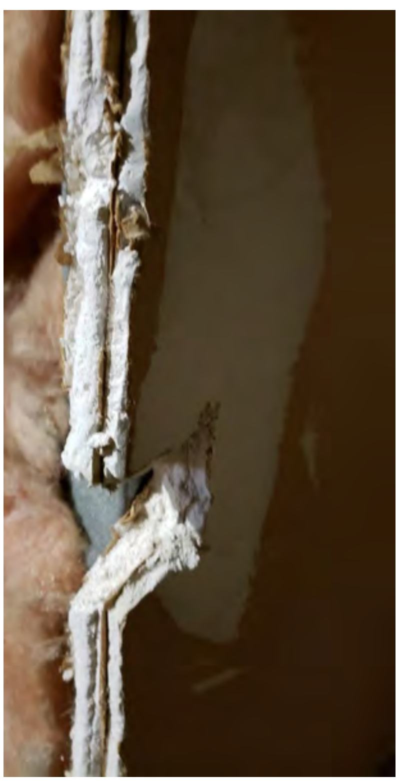
Batt insulation paper backing - located in the 1st and 2nd floor mechanical rooms, etc.

9

Duct tape on HVAC equipment - located in the 2nd floor mechanical rooms, etc.

10


Expansion joint and mastic on HVAC equipment - located
in the1st and 2nd floor mechanical rooms, etc. **Tan mastic tested positive for asbestos**

11


Dyrwall/joint compound (two layers in some areas) - located
in the 1st and 2nd floor mechanical rooms, etc.

12 

Green ceiling board system - located in the 2nd floor mechanical room, etc.

13 

Ceiling tiles - located throughout

SanAir Technologies Laboratory

The Identification Specialists

Analysis Report prepared for Phoenix EnviroCorp

Report Date: 6/10/2019

Project Name: CCU-Kimbel Library, 376 University Blvd., Conway,

Project #: 21-19-121-AB-I

SanAir ID#: 19026925

NVLAP TESTING

NVLAP LAB CODE 200870-0

1551 Oakbridge Dr. Suite B | Powhatan, Virginia 23139-8061
888.895.1177 | 804.897.1177 | fax: 804.897.0070 | IAQ@SanAir.com | SanAir.com

	SanAir ID Number 19026925 FINAL REPORT 6/10/2019 1:21:18 PM

Name: Phoenix EnviroCorp
Address: 4020 Shipyard Blvd
Wilmington, NC 28403
Phone:

Project Number: 21-19-121-AB-I
P.O. Number:
Project Name: CCU-Kimbel Library, 376 University Blvd., Conway,
Collected Date: 5/30/2019
Received Date: 6/6/2019 9:35:00 AM

Dear Tommie Green,

We at SanAir would like to thank you for the work you recently submitted. The 47 sample(s) were received on Thursday, June 06, 2019 via FedEx. The final report(s) is enclosed for the following sample(s): 053019-TG-01, 053019-TG-02, 053019-TG-03, 053019-TG-04, 053019-TG-05, 053019-TG-06, 053019-TG-07, 053019-TG-08, 053019-TG-09, 053019-TG-10, 053019-TG-11, 053019-TG-12, 053019-TG-13, 053019-TG-14, 053019-TG-15, 053019-TG-16, 053019-TG-17, 053019-TG-18, 053019-TG-19, 053019-TG-20, 053019-TG-21, 053019-TG-22, 053019-TG-23, 053019-TG-24, 053019-TG-25, 053019-TG-26, 053019-TG-27, 053019-TG-28, 053019-TG-29, 053019-TG-30, 053019-TG-31, 053019-TG-32, 053019-TG-33, 053019-TG-34, 053019-TG-35, 053019-TG-36, 053019-TG-37, 053019-TG-38, 053019-TG-39, 053019-TG-40, 053019-TG-41, 053019-TG-42, 053019-TG-43, 053019-TG-44, 053019-TG-45, 053019-TG-46, 053019-TG-47.

These results only pertain to this job and should not be used in the interpretation of any other job. This report is only complete in its entirety. Refer to the listing below of the pages included in a complete final report.

Sincerely,

Sandra Sobrino

Sandra Sobrino
Asbestos & Materials Laboratory Manager
SanAir Technologies Laboratory

Final Report Includes:
- Cover Letter
- Analysis Pages
- Disclaimers and Additional Information

Sample conditions:
- 47 samples in Good condition.

SanAir Technologies Laboratory

SanAir ID Number
19026925
FINAL REPORT
6/10/2019 1:21:18 PM

Name: Phoenix EnviroCorp
Address: 4020 Shipyard Blvd
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Phone:

Project Number: 21-19-121-AB-I
P.O. Number:
Project Name: CCU-Kimbel Library, 376 University Blvd., Conway,
Collected Date: 5/30/2019
Received Date: 6/6/2019 9:35:00 AM

Analyst: Fleming, Christopher

Asbestos Bulk PLM EPA 600/R-93/116

SanAir ID / Description	Stereoscopic Appearance	Components % Fibrous	% Non-fibrous	Asbestos Fibers
053019-TG-01 / 19026925-001 Pipe Insulation Covering On Large (Approx 18") Soft	Yellow Fibrous Homogeneous	90% Glass	10% Other	None Detected
053019-TG-02 / 19026925-002 Pipe Insulation Covering On Large (Approx 18") Soft	Various Fibrous Heterogeneous	70% Cellulose	30% Other	None Detected
053019-TG-03 / 19026925-003 Pipe Insulation Covering On Large (Approx 18") Soft	Various Fibrous Heterogeneous	70% Cellulose	30% Other	None Detected
053019-TG-04 / 19026925-004 Pipe Insulation On Large (Approx 18") Pipes-Located In The, Insulation	Black Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-04 / 19026925-004 Pipe Insulation On Large (Approx 18") Pipes-Located In The, Cover	White Fibrous Homogeneous	90% Cellulose	10% Other	None Detected
053019-TG-05 / 19026925-005 Pipe Insulation On Large (Approx 18") Pipes-Located In The, Insulation	Black Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-05 / 19026925-005 Pipe Insulation On Large (Approx 18") Pipes-Located In The, Cover	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-06 / 19026925-006 Pipe Insulation On Large (Approx 18") Pipes-Located In The, Insulation	Black Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-06 / 19026925-006 Pipe Insulation On Large (Approx 18") Pipes-Located In The, Cover	White Fibrous Homogeneous	90% Cellulose	10% Other	None Detected
053019-TG-07 / 19026925-007 Pipe Insulation Covering On Small (Approx 6") Soft Pipes sv	White Fibrous Homogeneous	70% Cellulose	30% Other	None Detected

Analyst:

Analysis Date: 6/10/2019

Approved Signatory:

Date: 6/10/2019

SanAir Technologies Laboratory

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Analyst: Fleming, Christopher

Asbestos Bulk PLM EPA 600/R-93/116

	Stereoscopic	Components		
SanAir ID / Description	Appearance	% Fibrous	% Non-fibrous	Asbestos Fibers
053019-TG-08 / 19026925-008 Pipe Insulation Covering On Small (Approx 6") Soft Pipes	White Fibrous Homogeneous	70% Cellulose	30% Other	None Detected
053019-TG-09 / 19026925-009 Pipe Insulation Covering On Small (Approx 6") Soft Pipes	White Fibrous Homogeneous	70% Cellulose	30% Other	None Detected
053019-TG-10 / 19026925-010 Flange Covering On Large (Approx 18") Soft Pipes-Located	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-11 / 19026925-011 Flange Covering On Large (Approx 18") Soft Pipes-Located	Grey Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-12 / 19026925-012 Flange Covering On Large (Approx 18") Soft Pipes-Located	Grey Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-13 / 19026925-013 Pipe Insulation On Hard Small (Approx 6") Pipes -Located In, Insulation	White Non-Fibrous Homogeneous	40% Cellulose	60% Other	None Detected
053019-TG-13 / 19026925-013 Pipe Insulation On Hard Small (Approx 6") Pipes -Located In, Cover	Various Fibrous Heterogeneous	70% Cellulose	30% Other	None Detected
053019-TG-14 / 19026925-014 Pipe Insulation On Hard Small (Approx 6") Pipes -Located In	White Non-Fibrous Homogeneous	40% Cellulose	60% Other	None Detected
053019-TG-15 / 19026925-015 Pipe Insulation On Hard Small (Approx 6") Pipes -Located In, Insulation	White Non-Fibrous Homogeneous	40% Cellulose	60% Other	None Detected

Analyst: Chris Fleming

Approved Signatory: Johnathan Wilson

Analysis Date: 6/10/2019

Date: 6/10/2019

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Analyst: Fleming, Christopher

Asbestos Bulk PLM EPA 600/R-93/116

SanAir ID / Description	Stereoscopic Appearance	Components % Fibrous	Components % Non-fibrous	Asbestos Fibers
053019-TG-15 / 19026925-015 Pipe Insulation On Hard Small (Approx 6") Pipes -Located In, Cover	Various Fibrous Heterogeneous	70% Cellulose	30% Other	None Detected
053019-TG-16 / 19026925-016 Flange Insulation On Hard Large (Approx 18") Pipes -Located, Insulation	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-16 / 19026925-016 Flange Insulation On Hard Large (Approx 18") Pipes -Located, Insulation	Black Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-16 / 19026925-016 Flange Insulation On Hard Large (Approx 18") Pipes -Located, Cover	White Fibrous Homogeneous	60% Cellulose	40% Other	None Detected
053019-TG-17 / 19026925-017 Flange Insulation On Hard Large (Approx 18") Pipes -Located, Insulation	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-17 / 19026925-017 Flange Insulation On Hard Large (Approx 18") Pipes -Located, Insulation	Black Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-17 / 19026925-017 Flange Insulation On Hard Large (Approx 18") Pipes -Located, Cover	White Fibrous Homogeneous	60% Cellulose	40% Other	None Detected
053019-TG-18 / 19026925-018 Flange Insulation On Hard Large (Approx 18") Pipes -Located, Insulation	White Non-Fibrous Homogeneous		100% Other	None Detected

Analyst: Chris Fleming

Analysis Date: 6/10/2019

Approved Signatory: Johnathan Wilson

Date: 6/10/2019

SanAir Technologies Laboratory

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Analyst: Fleming, Christopher

Asbestos Bulk PLM EPA 600/R-93/116

	Stereoscopic	Components		
SanAir ID / Description	Appearance	% Fibrous	% Non-fibrous	Asbestos Fibers
053019-TG-18 / 19026925-018 Flange Insulation On Hard Large (Approx 18") Pipes -Located, Insulation	Black Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-18 / 19026925-018 Flange Insulation On Hard Large (Approx 18") Pipes -Located, Cover	White Fibrous Homogeneous	60% Cellulose	40% Other	None Detected
053019-TG-19 / 19026925-019 Elbow Insulation On Hard Large (Approx 18") Pipes -Located, Insulation	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-19 / 19026925-019 Elbow Insulation On Hard Large (Approx 18") Pipes -Located, Insulation	Black Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-19 / 19026925-019 Elbow Insulation On Hard Large (Approx 18") Pipes -Located, Cover	White Fibrous Homogeneous	60% Cellulose	40% Other	None Detected
053019-TG-20 / 19026925-020 Elbow Insulation On Hard Large (Approx 18") Pipes -Located, Insulation	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-20 / 19026925-020 Elbow Insulation On Hard Large (Approx 18") Pipes -Located, Insulation	Black Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-20 / 19026925-020 Elbow Insulation On Hard Large (Approx 18") Pipes -Located, Cover	White Fibrous Homogeneous	60% Cellulose	40% Other	None Detected

Analyst: Approved Signatory:

Analysis Date: 6/10/2019 Date: 6/10/2019

SanAir Technologies Laboratory

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Analyst: Fleming, Christopher

Asbestos Bulk PLM EPA 600/R-93/116

	Stereoscopic	Components		
SanAir ID / Description	Appearance	% Fibrous	% Non-fibrous	Asbestos Fibers
053019-TG-21 / 19026925-021 Elbow Insulation On Hard Large (Approx 18") Pipes -Located, Insulation	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-21 / 19026925-021 Elbow Insulation On Hard Large (Approx 18") Pipes -Located, Insulation	Black Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-21 / 19026925-021 Elbow Insulation On Hard Large (Approx 18") Pipes -Located, Cover	White Fibrous Homogeneous	60% Cellulose	40% Other	None Detected
053019-TG-22 / 19026925-022 Batt Insulation Paper Backing - Located In The 1st & 2nd Flr	Black Fibrous Homogeneous	50% Cellulose	50% Other	None Detected
053019-TG-23 / 19026925-023 Batt Insulation Paper Backing - Located In The 1st & 2nd Flr	Black Fibrous Homogeneous	50% Cellulose	50% Other	None Detected
053019-TG-24 / 19026925-024 Batt Insulation Paper Backing - Located In The 1st & 2nd Flr	Black Fibrous Homogeneous	50% Cellulose	50% Other	None Detected
053019-TG-25 / 19026925-025 Duct Tape On HVAC Equipment - Located In The 2nd Flr Mech	Various Fibrous Heterogeneous	50% Cellulose	50% Other	None Detected
053019-TG-26 / 19026925-026 Duct Tape On HVAC Equipment - Located In The 2nd Flr Mech	Various Fibrous Heterogeneous	50% Cellulose	50% Other	None Detected
053019-TG-27 / 19026925-027 Duct Tape On HVAC Equipment - Located In The 2nd Flr Mech	Various Fibrous Heterogeneous	50% Cellulose	50% Other	None Detected

Analyst: *Chris Fleming*

Analysis Date: 6/10/2019

Approved Signatory: *Johnathan Wilson*

Date: 6/10/2019

SanAir Technologies Laboratory

SanAir ID Number
19026925
FINAL REPORT
6/10/2019 1:21:18 PM

Name: Phoenix EnviroCorp
Address: 4020 Shipyard Blvd
Wilmington, NC 28403
Phone:

Project Number: 21-19-121-AB-I
P.O. Number:
Project Name: CCU-Kimbel Library, 376 University Blvd., Conway,
Collected Date: 5/30/2019
Received Date: 6/6/2019 9:35:00 AM

Analyst: Fleming, Christopher

Asbestos Bulk PLM EPA 600/R-93/116

SanAir ID / Description	Stereoscopic Appearance	Components % Fibrous	% Non-fibrous	Asbestos Fibers
053019-TG-28 / 19026925-028 Expansion Joint & Mastic On HVAC Equip. -Located In The 1st, Expansion Joint	Black Non-Fibrous Homogeneous	40% Glass	60% Other	None Detected
053019-TG-28 / 19026925-028 Expansion Joint & Mastic On HVAC Equip. -Located In The 1st, Mastic	Brown Non-Fibrous Homogeneous		98% Other	2% Chrysotile
053019-TG-29 / 19026925-029 Expansion Joint & Mastic On HVAC Equip. -Located In The 1st, Expansion Joint	Black Non-Fibrous Homogeneous	40% Glass	60% Other	None Detected
053019-TG-29 / 19026925-029 Expansion Joint & Mastic On HVAC Equip. -Located In The 1st, Mastic	Brown Non-Fibrous Homogeneous			Not Analyzed
053019-TG-30 / 19026925-030 Expansion Joint & Mastic On HVAC Equip. -Located In The 1st, Expansion Joint	Black Non-Fibrous Homogeneous	40% Glass	60% Other	None Detected
053019-TG-30 / 19026925-030 Expansion Joint & Mastic On HVAC Equip. -Located In The 1st, Mastic	Brown Non-Fibrous Homogeneous			Not Analyzed
053019-TG-31 / 19026925-031 Drywall/Joint Compound (Two Layers)-Located In The 1st & 2nd, Drywall	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-31 / 19026925-031 Drywall/Joint Compound (Two Layers)-Located In The 1st & 2nd, Joint Compound	White Non-Fibrous Homogeneous		100% Other	None Detected

Analyst: Approved Signatory:

Analysis Date: 6/10/2019 Date: 6/10/2019

SanAir Technologies Laboratory

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Collected Date: 5/30/2019
Received Date: 6/6/2019 9:35:00 AM

Analyst: Fleming, Christopher

Asbestos Bulk PLM EPA 600/R-93/116

SanAir ID / Description	Stereoscopic Appearance	Components % Fibrous	% Non-fibrous	Asbestos Fibers
053019-TG-32 / 19026925-032 Drywall/Joint Compound (Two Layers)-Located In The 1st & 2nd, Drywall	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-32 / 19026925-032 Drywall/Joint Compound (Two Layers)-Located In The 1st & 2nd, Joint Compound	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-33 / 19026925-033 Drywall/Joint Compound (Two Layers)-Located In The 1st & 2nd, Drywall	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-33 / 19026925-033 Drywall/Joint Compound (Two Layers)-Located In The 1st & 2nd, Joint Compound	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-34 / 19026925-034 Drywall/Joint Compound (Two Layers)-Located In The 1st & 2nd, Drywall	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-34 / 19026925-034 Drywall/Joint Compound (Two Layers)-Located In The 1st & 2nd, Joint Compound	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-35 / 19026925-035 Drywall/Joint Compound (Two Layers)-Located In The 1st & 2nd, Drywall	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-35 / 19026925-035 Drywall/Joint Compound (Two Layers)-Located In The 1st & 2nd, Joint Compound	White Non-Fibrous Homogeneous		100% Other	None Detected

Analyst: Chris Fleming

Analysis Date: 6/10/2019

Approved Signatory: Johnathan Wilson

Date: 6/10/2019

SanAir Technologies Laboratory

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Project Number: 21-19-121-AB-I
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Collected Date: 5/30/2019
Received Date: 6/6/2019 9:35:00 AM

Analyst: Fleming, Christopher

Asbestos Bulk PLM EPA 600/R-93/116

SanAir ID / Description	Stereoscopic Appearance	Components % Fibrous	% Non-fibrous	Asbestos Fibers
053019-TG-36 / 19026925-036 Drywall/Joint Compound (Two Layers)-Located In The 1st & 2nd, Drywall	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-36 / 19026925-036 Drywall/Joint Compound (Two Layers)-Located In The 1st & 2nd, Joint Compound	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-37 / 19026925-037 Drywall/Joint Compound (Two Layers)-Located In The 1st & 2nd, Drywall	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-37 / 19026925-037 Drywall/Joint Compound (Two Layers)-Located In The 1st & 2nd, Joint Compound	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-38 / 19026925-038 Ceiling Board System-Located In The 2nd Flr Mechanical Room, Ceiling Board	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-38 / 19026925-038 Ceiling Board System-Located In The 2nd Flr Mechanical Room, Joint Compound	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-38 / 19026925-038 Ceiling Board System-Located In The 2nd Flr Mechanical Room, Insulation	Brown Fibrous Homogeneous	80% Cellulose	20% Other	None Detected
053019-TG-38 / 19026925-038 Ceiling Board System-Located In The 2nd Flr Mechanical Room, Tar	Black Non-Fibrous Homogeneous		100% Other	None Detected

Analyst: Approved Signatory:

Analysis Date: 6/10/2019 Date: 6/10/2019

SanAir Technologies Laboratory

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Analyst: Fleming, Christopher

Asbestos Bulk PLM EPA 600/R-93/116

SanAir ID / Description	Stereoscopic Appearance	Components % Fibrous	% Non-fibrous	Asbestos Fibers
053019-TG-39 / 19026925-039 Ceiling Board System-Located In The 2nd Flr Mechanical Room, Ceiling Board	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-39 / 19026925-039 Ceiling Board System-Located In The 2nd Flr Mechanical Room, Joint Compound	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-39 / 19026925-039 Ceiling Board System-Located In The 2nd Flr Mechanical Room, Insulation	Brown Fibrous Homogeneous	80% Cellulose	20% Other	None Detected
053019-TG-39 / 19026925-039 Ceiling Board System-Located In The 2nd Flr Mechanical Room, Tar	Black Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-40 / 19026925-040 Ceiling Board System-Located In The 2nd Flr Mechanical Room, Ceiling Board	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-40 / 19026925-040 Ceiling Board System-Located In The 2nd Flr Mechanical Room, Joint Compound	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-40 / 19026925-040 Ceiling Board System-Located In The 2nd Flr Mechanical Room, Insulation	Brown Fibrous Homogeneous	80% Cellulose	20% Other	None Detected
053019-TG-40 / 19026925-040 Ceiling Board System-Located In The 2nd Flr Mechanical Room, Tar	Black Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-41 / 19026925-041 Ceiling Board System-Located In The 2nd Flr Mechanical Room, Ceiling Board	White Non-Fibrous Homogeneous		100% Other	None Detected

Analyst: Chris Fleming | Approved Signatory: Johnathan Wilson

Analysis Date: 6/10/2019 | Date: 6/10/2019

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Analyst: Fleming, Christopher

Asbestos Bulk PLM EPA 600/R-93/116

SanAir ID / Description	Stereoscopic Appearance	Components % Fibrous	Components % Non-fibrous	Asbestos Fibers
053019-TG-41 / 19026925-041 Ceiling Board System-Located In The 2nd Flr Mechanical Room, Joint Compound	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-41 / 19026925-041 Ceiling Board System-Located In The 2nd Flr Mechanical Room, Insulation	Brown Fibrous Homogeneous	80% Cellulose	20% Other	None Detected
053019-TG-42 / 19026925-042 Ceiling Board System-Located In The 2nd Flr Mechanical Room, Ceiling Board	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-42 / 19026925-042 Ceiling Board System-Located In The 2nd Flr Mechanical Room, Joint Compound	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-42 / 19026925-042 Ceiling Board System-Located In The 2nd Flr Mechanical Room, Insulation	Brown Fibrous Homogeneous	80% Cellulose	20% Other	None Detected
053019-TG-43 / 19026925-043 Ceiling Board System-Located In The 2nd Flr Mechanical Room, Ceiling Board	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-43 / 19026925-043 Ceiling Board System-Located In The 2nd Flr Mechanical Room, Joint Compound	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-43 / 19026925-043 Ceiling Board System-Located In The 2nd Flr Mechanical Room, Insulation	Brown Fibrous Homogeneous	80% Cellulose	20% Other	None Detected

Analyst: Chris Fleming

Analysis Date: 6/10/2019

Approved Signatory: Johnathan Wilson

Date: 6/10/2019

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Project Number: 21-19-121-AB-I
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Collected Date: 5/30/2019
Received Date: 6/6/2019 9:35:00 AM

Analyst: Fleming, Christopher

Asbestos Bulk PLM EPA 600/R-93/116

SanAir ID / Description	Stereoscopic Appearance	Components % Fibrous	% Non-fibrous	Asbestos Fibers
053019-TG-44 / 19026925-044 Ceiling Board System-Located In The 2nd Flr Mechanical Room, Ceiling Board	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-44 / 19026925-044 Ceiling Board System-Located In The 2nd Flr Mechanical Room, Joint Compound	White Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-44 / 19026925-044 Ceiling Board System-Located In The 2nd Flr Mechanical Room, Insulation	Brown Fibrous Homogeneous	80% Cellulose	20% Other	None Detected
053019-TG-44 / 19026925-044 Ceiling Board System-Located In The 2nd Flr Mechanical Room, Tar	Black Non-Fibrous Homogeneous		100% Other	None Detected
053019-TG-45 / 19026925-045 Ceiling Tiles -Located Throughout	White Fibrous Homogeneous	70% Glass	30% Other	None Detected
053019-TG-46 / 19026925-046 Ceiling Tiles -Located Throughout	White Fibrous Homogeneous	70% Glass	30% Other	None Detected
053019-TG-47 / 19026925-047 Ceiling Tiles -Located Throughout	White Fibrous Homogeneous	70% Glass	30% Other	None Detected

Analyst:

Analysis Date: 6/10/2019

Approved Signatory:

Date: 6/10/2019

Disclaimer

The final report cannot be reproduced, except in full, without written authorization from SanAir. Fibers smaller than 5 microns cannot be seen with this method due to scope limitations. The accuracy of the results is dependent upon the client's sampling procedure and information provided to the laboratory by the client. SanAir assumes no responsibility for the sampling procedure and will provide evaluation reports based solely on the sample and information provided by the client. This report may not be used by the client to claim product endorsement by NVLAP or any other agency of the U.S. government. Samples are held for a period of 60 days.

For NY state samples, method EPA 600/M4-82-020 is performed.

Polarized- light microscopy is not consistently reliable in detecting asbestos in floor covering and similar non-friable organically bound materials. Quantitative transmission electron microscopy is currently the only method that can be used to determine if this material can be considered or treated as non-asbestos containing.

<u>Asbestos Certifications</u>
NVLAP lab code 200870
City of Philadelphia: ALL-460
PA Department of Environmental Protection Number: 68-05397
California License Number: 2915
Colorado License Number: AL-23143
Connecticut License Number: PH-0105
Massachusetts License Number: AA000222
Maine License Number: LB-0075
New York ELAP lab ID: 11983
Rhode Island License Number: AAL-126
Texas Department of State Health Services License Number: 300440
Commonwealth of Virginia 3333000323
Washington State License Number: C989
West Virginia License Number: LT000566
Vermont License: AL166318

Revision Date: 11/30/2017

Phoenix EnviroCorp
4020 SHIPYARD BLVD.
WILMINGTON, NC 28403

CHAIN OF CUSTODY

LABORATORY TEST REQUEST

1902 6925

CONTACT: Tommie Green	PHONE: (910) 397-0370 FAX: (910) 313-6094 EMAIL: kmgreen@phoenixenvirocorp.com	DATE SHIPPED:	5/30/2019
PEC Job #: 21-19-121-AB-I	CLIENT'S JOB NAME: CCU - Kimbel Library, 376 University Blvd., Conway, SC 29526		
SAMPLE TYPE: Asbestos Bulk (PLM) TEM	NUMBER OF SAMPLES: 34 13	TURN AROUND TIME SPECIFIED: _____ 2 Hr _____ 6 Hr __X__ 24 Hr _____ 48 Hr _____ 3-5 Day	

SPECIAL INSTRUCTIONS: 1.) Stop at first positive for each homogeneous area (HGA). 2.) List positive stops on analysis form. 3.) Separate all layers prior to analysis. 4.) Do not analyze ceramic tile; analyze any associated mastic, grout, mortar, backerboard, etc. . 5.) Do not analyze fiberglass. 6.) Confirm negative results for non-friable, organically bound material with one (1) TEM analysis per HGA. 7.) Any drywall or joint compound HGA that is > 1%, but < 5% shall be re-analyzed (separately) utilizing EPA 400 point count method. 8.) Please email results.

Sample #	Sample Area	Sample Date	HGA	Lab Analysis Requested
053019-TG-01	Pipe insulation covering on large (approx 18") soft/fiberglass insulated pipes - located in the 1st & 2nd flr mechanical rooms	05/30/19	1	PLM
053019-TG-02	Pipe insulation covering on large (approx 18") soft/fiberglass insulated pipes - located in the 1st & 2nd flr mechanical rooms	05/30/19	1	PLM
053019-TG-03	Pipe insulation covering on large (approx 18") soft/fiberglass insulated pipes - located in the 1st & 2nd flr mechanical rooms	05/30/19	1	PLM/TEM - NOB
053019-TG-04	Pipe insulation on large (approx 18") pipes - located in the 2nd flor mechanical rooms (black inner insulation)	05/30/19	2	PLM
053019-TG-05	Pipe insulation on large (approx 18") pipes - located in the 2nd flor mechanical rooms (black inner insulation)	05/30/19	2	PLM
053019-TG-06	Pipe insulation on large (approx 18") pipes - located in the 2nd flor mechanical rooms (black inner insulation)	05/30/19	2	PLM/TEM - NOB
053019-TG-07	Pipe insulation covering on small (appox 6") soft pipes - located in the 1st & 2nd flr mechanical rooms and 1st flr water heater room	05/30/19	3	PLM
053019-TG-08	Pipe insulation covering on small (appox 6") soft pipes - located in the 1st & 2nd flr mechanical rooms and 1st flr water heater room	05/30/19	3	PLM
053019-TG-09	Pipe insulation covering on small (appox 6") soft pipes - located in the 1st & 2nd flr mechanical rooms and 1st flr water heater room	05/30/19	3	PLM/TEM - NOB
053019-TG-10	Flange covering on large (approx 18") soft pipes - located in the 1st & 2nd flr mechanical rooms	05/30/19	4	PLM
053019-TG-11	Flange covering on large (approx 18") soft pipes - located in the 1st & 2nd flr mechanical rooms	05/30/19	4	PLM
053019-TG-12	Flange covering on large (approx 18") soft pipes - located in the 1st & 2nd flr mechanical rooms	05/30/19	4	PLM/TEM - NOB
053019-TG-13	Pipe insulation on hard small (approx 6") pipes - located in the 2nd flr mechanical room (white inner insulation)	05/30/19	5	PLM
053019-TG-14	Pipe insulation on hard small (approx 6") pipes - located in the 2nd flr mechanical room (white inner insulation)	05/30/19	5	PLM
053019-TG-15	Pipe insulation on hard small (approx 6") pipes - located in the 2nd flr mechanical room (white inner insulation)	05/30/19	5	PLM/TEM - NOB
053019-TG-16	Flange insulation on hard large (approx 18") pipes - located in the 1st & 2nd flr mechanical rooms	05/30/19	6	PLM
053019-TG-17	Flange insulation on hard large (approx 18") pipes - located in the 1st & 2nd flr mechanical rooms	05/30/19	6	PLM
053019-TG-18	Flange insulation on hard large (approx 18") pipes - located in the 1st & 2nd flr mechanical rooms	05/30/19	6	PLM/TEM - NOB
053019-TG-19	Elbow insulation on hard large (approx 18") pipes - located in the 1st & 2nd flr mechanical rooms	05/30/19	7	PLM
053019-TG-20	Elbow insulation on hard large (approx 18") pipes - located in the 1st & 2nd flr mechanical rooms	05/30/19	7	PLM

CHAIN OF CUSTODY RECORD

DATE	CONDITION OF SAMPLE	SAMPLES RECEIVED BY	SAMPLES RELEASED BY
5/30/2019	SEALED/GOOD	SIGNATURE JUN 0 6 2019 935	SIGNATURE

Phoenix EnviroCorp
4020 SHIPYARD BLVD.
WILMINGTON, NC 28403

CHAIN OF CUSTODY

LABORATORY TEST REQUEST

19026925

CONTACT: Tommie Green	PHONE: (910) 397-0370 FAX: (910) 313-6094 EMAIL: kmgreen@phoenixenvirocorp.com	DATE SHIPPED: 5/30/2019
PEC Job #: 21-19-121-AB-I	CLIENT'S JOB NAME: CCU - Kimbel Library, 376 University Blvd., Conway, SC 29526	
SAMPLE TYPE: Asbestos Bulk (PLM) TEM	NUMBER OF SAMPLES: 34 13	TURN AROUND TIME SPECIFIED: ____ 2 Hr ____ 6 Hr __X__ 24 Hr ____ 48 Hr ____ 3-5 Day

SPECIAL INSTRUCTIONS: 1.) Stop at first positive for each homogeneous area (HGA). 2.) List positive stops on analysis form. 3.) Separate all layers prior to analysis. 4.) Do not analyze ceramic tile; analyze any associated mastic, grout, mortar, backerboard, etc. . 5.) Do not analyze fiberglass. 6.) Confirm negative results for non-friable, organically bound material with one (1) TEM analysis per HGA. 7.) Any drywall or joint compound HGA that is > 1%, but < 5% shall be re-analyzed (separately) utilizing EPA 400 point count method. 8.) Please email results.

Sample #	Sample Area	Sample Date	HGA	Lab Analysis Requested
053019-TG-21	Elbow insulation on hard large (approx 18") pipes - located in the 1st & 2nd flr mechanical rooms	05/30/19	7	PLM/TEM - NOB
053019-TG-22	Batt insulation paper backing - located in the 1st & 2nd flr mechanical rooms, etc.	05/30/19	8	PLM
053019-TG-23	Batt insulation paper backing - located in the 1st & 2nd flr mechanical rooms, etc.	05/30/19	8	PLM
053019-TG-24	Batt insulation paper backing - located in the 1st & 2nd flr mechanical rooms, etc.	05/30/19	8	PLM/TEM - NOB
053019-TG-25	Duct tape on HVAC equipment - located in the 2nd flr mechanical room, etc.	05/30/19	9	PLM
053019-TG-26	Duct tape on HVAC equipment - located in the 2nd flr mechanical room, etc.	05/30/19	9	PLM
053019-TG-27	Duct tape on HVAC equipment - located in the 2nd flr mechanical room, etc.	05/30/19	9	PLM/TEM - NOB
053019-TG-28	Expansion joint & mastic on HVAC equip. - located in the 1st & 2nd floor mechanical rooms, etc.	05/30/19	10	PLM
053019-TG-29	Expansion joint & mastic on HVAC equip. - located in the 1st & 2nd floor mechanical rooms, etc.	05/30/19	10	PLM
053019-TG-30	Expansion joint & mastic on HVAC equip. - located in the 1st & 2nd floor mechanical rooms, etc.	05/30/19	10	PLM/TEM - NOB
053019-TG-31	Drywall/joint compound (two layers) - located in the 1st & 2nd floor mechanical rooms, etc.	05/30/19	11	PLM
053019-TG-32	Drywall/joint compound (two layers) - located in the 1st & 2nd floor mechanical rooms, etc.	05/30/19	11	PLM
053019-TG-33	Drywall/joint compound (two layers) - located in the 1st & 2nd floor mechanical rooms, etc.	05/30/19	11	PLM
053019-TG-34	Drywall/joint compound (two layers) - located in the 1st & 2nd floor mechanical rooms, etc.	05/30/19	11	PLM
053019-TG-35	Drywall/joint compound (two layers) - located in the 1st & 2nd floor mechanical rooms, etc.	05/30/19	11	PLM
053019-TG-36	Drywall/joint compound (two layers) - located in the 1st & 2nd floor mechanical rooms, etc.	05/30/19	11	PLM
053019-TG-37	Drywall/joint compound (two layers) - located in the 1st & 2nd floor mechanical rooms, etc.	05/30/19	11	PLM/TEM - NOB
053019-TG-38	Green ceiling board system - located in the 2nd flr mechanical room, etc.	05/30/19	12	PLM
053019-TG-39	Green ceiling board system - located in the 2nd flr mechanical room, etc.	05/30/19	12	PLM

CHAIN OF CUSTODY RECORD

DATE	CONDITION OF SAMPLE	SAMPLES RECEIVED BY	SAMPLES RELEASED BY
5/30/2019	SEALED/GOOD	SIGNATURE JUN 06 2019 935	SIGNATURE

Phoenix EnviroCorp
4020 SHIPYARD BLVD.
WILMINGTON, NC 28403

CHAIN OF COUSTODY

19026925

LABORATORY TEST REQUEST

CONTACT: Tommie Green	PHONE: (910) 397-0370 FAX: (910) 313-6094 EMAIL: kmgreen@phoenixenvirocorp.com		DATE SHIPPED: 5/30/2019
PEC Job #: 21-19-121-AB-I	CLIENT'S JOB NAME: CCU - Kimbel Library, 376 University Blvd., Conway, SC 29526		
SAMPLE TYPE: Asbestos Bulk (PLM) TEM	NUMBER OF SAMPLES: 34 13	TURN AROUND TIME SPECIFIED: ____ 2 Hr ____ 6 Hr __X__ 24 Hr ____ 48 Hr ____ 3-5 Day	

SPECIAL INSTRUCTIONS: 1.) Stop at first positive for each homogeneous area (HGA). 2.) List positive stops on analysis form. 3.) Separate all layers prior to analysis. 4.) Do not analyze ceramic tile; analyze any associated mastic, grout, mortar, backerboard, etc. . 5.) Do not analyze fiberglass. 6.) Confirm negative results for non-friable, organically bound material with one (1) TEM analysis per HGA. 7.) Any drywall or joint compound HGA that is > 1%, but < 5% shall be re-analyzed (separately) utilizing EPA 400 point count method. 8.) Please email results.

Sample #	Sample Area	Sample Date	HGA	Lab Analysis Requested
053019-TG-40	Green ceiling board system - located in the 2nd flr mechanical room, etc.	05/30/19	12	PLM
053019-TG-41	Green ceiling board system - located in the 2nd flr mechanical room, etc.	05/30/19	12	PLM
053019-TG-42	Green ceiling board system - located in the 2nd flr mechanical room, etc.	05/30/19	12	PLM
053019-TG-43	Green ceiling board system - located in the 2nd flr mechanical room, etc.	05/30/19	12	PLM
053019-TG-44	Green ceiling board system - located in the 2nd flr mechanical room, etc.	05/30/19	12	PLM/TEM - NOB
053019-TG-45	Ceiling tiles - located throughout	05/30/19	13	PLM
053019-TG-46	Ceiling tiles - located throughout	05/30/19	13	PLM
053019-TG-47	Ceiling tiles - located throughout	05/30/19	13	PLM/TEM - NOB

CHAIN OF CUSTODY RECORD

DATE	CONDITION OF SAMPLE	SAMPLES RECEIVED BY	SAMPLES RELEASED BY
5/30/2019	SEALED/GOOD	SIGNATURE JUN 0 6 2019 935	SIGNATURE

SanAir Technologies Laboratory

The Identification Specialists

Analysis Report prepared for Phoenix EnviroCorp

Report Date: 6/12/2019

Project Name: CCU-Kimbel Library, 376 University Blvd, Conway, S

Project #: 21-19-121-AB-I

SanAir ID#: 19027007

NVLAP TESTING

NVLAP LAB CODE 200870-0

1551 Oakbridge Dr. Suite B | Powhatan, Virginia 23139-8061
888.895.1177 | 804.897.1177 | fax: 804.897.0070 | IAQ@SanAir.com | SanAir.com

SanAir ID Number
19027007
FINAL REPORT
6/12/2019 7:28:55 PM

Name: Phoenix EnviroCorp
Address: 4020 Shipyard Blvd
Wilmington, NC 28403
Phone:

Project Number: 21-19-121-AB-I
P.O. Number:
Project Name: CCU-Kimbel Library, 376 University Blvd, Conway, S
Collected Date: 5/30/2019
Received Date: 6/6/2019 9:35:00 AM

Dear Tommie Green,

We at SanAir would like to thank you for the work you recently submitted. The 13 sample(s) were received on Thursday, June 06, 2019 via FedEx. The final report(s) is enclosed for the following sample(s): 053019-TG-03, 053019-TG-06, 053019-TG-09, 053019-TG-12, 053019-TG-15, 053019-TG-18, 053019-TG-21, 053019-TG-24, 053019-TG-27, 053019-TG-30, 053019-TG-37, 053019-TG-44, 053019-TG-47.

These results only pertain to this job and should not be used in the interpretation of any other job. This report is only complete in its entirety. Refer to the listing below of the pages included in a complete final report.

Sincerely,

Sandra Sobrino

Sandra Sobrino
Asbestos & Materials Laboratory Manager
SanAir Technologies Laboratory

Final Report Includes:
- Cover Letter
- Analysis Pages
- Disclaimers and Additional Information

Sample conditions:
- 13 samples in Good condition.

SanAir Technologies Laboratory

SanAir ID Number
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FINAL REPORT
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Address: 4020 Shipyard Blvd
Wilmington, NC 28403
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Project Number: 21-19-121-AB-I
P.O. Number:
Project Name: CCU-Kimbel Library, 376 University Blvd, Conway, S
Collected Date: 5/30/2019
Received Date: 6/6/2019 9:35:00 AM

Analyst: Sobrino, Sandra

Asbestos Bulk TEM EPA NOB EPA 600/R-93/116

Sample	Appearance	% Other Material	% Non-Asbestos Fibers	Asbestos Types	% Total Asbestos
053019-TG-06 Insulation19027007-002 Pipe Insulation On Large (Approx 18") Pipes Located In The	Non-Fibrous Homogeneous Black	100%		None Detected	
053019-TG-09 19027007-003 Pipe Insulation Covering On Small (Approx 6") Soft Pipes	Non-Fibrous Homogeneous White	100%		None Detected	
053019-TG-12 19027007-004 Flange Covering On Large (Approx 18") Soft Pipes- Located	Non-Fibrous Homogeneous Grey	100%		None Detected	
053019-TG-15 Insulation19027007-005 Pipe Insulation On Hard Small (Approx 6") Pipes -Located In	Non-Fibrous Homogeneous White	100%		None Detected	
053019-TG-18 Insulation19027007-006 Flange Insulation On Hard Large (Approx 18") Pipes- Located	Non-Fibrous Homogeneous White	100%		None Detected	
053019-TG-18 Insulation19027007-006 Flange Insulation On Hard Large (Approx 18") Pipes- Located	Non-Fibrous Homogeneous Black	100%		None Detected	

Analyst: Sandra Sobrino
Analysis Date: 6/12/2019

Approved Signatory: Sandra Sobrino
Date: 6/12/2019

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Collected Date: 5/30/2019
Received Date: 6/6/2019 9:35:00 AM

Analyst: Sobrino, Sandra

Asbestos Bulk TEM EPA NOB EPA 600/R-93/116

Sample	Appearance	% Other Material	% Non-Asbestos Fibers	Asbestos Types	% Total Asbestos
053019-TG-21 Insulation19027007-007 Elbow Insulation On Hard Large (Approx 18") Pipes - Located	Non-Fibrous Homogeneous White	100%		None Detected	
053019-TG-21 Insulation19027007-007 Elbow Insulation On Hard Large (Approx 18") Pipes - Located	Non-Fibrous Homogeneous Black	100%		None Detected	
053019-TG-30 19027007-010 Expansion Joint & Mastic On HVAC Equip. -Located In The 1st	Non-Fibrous Homogeneous Black	100%		None Detected	
053019-TG-44 Tar19027007-012 Ceiling Board System -Located In The 2nd Flr Mechanical Room	Non-Fibrous Homogeneous Black	100%		None Detected	

Analyst: Sandra Sobrino
Analysis Date: 6/12/2019

Approved Signatory: Sandra Sobrino
Date: 6/12/2019

Disclaimer

The final report cannot be reproduced, except in full, without written authorization from SanAir. The accuracy of the results is dependent upon the client's sampling procedure and information provided to the laboratory by the client. SanAir assumes no responsibility for the sampling procedure and will provide evaluation reports based solely on the sample and information provided by the client. This report may not be used by the client to claim product endorsement by NVLAP or any other agency of the U.S. government.

Phoenix EnviroCorp
4020 SHIPYARD BLVD
WILMINGTON, NC 28403

CHAIN OF CUSTODY

19027007

LABORATORY TEST REQUEST

CONTACT: Tommie Green	PHONE: (910) 397-0370 FAX: (910) 313-6094 EMAIL: kmgreen@phoenixenvirocorp.com		DATE SHIPPED: 5/30/2019
PEC Job #: 21-19-121-AB-I	CLIENT'S JOB NAME: CCU - Kimbel Library, 376 University Blvd., Conway, SC 29526		
SAMPLE TYPE: Asbestos Bulk (PLM) TEM	NUMBER OF SAMPLES: 34 13	TURN AROUND TIME SPECIFIED: ___ 2 Hr ___ 6 Hr __X__ 24 Hr ___ 48 Hr ___ 3-5 Day	

SPECIAL INSTRUCTIONS: 1.) Stop at first positive for each homogeneous area (HGA). 2.) List positive stops on analysis form. 3.) Separate all layers prior to analysis. 4.) Do not analyze ceramic tile; analyze any associated mastic, grout, mortar, backerboard, etc. . 5.) Do not analyze fiberglass. 6.) Confirm negative results for non-friable, organically bound material with one (1) TEM analysis per HGA. 7.) Any drywall or joint compound HGA that is > 1%, but < 5% shall be re-analyzed (separately) utilizing EPA 400 point count method. 8.) Please email results.

Sample #	Sample Area	Sample Date	HGA	Lab Analysis Requested
053019-TG-01	Pipe insulation covering on large (approx 18") soft/fiberglass insulated pipes - located in the 1st & 2nd flr mechanical rooms	05/30/19	1	PLM
053019-TG-02	Pipe insulation covering on large (approx 18") soft/fiberglass insulated pipes - located in the 1st & 2nd flr mechanical rooms	05/30/19	1	PLM
053019-TG-03	Pipe insulation covering on large (approx 18") soft/fiberglass insulated pipes - located in the 1st & 2nd flr mechanical rooms	05/30/19	1	PLM/TEM - NOB
053019-TG-04	Pipe insulation on large (approx 18") pipes - located in the 2nd flor mechanical rooms (black inner insulation)	05/30/19	2	PLM
053019-TG-05	Pipe insulation on large (approx 18") pipes - located in the 2nd flor mechanical rooms (black inner insulation)	05/30/19	2	PLM
053019-TG-06	Pipe insulation on large (approx 18") pipes - located in the 2nd flor mechanical rooms (black inner insulation)	05/30/19	2	PLM/TEM - NOB
053019-TG-07	Pipe insulation covering on small (appox 6") soft pipes - located in the 1st & 2nd flr mechanical rooms and 1st flr water heater room	05/30/19	3	PLM
053019-TG-08	Pipe insulation covering on small (appox 6") soft pipes - located in the 1st & 2nd flr mechanical rooms and 1st flr water heater room	05/30/19	3	PLM
053019-TG-09	Pipe insulation covering on small (appox 6") soft pipes - located in the 1st & 2nd flr mechanical rooms and 1st flr water heater room	05/30/19	3	PLM/TEM - NOB
053019-TG-10	Flange covering on large (approx 18") soft pipes - located in the 1st & 2nd flr mechanical rooms	05/30/19	4	PLM
053019-TG-11	Flange covering on large (approx 18") soft pipes - located in the 1st & 2nd flr mechanical rooms	05/30/19	4	PLM
053019-TG-12	Flange covering on large (approx 18") soft pipes - located in the 1st & 2nd flr mechanical rooms	05/30/19	4	PLM/TEM - NOB
053019-TG-13	Pipe insulation on hard small (approx 6") pipes - located in the 2nd flr mechanical room (white inner insulation)	05/30/19	5	PLM
053019-TG-14	Pipe insulation on hard small (approx 6") pipes - located in the 2nd flr mechanical room (white inner insulation)	05/30/19	5	PLM
053019-TG-15	Pipe insulation on hard small (approx 6") pipes - located in the 2nd flr mechanical room (white inner insulation)	05/30/19	5	PLM/TEM - NOB
053019-TG-16	Flange insulation on hard large (approx 18") pipes - located in the 1st & 2nd flr mechanical rooms	05/30/19	6	PLM
053019-TG-17	Flange insulation on hard large (approx 18") pipes - located in the 1st & 2nd flr mechanical rooms	05/30/19	6	PLM
053019-TG-18	Flange insulation on hard large (approx 18") pipes - located in the 1st & 2nd flr mechanical rooms	05/30/19	6	PLM/TEM - NOB
053019-TG-19	Elbow insulation on hard large (approx 18") pipes - located in the 1st & 2nd flr mechanical rooms	05/30/19	7	PLM
053019-TG-20	Elbow insulation on hard large (approx 18") pipes - located in the 1st & 2nd flr mechanical rooms	05/30/19	7	PLM

CHAIN OF CUSTODY RECORD

DATE	CONDITION OF SAMPLE	SAMPLES RECEIVED BY	SAMPLES RELEASED BY
5/30/2019	SEALED/GOOD	SIGNATURE JUN 0 6 2019	SIGNATURE

Phoenix EnviroCorp
4020 SHIPYARD BLVD.
WILMINGTON, NC 28403

CHAIN OF CUSTODY

19027007

LABORATORY TEST REQUEST

CONTACT: Tommie Green	PHONE: (910) 397-0370 FAX: (910) 313-6094 EMAIL: kmgreen@phoenixenvirocorp.com	DATE SHIPPED: 5/30/2019
PEC Job #: 21-19-121-AB-I	CLIENT'S JOB NAME: CCU - Kimbel Library, 376 University Blvd., Conway, SC 29526	
SAMPLE TYPE: Asbestos Bulk (PLM) TEM	NUMBER OF SAMPLES: 34 13	TURN AROUND TIME SPECIFIED: ____ 2 Hr ____ 6 Hr __X__ 24 Hr ____ 48 Hr ____ 3-5 Day

SPECIAL INSTRUCTIONS: 1.) Stop at first positive for each homogeneous area (HGA). 2.) List positive stops on analysis form. 3.) Separate all layers prior to analysis. 4.) Do not analyze ceramic tile; analyze any associated mastic, grout, mortar, backerboard, etc. . 5.) Do not analyze fiberglass. 6.) Confirm negative results for non-friable, organically bound material with one (1) TEM analysis per HGA. 7.) Any drywall or joint compound HGA that is > 1%, but < 5% shall be re-analyzed (separately) utilizing EPA 400 point count method. 8.) Please email results.

Sample #	Sample Area	Sample Date	HGA	Lab Analysis Requested
053019-TG-21	Elbow insulation on hard large (approx 18") pipes - located in the 1st & 2nd flr mechanical rooms	05/30/19	7	PLM/TEM - NOB
053019-TG-22	Batt insulation paper backing - located in the 1st & 2nd flr mechanical rooms, etc.	05/30/19	8	PLM
053019-TG-23	Batt insulation paper backing - located in the 1st & 2nd flr mechanical rooms, etc.	05/30/19	8	PLM
053019-TG-24	Batt insulation paper backing - located in the 1st & 2nd flr mechanical rooms, etc.	05/30/19	8	PLM/TEM - NOB
053019-TG-25	Duct tape on HVAC equipment - located in the 2nd flr mechanical room, etc.	05/30/19	9	PLM
053019-TG-26	Duct tape on HVAC equipment - located in the 2nd flr mechanical room, etc.	05/30/19	9	PLM
053019-TG-27	Duct tape on HVAC equipment - located in the 2nd flr mechanical room, etc.	05/30/19	9	PLM/TEM - NOB
053019-TG-28	Expansion joint & mastic on HVAC equip. - located in the 1st & 2nd floor mechanical rooms, etc.	05/30/19	10	PLM
053019-TG-29	Expansion joint & mastic on HVAC equip. - located in the 1st & 2nd floor mechanical rooms, etc.	05/30/19	10	PLM
053019-TG-30	Expansion joint & mastic on HVAC equip. - located in the 1st & 2nd floor mechanical rooms, etc.	05/30/19	10	PLM/TEM - NOB
053019-TG-31	Drywall/joint compound (two layers) - located in the 1st & 2nd floor mechanical rooms, etc.	05/30/19	11	PLM
053019-TG-32	Drywall/joint compound (two layers) - located in the 1st & 2nd floor mechanical rooms, etc.	05/30/19	11	PLM
053019-TG-33	Drywall/joint compound (two layers) - located in the 1st & 2nd floor mechanical rooms, etc.	05/30/19	11	PLM
053019-TG-34	Drywall/joint compound (two layers) - located in the 1st & 2nd floor mechanical rooms, etc.	05/30/19	11	PLM
053019-TG-35	Drywall/joint compound (two layers) - located in the 1st & 2nd floor mechanical rooms, etc.	05/30/19	11	PLM
053019-TG-36	Drywall/joint compound (two layers) - located in the 1st & 2nd floor mechanical rooms, etc.	05/30/19	11	PLM
053019-TG-37	Drywall/joint compound (two layers) - located in the 1st & 2nd floor mechanical rooms, etc.	05/30/19	11	PLM/TEM - NOB
053019-TG-38	Green ceiling board system - located in the 2nd flr mechanical room, etc.	05/30/19	12	PLM
053019-TG-39	Green ceiling board system - located in the 2nd flr mechanical room, etc.	05/30/19	12	PLM

CHAIN OF CUSTODY RECORD

DATE	CONDITION OF SAMPLE	SAMPLES RECEIVED BY	SAMPLES RELEASED BY
5/30/2019	SEALED/GOOD	SIGNATURE JUN 0 6 2019	SIGNATURE Tommie Green

19027007

Phoenix EnviroCorp
4020 SHIPYARD BLVD
WILMINGTON NC 28403

CHAIN OF CUSTODY

LABORATORY TEST REQUEST

CONTACT: Tommie Green	PHONE: (910) 397-0370 FAX: (910) 313-6094 EMAIL: kmgreen@phoenixenvirocorp.com		DATE SHIPPED: 5/30/2019
PEC Job #: 21-19-121-AB-I	CLIENT'S JOB NAME: CCU - Kimbel Library, 376 University Blvd., Conway, SC 29526		
SAMPLE TYPE: Asbestos Bulk (PLM) TEM	NUMBER OF SAMPLES: 34 13	TURN AROUND TIME SPECIFIED: ____ 2 Hr ____ 6 Hr _X_ 24 Hr ____ 48 Hr ____ 3-5 Day	

SPECIAL INSTRUCTIONS: 1.) Stop at first positive for each homogeneous area (HGA). 2.) List positive stops on analysis form. 3.) Separate all layers prior to analysis. 4.) Do not analyze ceramic tile; analyze any associated mastic, grout, mortar, backerboard, etc. . 5.) Do not analyze fiberglass. 6.) Confirm negative results for non-friable, organically bound material with one (1) TEM analysis per HGA. 7.) Any drywall or joint compound HGA that is > 1%, but < 5% shall be re-analyzed (separately) utilizing EPA 400 point count method. 8.) Please email results.

Sample #	Sample Area	Sample Date	HGA	Lab Analysis Requested
053019-TG-40	Green ceiling board system - located in the 2nd flr mechanical room, etc.	05/30/19	12	PLM
053019-TG-41	Green ceiling board system - located in the 2nd flr mechanical room, etc.	05/30/19	12	PLM
053019-TG-42	Green ceiling board system - located in the 2nd flr mechanical room, etc.	05/30/19	12	PLM
053019-TG-43	Green ceiling board system - located in the 2nd flr mechanical room, etc.	05/30/19	12	PLM
053019-TG-44	Green ceiling board system - located in the 2nd flr mechanical room, etc.	05/30/19	12	PLM/TEM - NOB
053019-TG-45	Ceiling tiles - located throughout	05/30/19	13	PLM
053019-TG-46	Ceiling tiles - located throughout	05/30/19	13	PLM
053019-TG-47	Ceiling tiles - located throughout	05/30/19	13	PLM/TEM - NOB

CHAIN OF CUSTODY RECORD

DATE	CONDITION OF SAMPLE	SAMPLES RECEIVED BY	SAMPLES RELEASED BY
5/30/2019	SEALED/GOOD	SIGNATURE JUN 06 2019	SIGNATURE [signature]

SCDHEC ISSUED
Asbestos ID Card

Tommie Green

		Expiration Date:
CONSULTPD	**PD-00123**	**02/06/20**
CONSULTMP	**MP-00184**	**02/04/20**

United States Department of Commerce
National Institute of Standards and Technology

NVLAP®

Certificate of Accreditation to ISO/IEC 17025:2005

NVLAP LAB CODE: 200870-0

SanAir Technologies Laboratory, Inc.
Powhatan, VA

is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:

Asbestos Fiber Analysis

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated January 2009).

2019-04-01 through 2020-03-31
Effective Dates

For the National Voluntary Laboratory Accreditation Program

National Voluntary Laboratory Accreditation Program

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

SanAir Technologies Laboratory, Inc.
1551 Oakbridge Drive
Suite B
Powhatan, VA 23139
Ms. Sandra Sobrino
Phone: 804-897-1177 Fax: 804-897-0070
Email: ssobrino@sanair.com
http://www.sanair.com

ASBESTOS FIBER ANALYSIS **NVLAP LAB CODE 200870-0**

Bulk Asbestos Analysis

Code	Description
18/A01	EPA -- 40 CFR Appendix E to Subpart E of Part 763, Interim Method of the Determination of Asbestos in Bulk Insulation Samples
18/A03	EPA 600/R-93/116: Method for the Determination of Asbestos in Bulk Building Materials

Airborne Asbestos Analysis

Code	Description
18/A02	U.S. EPA's "Interim Transmission Electron Microscopy Analytical Methods-Mandatory and Nonmandatory-and Mandatory Section to Determine Completion of Response Actions" as found in 40 CFR, Part 763, Subpart E, Appendix A.

For the National Voluntary Laboratory Accreditation Program

Phoenix EnviroCorp

June 1, 2021

Mark Avant
Coastal Carolina University
Facilities Maintenance
P.O. Box 261954
Conway, SC 29528-6054

Re: PEC Job # 21-21-162-AB-I; Coastal Carolina University, Kimbel Library, 376 University Boulevard, Conway, SC – Asbestos Bulk Sampling Report

On May 11, 2021 and May 25, 2021, Phoenix EnviroCorp (PEC) representative Tommie Green (South Carolina Consultant/Project Designer #PD-00123, South Carolina Consultant/Management Planner #MP-00184) performed an asbestos survey on materials specified by the client that may be disturbed during a planned renovation.

According to the client, building materials in the following areas may also be affected during the planned renovation: the men's and women's restrooms on the 1st and 2nd floors, the elevator, the front and rear stairs, and the Starbucks area. Suspect asbestos materials in these areas shall be sampled prior to disturbance.

Fiberglass insulation with plastic covering on all pipe elbows in the front left mechanical room, except the chilled water line.

The collected samples were placed into individual sample containers, sealed, and assigned a unique identification number at the time of collection. The sample information was logged onto a chain of custody/laboratory request form and submitted to a third-party laboratory for analysis.

The completion of this survey included the collection of one-hundred seven (107) bulk samples. The analysis of these samples was performed by Polarized Light Microscopy (PLM) utilizing dispersion staining techniques. In addition, per South Carolina asbestos regulations, all non-friable organically bound (NOB) materials found to contain less than one percent (<1%) asbestos per PLM analysis are required to be re-analyzed utilizing Transmission Electron Microscopy (TEM) analysis. Any multi-layered samples/ heterogeneous samples analyzed were first separated into sub-samples and analyzed separately per EPA protocol. Positive stop instructions were issued for all homogeneous samples materials that previously tested positive for asbestos content. Upon completion of analysis, a total of one-hundred sixty-one (161) samples were analyzed via PLM and forty-three (43) NOB materials were analyzed via TEM. The results are enclosed in this report.

Note: For directional purposes "front" is determined by facing University Boulevard from inside the building, unless otherwise stated.

Asbestos Results

Of the homogeneous materials sampled, the following were found to contain greater than one percent (>1%) asbestos following the required analysis and are considered to be asbestos-containing:

- **No materials were found to be asbestos-containing**

Of the homogeneous materials sampled, the following were found to contain less than one percent (<1%) asbestos following the required analysis and are considered to be non-asbestos-containing:

- Mastic associated with multicolored carpet located throughout the 1st and 2nd floors - **None detected**
- Mastic associated with base cove installed with multicolored carpet located throughout the 1st and 2nd floors - **None detected**
- Drywall/joint compound located on the front wall of the 1st and 2nd floors **- None detected**
- Wallpaper on the front wall of the 1st floor **- None detected**
- Batt insulation backing located in the front wall cavity on the 1st and 2nd floors **- None detected**
- Vinyl flooring system under the carpet in office areas on the 1st floor. Two layers in some areas **- None detected**
- Mastic associated with brown carpet located in the rear left area of the 2nd floor – **None detected**
- Mastic associated with base cove installed with brown carpet located in the rear left area of the 2nd floor– **None detected**
- Mastic associated with green flower-patterned carpet located in the front right area of the 2nd floor – **None detected**
- Mastic associated with base cove installed with green flower-patterned carpet located in the front right area of the 2nd floor – **None detected**
- Insulation covering on approximately 2-inch fiberglass insulated city water pipe located in the front left mechanical room– **< 1% Chrysotile asbestos**
- Insulation covering on approximately 3-inch fiberglass insulated pipe connected to the city water pipe located in the front left mechanical room – **None detected**
- Flange on approximately 3-inch pipe connected to the city water pipe located in the front left mechanical room – **None detected**
- Insulation covering on approximately 2-inch fiberglass insulated hot water make-up pipe located in the front left mechanical room **– None detected**
- Flange on approximately 2 inch hot water make-up pipe located in the front left mechanical room **– None detected**
- Insulation covering on "Chiller" tank located in the front left mechanical room **– None detected**
- Insulation covering on approximately 6-inch fiberglass insulated pipe connected to the "Chiller" tank located in the front left mechanical room **– None detected**
- Flange on approximately 6-inch fiberglass insulated pipe connected to the "Chiller" tank located in the front left mechanical room **– None detected**
- White mastic on HVAC ductwork located in the front left mechanical room **– None detected**
- Brown mastic on HVAC ductwork located in the front left mechanical room **– None detected**

- Insulation on approximately 6-inch Chilled water pipe located in the front left mechanical room **– None detected**
- Elbow on approximately 6-inch Chilled water pipe located in the front left mechanical room **– None detected**
- Flange on approximately 6-inch Chilled water pipe located in the front left mechanical room **– None detected**
- Insulation covering on approximately 4-inch soft/fiberglass insulated pipe connected to B-1 equipment located in the front left mechanical room **– None detected**
- Flange on approximately 4-inch soft/fiberglass insulated pipe connected to B1 equipment located in the front left mechanical room **– None detected**
- Insulation on approximately 3-inch hard insulated pipe connected to B-1 equipment located in the front left mechanical room **– None detected**
- Flange on approximately 3-inch hard insulated pipe connected to B-1 equipment located in the front left mechanical room **– None detected**
- Insulation on approximately 4-inch hard insulated pipe connected to the chilled water line located in the front left mechanical room **– None detected**
- Flange on approximately 4-inch hard insulated pipe connected to the chilled water line located in the front left mechanical room **– None detected**
- Insulation covering on approximately 2-inch fiberglass insulated pipe connected to the air handler located in the front left mechanical room **– None detected**
- Base molding located in the front left mechanical room **– None detected**
- HVAC system expansion joint located in the front left mechanical room **– None detected**
- Ceiling drywall/joint compound located in the front left mechanical room **– None detected**
- Ceiling cavity batt insulation backing located in the front left mechanical room **– None detected**

Conclusions: No suspect asbestos materials were found to be asbestos containing.

Enclosed in this report are the inspector accreditation, lab accreditation, asbestos analysis forms, Chain of Custody, and photographic documentation.

Should you have any questions, please do not hesitate to call.

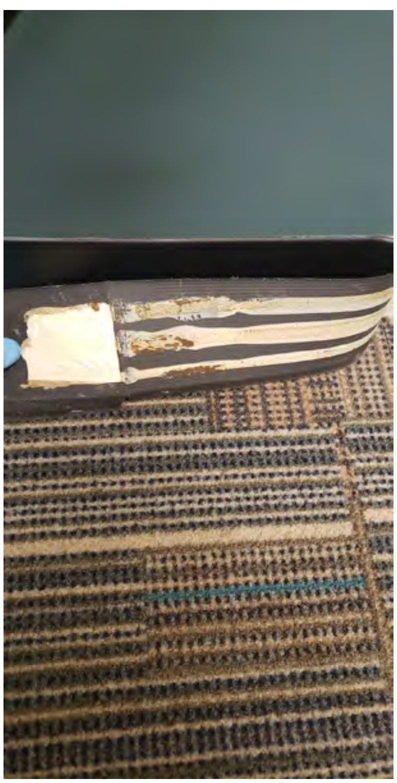
Thank you,

Tommie Green
Asbestos Inspector
SC Consultant Project Designer PD-00123
SC Consultant/Management Planner MP-00184

Photo 1

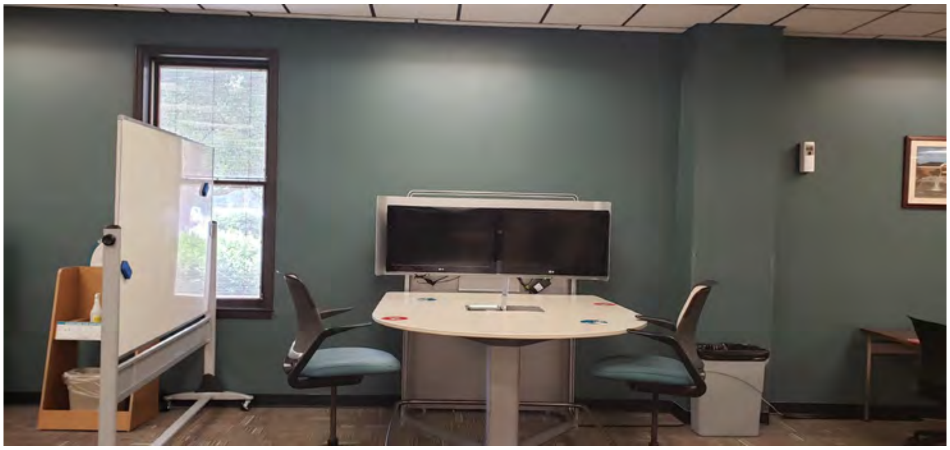
Mastic associated with multicolored carpet located throughtout the 1st & 2nd floors

Photo 2



Mastic associated with base cove installed with multicolored carpet located throughout the 1st & 2nd floors

Photo 3



Drywall/joint compound located on the front wall of the 1st & 2nd floors

Photo 4

Wallpaper on the front wall of the 1st floor

Photo 5

Vinyl flooring system under carpet in office areas on the 1st floor
Two layers in some areas

Photo 6

Mastic associated with multicolored carpet located throughout the 2nd floor

Photo 7

Mastic associated with base cove installed with brown carpet located in the rear left area of the 2nd floor

Photo 8

Mastic associated with green flower patterned carpet located in the front right area of the 2nd floor

Photo 9

Mastic associated with base cove installed with green flower patterned carpet located in the front right area of the 2nd floor

Photo 1

Insulation covering on approximately 2-inch fiberglass insulated city water pipe located in the front left mechanical room

Photo 2

Insulation covering on approximately 3-inch fiberglass insulated pipe connected to the city water pipe located in the front left mechanical room

Photo 3

Insulation covering on approximately 2-inch fiberglass insulated hot water make-up pipe located in the front left mechanical room

Photo 4

Insulation covering on "Chiller" tank located in the front left mechanical room

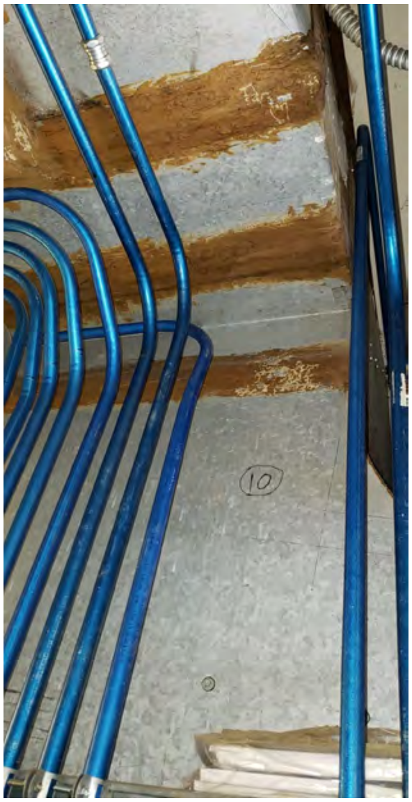
Photo 5

Insulation covering on approximately 6-inch fiberglass insulated pipe connected to the "Chiller" tank located in the front left mechanical room

Photo 6

White mastic on HVAC ductwork located in the front left mechanical room

Photo 7



Brown mastic on HVAC ductwork located in the front left mechanical room

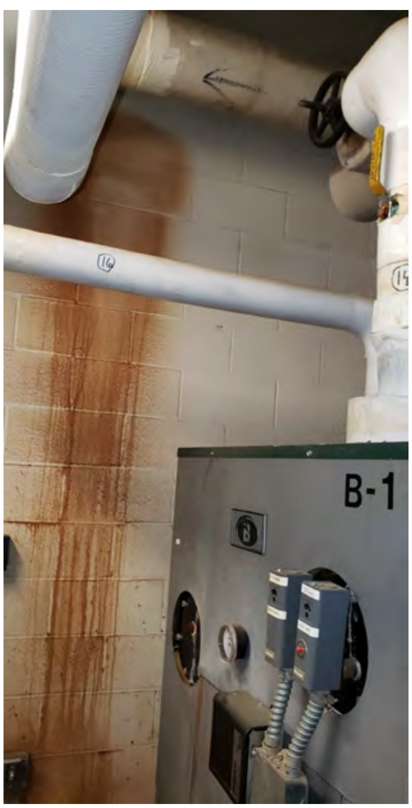
Photo 8

Insulation on approximately 6-inch Chilled water pipe located in the front left mechanical room

Photo 9

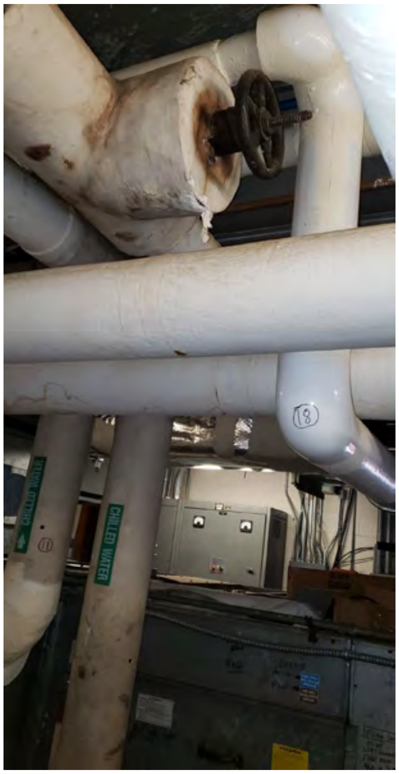
Insulation covering on approximately 4-inch soft/fiberglass insulated pipe connected to B-1 equipment located in the front left mechanical room

Photo 10



Insulation on approximately 3-inch hard insulated pipe connected to B-1 equipment located in the front left mechanical room

Photo 11



Insulation on approximately 4-inch hard insulated pipe connected to the chilled water line located in the front left mechanical room

Photo 12

Insulation covering on approximately 2-inch fiberglass insulated pipe connected to the air handler located in the front left mechanical room

Photo 13

Base molding located in the front left mechanical room

Photo 14

HVAC system expansion joint located in the front left mechanical room

SanAir Technologies Laboratory

The Identification Specialists

Analysis Report prepared for Phoenix EnviroCorp

Report Date: 5/14/2021

Project Name: Coastal Carolina Univeristy-Kimbel Library

Project #: 21-21-162-AB-I

SanAir ID#: 21023177

NVLAP® TESTING

NVLAP LAB CODE 200870-0

1551 Oakbridge Dr. Suite B | Powhatan, Virginia 23139-8061
888.895.1177 | 804.897.1177 | fax: 804.897.0070 | IAQ@SanAir.com | SanAir.com

SanAir ID Number
21023177
FINAL REPORT
5/14/2021 1:53:04 PM

Name: Phoenix EnviroCorp
Address: 4020 Shipyard Blvd
Wilmington, NC 28403
Phone: 910-397-0370

Project Number: 21-21-162-AB-I
P.O. Number:
Project Name: Coastal Carolina Univeristy-Kimbel Library
Collected Date: 5/11/2021
Received Date: 5/13/2021 9:40:00 AM

Dear Tommie Green,

We at SanAir would like to thank you for the work you recently submitted. The 11 sample(s) were received on Thursday, May 13, 2021 via FedEx. The final report(s) is enclosed for the following sample(s): 051121-TG-03, 051121-TG-06, 051121-TG-11, 051121-TG-14, 051121-TG-17, 051121-TG-20, 051121-TG-23, 051121-TG-26, 051121-TG-29, 051121-TG-32, 051121-TG-35.

These results only pertain to this job and should not be used in the interpretation of any other job. This report is only complete in its entirety. Refer to the listing below of the pages included in a complete final report.

Sincerely,

Sandra Sobrino

Sandra Sobrino
Asbestos & Materials Laboratory Manager
SanAir Technologies Laboratory

Final Report Includes:
- Cover Letter
- Analysis Pages
- Disclaimers and Additional Information

Sample conditions:
- 11 samples in Good condition.

SanAir Technologies Laboratory

SanAir ID Number
21023177
FINAL REPORT
5/14/2021 1:53:04 PM

Name: Phoenix EnviroCorp
Address: 4020 Shipyard Blvd
Wilmington, NC 28403
Phone: 910-397-0370

Project Number: 21-21-162-AB-I
P.O. Number:
Project Name: Coastal Carolina Univeristy-Kimbel Library
Collected Date: 5/11/2021
Received Date: 5/13/2021 9:40:00 AM

Analyst: Tallert, Jonathan

Asbestos Bulk TEM EPA NOB EPA 600/R-93/116

Sample	Appearance	% Other Material	% Non-Asbestos Fibers	Asbestos Types	% Total Asbestos
051121-TG-03 21023177-001 Mastic Assoc With Carpet Located Throughout The 1st & 2nd Fl	Non-Fibrous Homogeneous Blue	100%		None Detected	
051121-TG-06 21023177-002 Mastic Assoc With Base Cove Installed With Carpet Located Th	Non-Fibrous Homogeneous Cream	100%		None Detected	
051121-TG-11 Drywall21023177-003 Drywall/Joint Compound Located On The Front Wall Of The 1st	Non-Fibrous Homogeneous White	100%		None Detected	
051121-TG-11 Joint Compound21023177-003 Drywall/Joint Compound Located On The Front Wall Of The 1st	Non-Fibrous Homogeneous White	100%		None Detected	
051121-TG-14 21023177-004 Wallpaper On The Front Wall Of The 1st Floor	Non-Fibrous Heterogeneous White	100%		None Detected	
051121-TG-17 21023177-005 Batt Insulation Backing Located In The Front Wall Cavity On	Fibrous Heterogeneous Silver	100%		None Detected	

Analyst: [signature]
Analysis Date: 5/14/2021

Approved Signatory: [signature]
Date: 5/14/2021

SanAir Technologies Laboratory

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Project Number: 21-21-162-AB-I
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Collected Date: 5/11/2021
Received Date: 5/13/2021 9:40:00 AM

Analyst: Tallert, Jonathan

Asbestos Bulk TEM EPA NOB EPA 600/R-93/116

Sample	Appearance	% Other Material	% Non-Asbestos Fibers	Asbestos Types	% Total Asbestos
051121-TG-20 Vinyl Flooring21023177-006 Vinyl Flooring System Under Carpet In Offices Areas, Two Lay	Non-Fibrous Heterogeneous Grey	100%		None Detected	
051121-TG-20 Mastic21023177-006 Vinyl Flooring System Under Carpet In Offices Areas, Two Lay	Non-Fibrous Heterogeneous Various	100%		None Detected	
051121-TG-20 Vinyl Flooring21023177-006 Vinyl Flooring System Under Carpet In Offices Areas, Two Lay	Non-Fibrous Homogeneous Brown	100%		None Detected	
051121-TG-20 Underlayment21023177-006 Vinyl Flooring System Under Carpet In Offices Areas, Two Lay	Non-Fibrous Homogeneous Yellow	100%		None Detected	
051121-TG-20 Mastic21023177-006 Vinyl Flooring System Under Carpet In Offices Areas, Two Lay	Non-Fibrous Heterogeneous Beige	100%		None Detected	

Analyst:

Analysis Date: 5/14/2021

Approved Signatory:

Date: 5/14/2021

SanAir Technologies Laboratory

SanAir ID Number
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5/14/2021 1:53:04 PM

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Received Date: 5/13/2021 9:40:00 AM

Analyst: Tallert, Jonathan

Asbestos Bulk TEM EPA NOB EPA 600/R-93/116

Sample	Appearance	% Other Material	% Non-Asbestos Fibers	Asbestos Types	% Total Asbestos
051121-TG-23 21023177-007 Mastic Assoc With Carpet Located Throughout The 2nd Floor	Non-Fibrous Heterogeneous Various	100%		None Detected	
051121-TG-26 21023177-008 Mastic Assoc With Carpet Located In The Rear Left Area Of Th	Non-Fibrous Heterogeneous Yellow	100%		None Detected	
051121-TG-29 21023177-009 Mastic Assoc With Base Cove Installed With Carpet Located In	Non-Fibrous Homogeneous Brown	100%		None Detected	
051121-TG-32 21023177-010 Mastic Assoc With Patterned Carpet Located In The Front Righ	Non-Fibrous Homogeneous Yellow	100%		None Detected	
051121-TG-35 21023177-011 Mastic Assoc With Base Cove Installed With Patterned Carpet	Non-Fibrous Homogeneous Beige	100%		None Detected	

Analyst: 　　　　Approved Signatory:

Analysis Date: 5/14/2021 　　　　Date: 5/14/2021

Disclaimer

The final report cannot be reproduced, except in full, without written authorization from SanAir. The accuracy of the results is dependent upon the client's sampling procedure and information provided to the laboratory by the client. SanAir assumes no responsibility for the sampling procedure and will provide evaluation reports based solely on the sample and information provided by the client. This report may not be used by the client to claim product endorsement by NVLAP or any other agency of the U.S. government.

Phoenix EnviroCorp
4020 SHIPYARD BLVD
WILMINGTON NC 28403

CHAIN OF CUSTODY

21023177

LABORATORY TEST REQUEST

CONTACT: Tommie Green	PHONE: (910) 397-0370 FAX: (910) 313-6094 EMAIL: kmgreen@phoenixenvirocorp.com	DATE SHIPPED:	5/11/2021
EC Job #: 21-21-162-AB-I	CLIENT'S JOB NAME:	Coastal Carolina University - Kimbel Library 376 University Boulevard, Conway, SC 29528	
AMPLE TYPE: Asbestos Bulk (PLM) TEM	NUMBER OF SAMPLES: 24 11	TURN AROUND TIME SPECIFIED: ____ 2 Hr ____ 6 Hr __X__ 24 Hr ____ 48 Hr ____ 3-5 Day	

SPECIAL INSTRUCTIONS: 1.) Stop at first positive for each homogeneous area (HGA). 2.) List positive stops on analysis form. 3.) Separate all layers prior to analysis. 4.) Do not analyze ceramic tile; analyze any associated mastic, grout, mortar, backerboard, etc. . 5.) Do not analyze fiberglass. 6.) Confirm negative results for non-friable, organically bound material with one (1) TEM analysis per HGA. 7.) Any drywall or joint compound HGA that is > 1%, but < 5% shall be re-analyzed (separately) utilizing EPA 400 point count method. 8.) Please email results.

Sample #	Sample Area	Sample Date	HGA	Sq. Footage	Lab Analysis Requested
051121-TG-01	Mastic assoc with multicolored carpet located throughtout the 1st & 2nd floors	05/11/21	1	44,400	PLM
051121-TG-02	Mastic assoc with multicolored carpet located throughtout the 1st & 2nd floors	05/11/21	1		PLM
051121-TG-03	Mastic assoc with multicolored carpet located throughtout the 1st & 2nd floors	05/11/21	1		PLM/TEM - NOB
1121-TG-04	Mastic assoc with base cove installed with multicolored carpet located throughout the 1st & 2nd floors	05/11/21	2	44,400	PLM
1121-TG-05	Mastic assoc with base cove installed with multicolored carpet located throughout the 1st & 2nd floors	05/11/21	2		PLM
1121-TG-06	Mastic assoc with base cove installed with multicolored carpet located throughout the 1st & 2nd floors	05/11/21	2		PLM/TEM - NOB
51121-TG-07	Dryw ll/joint compound located on the front wall of the 1st & 2nd floors	05/11/21	3	2,300	PLM
051121-TG-08	Drywall/joint compound located on the front wall of the 1st & 2nd floors	05/11/21	3		PLM
051121-TG-09	Drywall/joint compound located on the front wall of the 1st & 2nd floors	05/11/21	3		PLM
051121-TG-10	Drywall/joint compound located on the front wall of the 1st & 2nd floors	05/11/21	3		PLM
1121-TG-11	Drywall/joint compound located on the front wall of the 1st & 2nd floors	05/11/21	3		PLM/TEM - NOB
1121-TG-12	Wallpaper on the front wall of the 1st floor	05/11/21	4	1,100	PLM
1121-TG-13	Wallpaper on the front wall of the 1st floor	05/11/21	4		PLM
121-TG-14	Wallpaper on the front wall of the 1st floor	05/11/21	4		PLM/TEM - NOB
121-TG-15	Batt insulation backing located in the front wall cavity on the 1st & 2nd floors	05/11/21	5	2,300	PLM
121-TG-16	Batt insulation backing located in the front wall cavity on the 1st & 2nd floors	05/11/21	5		PLM
51121-TG-17	Batt insulation backing located in the front wall cavity on the 1st & 2nd floors	05/11/21	5		PLM/TEM - NOB
051121-TG-18	Vinyl flooring system under carpet in offices areas. Two layers in some areas	05/11/21	6	3,800	PLM
051121-TG-19	Vinyl flooring system under carpet in offices areas. Two layers in some areas	05/11/21	6		PLM
51121-TG-20	Vinyl flooring system under carpet in offices areas. Two layers in some areas	05/11/21	6		PLM/TEM - NOB

CHAIN OF CUSTODY RECORD

DATE	CONDITION OF SAMPLE	SAMPLES RECEIVED BY	SAMPLES RELEASED BY
5/11/2021	SEALED/GOOD	SIGNATURE AH 5-13-21 9:40AM	SIGNATURE Tommie Green

Phoenix EnviroCorp
4020 SHIPYARD BLVD
WILMINGTON NC 28403

CHAIN OF CUSTODY

21023177

LABORATORY TEST REQUEST

NTACT: Tommie Green	PHONE: (910) 397-0370 FAX: (910) 313-6094 EMAIL: kmgreen@phoenixenvirocorp.com	DATE SHIPPED:	5/11/2021
PEC Job #: 21-21-162-AB-I	CLIENT'S JOB NAME:	Coastal Carolina University - Kimbel Library 376 University Boulevard, Conway, SC 29528	
SAMPLE TYPE: Asbestos Bulk (PLM) TEM	NUMBER OF SAMPLES: 19 4	TURN AROUND TIME SPECIFIED: _____ 2 Hr _____ 6 Hr __X__ 24 Hr _____ 48 Hr _____ 3-5 Day	

SPECIAL INSTRUCTIONS: 1.) Stop at first positive for each homogeneous area (HGA). 2.) List positive stops on analysis form. 3.) Separate all layers prior to analysis. 4.) Do not analyze ceramic tile; analyze any associated mastic, grout, mortar, backerboard, etc. . 5.) Do not analyze fiberglass. 6.) Confirm negative results for non-friable, organically bound material with one (1) TEM analysis per HGA. 7.) Any drywall or joint compound HGA that is > 1%, but < 5% shall be re-analyzed (separately) utilizing EPA 400 point count method. 8.) Please email results.

Sample #	Sample Area	Sample Date	HGA	Sq. Footage	Lab Analysis Requested
1121-TG-21	Mastic assoc with multicolored carpet located throughout the 2nd floor	05/11/21	1	44,400	PLM
1121-TG-22	Mastic assoc with multicolored carpet located throughout the 2nd floor	05/11/21	1		PLM
051121-TG-23	Mastic assoc with multicolored carpet located throughout the 2nd floor	05/11/21	1		PLM/TEM - NOB
051121-TG-24	Mastic assoc with brown carpet located in the rear left area of the 2nd floor	05/11/21	7	1,030	PLM
051121-TG-25	Mastic assoc with brown carpet located in the rear left area of the 2nd floor	05/11/21	7		PLM
051121-TG-26	Mastic assoc with brown carpet located in the rear left area of the 2nd floor	05/11/21	7		PLM/TEM - NOB
51121-TG-27	Mastic assoc with base cove installed with brown carpet located in the rear left area of the 2nd floor	05/11/21	8	134 LF	PLM
51121-TG-28	Mastic assoc with base cove installed with brown carpet located in the rear left area of the 2nd floor	05/11/21	8		PLM
11.1-TG-29	Mastic assoc with base cove installed with brown carpet located in the rear left area of the 2nd floor	05/11/21	8		PLM/TEM - NOB
1121-TG-30	Mastic assoc with green flower patterned carpet located in the front right area of the 2nd floor	05/11/21	9	600	PLM
1121-TG-31	Mastic assoc with green flower patterned carpet located in the front right area of the 2nd floor	05/11/21	9		PLM
051121-TG-32	Mastic assoc with green flower patterned carpet located in the front right area of the 2nd floor	05/11/21	9		PLM/TEM - NOB
051121-TG-33	Mastic assoc with base cove installed with green flower patterned carpet located in the front right area of the 2nd floor	05/11/21	10	71 LF	PLM
051121-TG-34	Mastic assoc with base cove installed with green flower patterned carpet located in the front right area of the 2nd floor	05/11/21	10		PLM
051121-TG-35	Mastic assoc with base cove installed with green flower patterned carpet located in the front right area of the 2nd floor	05/11/21	10		PLM/TEM - NOB

CHAIN OF CUSTODY RECORD

DATE	CONDITION OF SAMPLE	SAMPLES RECEIVED BY	SAMPLES RELEASED BY
5/11/2021	SEALED/GOOD	SIGNATURE AM 5.13.21 9:40Am	SIGNATURE Tommie Green

SanAir Technologies Laboratory

The Identification Specialists

Analysis Report prepared for Phoenix EnviroCorp

Report Date: 5/14/2021

Project Name: Coastal Carolina University-Kimbel Library

Project #: 21-21-162-AB-I

SanAir ID#: 21023172

NVLAP TESTING

NVLAP LAB CODE 200870-0

1551 Oakbridge Dr. Suite B | Powhatan, Virginia 23139-8061
888.895.1177 | 804.897.1177 | fax: 804.897.0070 | IAQ@SanAir.com | SanAir.com

	SanAir ID Number 21023172 FINAL REPORT 5/14/2021 9:37:24 AM

Name: Phoenix EnviroCorp
Address: 4020 Shipyard Blvd
Wilmington, NC 28403
Phone: 910-397-0370

Project Number: 21-21-162-AB-I
P.O. Number:
Project Name: Coastal Carolina University-Kimbel Library
Collected Date: 5/11/2021
Received Date: 5/13/2021 9:40:00 AM

Dear Tommie Green,

We at SanAir would like to thank you for the work you recently submitted. The 35 sample(s) were received on Thursday, May 13, 2021 via FedEx. The final report(s) is enclosed for the following sample(s): 051121-TG-01, 051121-TG-02, 051121-TG-03, 051121-TG-04, 051121-TG-05, 051121-TG-06, 051121-TG-07, 051121-TG-08, 051121-TG-09, 051121-TG-10, 051121-TG-11, 051121-TG-12, 051121-TG-13, 051121-TG-14, 051121-TG-15, 051121-TG-16, 051121-TG-17, 051121-TG-18, 051121-TG-19, 051121-TG-20, 051121-TG-21, 051121-TG-22, 051121-TG-23, 051121-TG-24, 051121-TG-25, 051121-TG-26, 051121-TG-27, 051121-TG-28, 051121-TG-29, 051121-TG-30, 051121-TG-31, 051121-TG-32, 051121-TG-33, 051121-TG-34, 051121-TG-35.

These results only pertain to this job and should not be used in the interpretation of any other job. This report is only complete in its entirety. Refer to the listing below of the pages included in a complete final report.

Sincerely,

Sandra Sobrino

Sandra Sobrino
Asbestos & Materials Laboratory Manager
SanAir Technologies Laboratory

Final Report Includes:
- Cover Letter
- Analysis Pages
- Disclaimers and Additional Information

Sample conditions:
- 35 samples in Good condition.

SanAir Technologies Laboratory

SanAir ID Number
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Project Name: Coastal Carolina University-Kimbel Library
Collected Date: 5/11/2021
Received Date: 5/13/2021 9:40:00 AM

Analyst: Moore, Brandi

Asbestos Bulk PLM EPA 600/R-93/116

SanAir ID / Description	Stereoscopic Appearance	Components % Fibrous	Components % Non-fibrous	Asbestos Fibers
051121-TG-01 / 21023172-001 Mastic Assoc With Carpet Located Throughout The 1st & 2nd Fl	Various Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-02 / 21023172-002 Mastic Assoc With Carpet Located Throughout The 1st & 2nd Fl	Various Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-03 / 21023172-003 Mastic Assoc With Carpet Located Throughout The 1st & 2nd Fl	Green Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-04 / 21023172-004 Mastic Assoc With Base Cove Installed With Carpet Located Th	Cream Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-05 / 21023172-005 Mastic Assoc With Base Cove Installed With Carpet Located Th	Cream Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-06 / 21023172-006 Mastic Assoc With Base Cove Installed With Carpet Located Th	Cream Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-07 / 21023172-007 Drywall/Joint Compound Located On The Front Wall Of The 1st, Drywall	White Non-Fibrous Homogeneous	5% Cellulose	95% Other	None Detected
051121-TG-07 / 21023172-007 Drywall/Joint Compound Located On The Front Wall Of The 1st, Joint Compound	White Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-08 / 21023172-008 Drywall/Joint Compound Located On The Front Wall Of The 1st, Drywall	White Non-Fibrous Homogeneous	5% Cellulose	95% Other	None Detected

Analyst: Brandi Moore

Analysis Date: 5/14/2021

Approved Signatory: Sandra Sobrino

Date: 5/14/2021

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Analyst: Moore, Brandi

Asbestos Bulk PLM EPA 600/R-93/116

SanAir ID / Description	Stereoscopic Appearance	Components % Fibrous	Components % Non-fibrous	Asbestos Fibers
051121-TG-08 / 21023172-008 Drywall/Joint Compound Located On The Front Wall Of The 1st, Joint Compound	White Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-09 / 21023172-009 Drywall/Joint Compound Located On The Front Wall Of The 1st, Drywall	White Non-Fibrous Homogeneous	5% Cellulose	95% Other	None Detected
051121-TG-09 / 21023172-009 Drywall/Joint Compound Located On The Front Wall Of The 1st, Joint Compound	White Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-10 / 21023172-010 Drywall/Joint Compound Located On The Front Wall Of The 1st, Drywall	White Non-Fibrous Homogeneous	5% Cellulose	95% Other	None Detected
051121-TG-10 / 21023172-010 Drywall/Joint Compound Located On The Front Wall Of The 1st, Joint Compound	White Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-11 / 21023172-011 Drywall/Joint Compound Located On The Front Wall Of The 1st, Drywall	White Non-Fibrous Homogeneous	5% Cellulose	95% Other	None Detected
051121-TG-11 / 21023172-011 Drywall/Joint Compound Located On The Front Wall Of The 1st, Joint Compound	White Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-12 / 21023172-012 Wallpaper On The Front Wall Of The 1st Floor	Various Non-Fibrous Heterogeneous	30% Cellulose	70% Other	None Detected
051121-TG-13 / 21023172-013 Wallpaper On The Front Wall Of The 1st Floor	Various Non-Fibrous Heterogeneous	30% Cellulose	70% Other	None Detected

Analyst: Brandi Moore

Analysis Date: 5/14/2021

Approved Signatory: Sandra Sobrino

Date: 5/14/2021

SanAir ID Number
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Wilmington, NC 28403
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Project Number: 21-21-162-AB-I
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Analyst: Moore, Brandi

Asbestos Bulk PLM EPA 600/R-93/116

SanAir ID / Description	Stereoscopic Appearance	Components % Fibrous	Components % Non-fibrous	Asbestos Fibers
051121-TG-14 / 21023172-014 Wallpaper On The Front Wall Of The 1st Floor	Various Non-Fibrous Heterogeneous	30% Cellulose	70% Other	None Detected
051121-TG-15 / 21023172-015 Batt Insulation Backing Located In The Front Wall Cavity On	Black Fibrous Heterogeneous	55% Cellulose	45% Other	None Detected
051121-TG-16 / 21023172-016 Batt Insulation Backing Located In The Front Wall Cavity On	Black Fibrous Heterogeneous	55% Cellulose	45% Other	None Detected
051121-TG-17 / 21023172-017 Batt Insulation Backing Located In The Front Wall Cavity On	Black Fibrous Heterogeneous	55% Cellulose	45% Other	None Detected
051121-TG-18 / 21023172-018 Vinyl Flooring System Under Carpet In Offices Areas, Two Lay, Vinyl Flooring	Various Non-Fibrous Heterogeneous		100% Other	None Detected
051121-TG-18 / 21023172-018 Vinyl Flooring System Under Carpet In Offices Areas, Two Lay, Mastic	Yellow Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-19 / 21023172-019 Vinyl Flooring System Under Carpet In Offices Areas, Two Lay, Vinyl Flooring	Various Non-Fibrous Heterogeneous		100% Other	None Detected
051121-TG-19 / 21023172-019 Vinyl Flooring System Under Carpet In Offices Areas, Two Lay, Mastic	Yellow Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-19 / 21023172-019 Vinyl Flooring System Under Carpet In Offices Areas, Two Lay, Vinyl Flooring	Grey Non-Fibrous Heterogeneous	25% Cellulose	75% Other	None Detected

Analyst: Brandi Moore

Analysis Date: 5/14/2021

Approved Signatory: Sandra Sobrino

Date: 5/14/2021

SanAir Technologies Laboratory

SanAir ID Number
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Collected Date: 5/11/2021
Received Date: 5/13/2021 9:40:00 AM

Analyst: Moore, Brandi

Asbestos Bulk PLM EPA 600/R-93/116

	Stereoscopic	Components		
SanAir ID / Description	**Appearance**	**% Fibrous**	**% Non-fibrous**	**Asbestos Fibers**
051121-TG-19 / 21023172-019 Vinyl Flooring System Under Carpet In Offices Areas, Two Lay, Mastic	Various Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-20 / 21023172-020 Vinyl Flooring System Under Carpet In Offices Areas, Two Lay, Vinyl Flooring	Various Non-Fibrous Heterogeneous		100% Other	None Detected
051121-TG-20 / 21023172-020 Vinyl Flooring System Under Carpet In Offices Areas, Two Lay, Mastic	Yellow Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-20 / 21023172-020 Vinyl Flooring System Under Carpet In Offices Areas, Two Lay, Vinyl Flooring	Grey Non-Fibrous Heterogeneous	25% Cellulose	75% Other	None Detected
051121-TG-20 / 21023172-020 Vinyl Flooring System Under Carpet In Offices Areas, Two Lay, Mastic	Various Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-21 / 21023172-021 Mastic Assoc With Carpet Located Throughout The 2nd Floor, Mastic	Various Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-21 / 21023172-021 Mastic Assoc With Carpet Located Throughout The 2nd Floor, Leveler	White Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-22 / 21023172-022 Mastic Assoc With Carpet Located Throughout The 2nd Floor	Various Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-23 / 21023172-023 Mastic Assoc With Carpet Located Throughout The 2nd Floor	Various Non-Fibrous Homogeneous		100% Other	None Detected

Analyst: Brandi Moore

Approved Signatory: Sandra Sobrino

Analysis Date: 5/14/2021

Date: 5/14/2021

SanAir Technologies Laboratory

SanAir ID Number
21023172
FINAL REPORT
5/14/2021 9:37:24 AM

Name: Phoenix EnviroCorp
Address: 4020 Shipyard Blvd
Wilmington, NC 28403
Phone: 910-397-0370

Project Number: 21-21-162-AB-I
P.O. Number:
Project Name: Coastal Carolina University-Kimbel Library
Collected Date: 5/11/2021
Received Date: 5/13/2021 9:40:00 AM

Analyst: Moore, Brandi

Asbestos Bulk PLM EPA 600/R-93/116

SanAir ID / Description	Stereoscopic Appearance	Components % Fibrous	Components % Non-fibrous	Asbestos Fibers
051121-TG-24 / 21023172-024 Mastic Assoc With Carpet Located In The Rear Left Area Of Th	Yellow Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-25 / 21023172-025 Mastic Assoc With Carpet Located In The Rear Left Area Of Th	Yellow Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-26 / 21023172-026 Mastic Assoc With Carpet Located In The Rear Left Area Of Th, Mastic	Yellow Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-26 / 21023172-026 Mastic Assoc With Carpet Located In The Rear Left Area Of Th, Leveler	Grey Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-27 / 21023172-027 Mastic Assoc With Base Cove Installed With Carpet Located In, Mastic	Yellow Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-27 / 21023172-027 Mastic Assoc With Base Cove Installed With Carpet Located In, Mastic	Cream Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-28 / 21023172-028 Mastic Assoc With Base Cove Installed With Carpet Located In, Mastic	Cream Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-28 / 21023172-028 Mastic Assoc With Base Cove Installed With Carpet Located In, Mastic	Brown Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-29 / 21023172-029 Mastic Assoc With Base Cove Installed With Carpet Located In, Mastic	Cream Non-Fibrous Homogeneous		100% Other	None Detected

Analyst: Brandi Moore
Analysis Date: 5/14/2021

Approved Signatory: Sandra Sobrino
Date: 5/14/2021

SanAir Technologies Laboratory

SanAir ID Number
21023172
FINAL REPORT
5/14/2021 9:37:24 AM

Name: Phoenix EnviroCorp
Address: 4020 Shipyard Blvd
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Project Number: 21-21-162-AB-I
P.O. Number:
Project Name: Coastal Carolina University-Kimbel Library
Collected Date: 5/11/2021
Received Date: 5/13/2021 9:40:00 AM

Analyst: Moore, Brandi

Asbestos Bulk PLM EPA 600/R-93/116

SanAir ID / Description	Stereoscopic Appearance	Components % Fibrous	% Non-fibrous	Asbestos Fibers
051121-TG-29 / 21023172-029 Mastic Assoc With Base Cove Installed With Carpet Located In, Mastic	Brown Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-30 / 21023172-030 Mastic Assoc With Patterned Carpet Located In The Front Righ, Mastic	Yellow Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-30 / 21023172-030 Mastic Assoc With Patterned Carpet Located In The Front Righ, Leveler	White Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-31 / 21023172-031 Mastic Assoc With Patterned Carpet Located In The Front Righ	Yellow Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-32 / 21023172-032 Mastic Assoc With Patterned Carpet Located In The Front Righ	Yellow Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-33 / 21023172-033 Mastic Assoc With Base Cove Installed With Patterned Carpet	Cream Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-34 / 21023172-034 Mastic Assoc With Base Cove Installed With Patterned Carpet	Cream Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-35 / 21023172-035 Mastic Assoc With Base Cove Installed With Patterned Carpet, Mastic	Cream Non-Fibrous Homogeneous		100% Other	None Detected
051121-TG-35 / 21023172-035 Mastic Assoc With Base Cove Installed With Patterned Carpet, Mastic	Brown Non-Fibrous Homogeneous		100% Other	None Detected

Analyst: Brandi Moore

Approved Signatory: Sandra Sobrino

Analysis Date: 5/14/2021

Date: 5/14/2021

Disclaimer

This report is the sole property of the client named on the SanAir Technologies Laboratory chain-of-custody (COC). Results in the report are confidential information intended only for the use by the customer listed on the COC. Neither results nor reports will be discussed with or released to any third party without our client's written permission. The final report shall not be reproduced except in full without written approval of the laboratory to assure that parts of the report are not taken out of context. The information provided in this report applies only to the samples submitted and is relevant only for the date, time, and location of sampling. The accuracy of the results is dependent upon the client's sampling procedure and information provided to the laboratory by the client. SanAir assumes no responsibility for the sampling procedure and will provide evaluation reports based solely on the sample(s) in the condition in which they arrived at the laboratory and information provided by the client on the COC, such as: project number, project name, collection dates, po number, special instructions, samples collected by, sample numbers, sample identifications, sample type, selected analysis type, flow rate, total volume or area, and start stop times that may affect the validity of the results in this report. Samples were received in good condition unless otherwise noted on the report. SanAir assumes no responsibility or liability for the manner in which the results are used or interpreted. This report does not constitute and shall not be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any other U.S. governmental agencies and may not be certified by every local, state, and federal regulatory agencies.

Samples are held for a period of 60 days. Fibers smaller than 5 microns cannot be seen with this method due to scope limitations.

For NY state samples, method EPA 600/M4-82-020 is performed.

NYELAP Disclaimer:
Polarized- light microscopy is not consistently reliable in detecting asbestos in floor covering and similar non-friable organically bound materials. Quantitative transmission electron microscopy is currently the only method that can be used to determine if this material can be considered or treated as non-asbestos containing.

<u>Asbestos Certifications</u>
NVLAP lab code 200870-0
City of Philadelphia: ALL-460
PA Department of Environmental Protection Number: 68-05397
California License Number: 2915
Colorado License Number: AL-23143
Connecticut License Number: PH-0105
Massachusetts License Number: AA000222
Maine License Number: LB-0075, LA-0084
New York ELAP lab ID: 11983
Rhode Island License Number: PCM00126, PLM00126, TEM00126
Texas Department of State Health Services License Number: 300440
Commonwealth of Virginia 3333000323
Washington State License Number: C989
West Virginia License Number: LT000616
Vermont License: AL166318
Louisiana Department of Environmental Quality: 212253, Cert 05088

Revision Date: 8/14/2020

Phoenix EnviroCorp
4020 SHIPYARD BLVD.
WILMINGTON, NC 28403

CHAIN OF COUSTODY

21023172

LABORATORY TEST REQUEST

CONTACT: Tommie Green	PHONE: (910) 397-0370 FAX: (910) 313-6094 EMAIL: kmgreen@phoenixenvirocorp.com	DATE SHIPPED: 5/11/2021
PEC Job #: 21-21-162-AB-I	CLIENT'S JOB NAME: Coastal Carolina University - Kimbel Library 376 University Boulevard, Conway, SC 29528	
SAMPLE TYPE: Asbestos Bulk (PLM) TEM	NUMBER OF SAMPLES: 24 11	TURN AROUND TIME SPECIFIED: ____ 2 Hr ____ 6 Hr __X__ 24 Hr ____ 48 Hr ____ 3-5 Day

SPECIAL INSTRUCTIONS: 1.) Stop at first positive for each homogeneous area (HGA). 2.) List positive stops on analysis form. 3.) Separate all layers prior to analysis. 4.) Do not analyze ceramic tile; analyze any associated mastic, grout, mortar, backerboard, etc. . 5.) Do not analyze fiberglass. 6.) Confirm negative results for non-friable, organically bound material with one (1) TEM analysis per HGA. 7.) Any drywall or joint compound HGA that is > 1%, but < 5% shall be re-analyzed (separately) utilizing EPA 400 point count method. 8.) Please email results.

Sample #	Sample Area	Sample Date	HGA	Sq. Footage	Lab Analysis Requested
051121-TG-01	Mastic assoc with multicolored carpet located throughtout the 1st & 2nd floors	05/11/21	1	44,400	PLM
051121-TG-02	Mastic assoc with multicolored carpet located throughtout the 1st & 2nd floors	05/11/21	1		PLM
051121-TG-03	Mastic assoc with multicolored carpet located throughtout the 1st & 2nd floors	05/11/21	1		PLM/TEM - NOB
051121-TG-04	Mastic assoc with base cove installed with multicolored carpet located throughout the 1st & 2nd floors	05/11/21	2	44,400	PLM
051121-TG-05	Mastic assoc with base cove installed with multicolored carpet located throughout the 1st & 2nd floors	05/11/21	2		PLM
051121-TG-06	Mastic assoc with base cove installed with multicolored carpet located throughout the 1st & 2nd floors	05/11/21	2		PLM/TEM - NOB
051121-TG-07	Drywall/joint compound located on the front wall of the 1st & 2nd floors	05/11/21	3	2,300	PLM
051121-TG-08	Drywall/joint compound located on the front wall of the 1st & 2nd floors	05/11/21	3		PLM
051121-TG-09	Drywall/joint compound located on the front wall of the 1st & 2nd floors	05/11/21	3		PLM
051121-TG-10	Drywall/joint compound located on the front wall of the 1st & 2nd floors	05/11/21	3		PLM
051121-TG-11	Drywall/joint compound located on the front wall of the 1st & 2nd floors	05/11/21	3		PLM/TEM - NOB
051121-TG-12	Wallpaper on the front wall of the 1st floor	05/11/21	4	1,100	PLM
051121-TG-13	Wallpaper on the front wall of the 1st floor	05/11/21	4		PLM
051121-TG-14	Wallpaper on the front wall of the 1st floor	05/11/21	4		PLM/TEM - NOB
051121-TG-15	Batt insulation backing located in the front wall cavity on the 1st & 2nd floors	05/11/21	5	2,300	PLM
051121-TG-16	Batt insulation backing located in the front wall cavity on the 1st & 2nd floors	05/11/21	5		PLM
051121-TG-17	Batt insulation backing located in the front wall cavity on the 1st & 2nd floors	05/11/21	5		PLM/TEM - NOB
051121-TG-18	Vinyl flooring system under carpet in offices areas. Two layers in some areas	05/11/21	6	3,800	PLM
051121-TG-19	Vinyl flooring system under carpet in offices areas. Two layers in some areas	05/11/21	6		PLM
051121-TG-20	Vinyl flooring system under carpet in offices areas. Two layers in some areas	05/11/21	6		PLM/TEM - NOB

CHAIN OF CUSTODY RECORD

DATE	CONDITION OF SAMPLE	SAMPLES RECEIVED BY	SAMPLES RELEASED BY
5/11/2021	SEALED/GOOD	SIGNATURE AH 5.13.21 9:40am	SIGNATURE Tommie Green

Phoenix EnviroCorp
4020 SHIPYARD BLVD.
WILMINGTON, NC 28403

CHAIN OF COUSTODY

21023172

LABORATORY TEST REQUEST

CONTACT: Tommie Green	PHONE: (910) 397-0370 FAX: (910) 313-6094 EMAIL: kmgreen@phoenixenvirocorp.com	DATE SHIPPED:	5/11/2021
PEC Job #: 21-21-162-AB-I	CLIENT'S JOB NAME:	Coastal Carolina University - Kimbel Library 376 University Boulevard, Conway, SC 29528	
SAMPLE TYPE: Asbestos Bulk (PLM) TEM	NUMBER OF SAMPLES: 19 4	TURN AROUND TIME SPECIFIED: ____ 2 Hr ____ 6 Hr __X__ 24 Hr ____ 48 Hr ____ 3-5 Day	

SPECIAL INSTRUCTIONS: 1.) Stop at first positive for each homogeneous area (HGA). 2.) List positive stops on analysis form. 3.) Separate all layers prior to analysis. 4.) Do not analyze ceramic tile; analyze any associated mastic, grout, mortar, backerboard, etc. . 5.) Do not analyze fiberglass. 6.) Confirm negative results for non-friable, organically bound material with one (1) TEM analysis per HGA. 7.) Any drywall or joint compound HGA that is > 1%, but < 5% shall be re-analyzed (separately) utilizing EPA 400 point count method. 8.) Please email results.

Sample #	Sample Area	Sample Date	HGA	Sq. Footage	Lab Analysis Requested
051121-TG-21	Mastic assoc with multicolored carpet located throughout the 2nd floor	05/11/21	1	44,400	PLM
051121-TG-22	Mastic assoc with multicolored carpet located throughout the 2nd floor	05/11/21	1		PLM
051121-TG-23	Mastic assoc with multicolored carpet located throughout the 2nd floor	05/11/21	1		PLM/TEM - NOB
051121-TG-24	Mastic assoc with brown carpet located in the rear left area of the 2nd floor	05/11/21	7	1,030	PLM
051121-TG-25	Mastic assoc with brown carpet located in the rear left area of the 2nd floor	05/11/21	7		PLM
051121-TG-26	Mastic assoc with brown carpet located in the rear left area of the 2nd floor	05/11/21	7		PLM/TEM - NOB
051121-TG-27	Mastic assoc with base cove installed with brown carpet located in the rear left area of the 2nd floor	05/11/21	8	134 LF	PLM
051121-TG-28	Mastic assoc with base cove installed with brown carpet located in the rear left area of the 2nd floor	05/11/21	8		PLM
051121-TG-29	Mastic assoc with base cove installed with brown carpet located in the rear left area of the 2nd floor	05/11/21	8		PLM/TEM - NOB
051121-TG-30	Mastic assoc with green flower patterned carpet located in the front right area of the 2nd floor	05/11/21	9	600	PLM
051121-TG-31	Mastic assoc with green flower patterned carpet located in the front right area of the 2nd floor	05/11/21	9		PLM
051121-TG-32	Mastic assoc with green flower patterned carpet located in the front right area of the 2nd floor	05/11/21	9		PLM/TEM - NOB
051121-TG-33	Mastic assoc with base cove installed with green flower patterned carpet located in the front right area of the 2nd floor	05/11/21	10	71 LF	PLM
051121-TG-34	Mastic assoc with base cove installed with green flower patterned carpet located in the front right area of the 2nd floor	05/11/21	10		PLM
051121-TG-35	Mastic assoc with base cove installed with green flower patterned carpet located in the front right area of the 2nd floor	05/11/21	10		PLM/TEM - NOB

CHAIN OF CUSTODY RECORD

DATE	CONDITION OF SAMPLE	SAMPLES RECEIVED BY	SAMPLES RELEASED BY
5/11/2021	SEALED/GOOD	SIGNATURE AM 5-13-21 9:40Am	SIGNATURE [signature]

SanAir Technologies Laboratory

The Identification Specialists

Analysis Report prepared for Phoenix EnviroCorp

Report Date: 5/28/2021

Project Name: Coastal Carolina University-Kimbel Library

Project #: 21-21-162-AB-I

SanAir ID#: 21025973

NVLAP TESTING

NVLAP LAB CODE 200870-0

1551 Oakbridge Dr. Suite B | Powhatan, Virginia 23139-8061
888.895.1177 | 804.897.1177 | fax: 804.897.0070 | IAQ@SanAir.com | SanAir.com

SanAir ID Number
21025973
FINAL REPORT
5/28/2021 11:06:59 AM

Name: Phoenix EnviroCorp
Address: 4020 Shipyard Blvd
Wilmington, NC 28403
Phone: 910-397-0370

Project Number: 21-21-162-AB-I
P.O. Number:
Project Name: Coastal Carolina University-Kimbel Library
Collected Date: 5/25/2021
Received Date: 5/27/2021 10:00:00 AM

Dear Tommie Green,

We at SanAir would like to thank you for the work you recently submitted. The 72 sample(s) were received on Thursday, May 27, 2021 via FedEx. The final report(s) is enclosed for the following sample(s): 052521-TG-01, 052521-TG-02, 052521-TG-03, 052521-TG-04, 052521-TG-05, 052521-TG-06, 052521-TG-07, 052521-TG-08, 052521-TG-09, 052521-TG-10, 052521-TG-11, 052521-TG-12, 052521-TG-13, 052521-TG-14, 052521-TG-15, 052521-TG-16, 052521-TG-17, 052521-TG-18, 052521-TG-19, 052521-TG-20, 052521-TG-21, 052521-TG-22, 052521-TG-23, 052521-TG-24, 052521-TG-25, 052521-TG-26, 052521-TG-27, 052521-TG-28, 052521-TG-29, 052521-TG-30, 052521-TG-31, 052521-TG-32, 052521-TG-33, 052521-TG-34, 052521-TG-35, 052521-TG-36, 052521-TG-37, 052521-TG-38, 052521-TG-39, 052521-TG-40, 052521-TG-41, 052521-TG-42, 052521-TG-43, 052521-TG-44, 052521-TG-45, 052521-TG-46, 052521-TG-47, 052521-TG-48, 052521-TG-49, 052521-TG-50, 052521-TG-51, 052521-TG-52, 052521-TG-53, 052521-TG-54, 052521-TG-55, 052521-TG-56, 052521-TG-57, 052521-TG-58, 052521-TG-59, 052521-TG-60, 052521-TG-61, 052521-TG-62, 052521-TG-63, 052521-TG-64, 052521-TG-65, 052521-TG-66, 052521-TG-67, 052521-TG-68, 052521-TG-69, 052521-TG-70, 052521-TG-71, 052521-TG-72.

These results only pertain to this job and should not be used in the interpretation of any other job. This report is only complete in its entirety. Refer to the listing below of the pages included in a complete final report.

Sincerely,

Sandra Sobrino

Sandra Sobrino
Asbestos & Materials Laboratory Manager
SanAir Technologies Laboratory

Final Report Includes:
- Cover Letter
- Analysis Pages
- Disclaimers and Additional Information

Sample conditions:
- 72 samples in Good condition.

SanAir Technologies Laboratory

SanAir ID Number
21025973
FINAL REPORT
5/28/2021 11:06:59 AM

Name: Phoenix EnviroCorp
Address: 4020 Shipyard Blvd
Wilmington, NC 28403
Phone: 910-397-0370

Project Number: 21-21-162-AB-I
P.O. Number:
Project Name: Coastal Carolina University-Kimbel Library
Collected Date: 5/25/2021
Received Date: 5/27/2021 10:00:00 AM

Analyst: Hogrefe, Sarah

Asbestos Bulk PLM EPA 600/R-93/116

SanAir ID / Description	Stereoscopic Appearance	Components % Fibrous	Components % Non-fibrous	Asbestos Fibers
052521-TG-01 / 21025973-001 Insulation Covering On Approx 2" Fiberglass Insulated City W	White Fibrous Heterogeneous	50% Cellulose 25% Glass	25% Other	None Detected
052521-TG-02 / 21025973-002 Insulation Covering On Approx 2" Fiberglass Insulated City W	White Fibrous Heterogeneous	50% Cellulose 25% Glass	25% Other	None Detected
052521-TG-03 / 21025973-003 Insulation Covering On Approx 2" Fiberglass Insulated City W	White Fibrous Heterogeneous	50% Cellulose 25% Glass	25% Other	None Detected
052521-TG-04 / 21025973-004 Insulation Covering On Approx 3" Fiberglass Insulated City W	White Fibrous Heterogeneous	50% Cellulose 25% Glass	25% Other	None Detected
052521-TG-05 / 21025973-005 Insulation Covering On Approx 3" Fiberglass Insulated City W	White Fibrous Heterogeneous	50% Cellulose 25% Glass	25% Other	None Detected
052521-TG-06 / 21025973-006 Insulation Covering On Approx 3" Fiberglass Insulated City W	White Fibrous Heterogeneous	50% Cellulose 25% Glass	25% Other	None Detected
052521-TG-07 / 21025973-007 Flange On Approx 3" Pipe Connected To The City Water Pipe Lo	White Non-Fibrous Heterogeneous	20% Cellulose 5% Glass	75% Other	None Detected
052521-TG-08 / 21025973-008 Flange On Approx 3" Pipe Connected To The City Water Pipe Lo	White Non-Fibrous Heterogeneous	20% Cellulose 5% Glass	75% Other	None Detected
052521-TG-09 / 21025973-009 Flange On Approx 3" Pipe Connected To The City Water Pipe Lo	White Non-Fibrous Heterogeneous	20% Cellulose 5% Glass	75% Other	None Detected
052521-TG-10 / 21025973-010 Insulation Covering On Approx 2" Fiberglass Insulated Hot Wa	White Fibrous Heterogeneous	50% Cellulose 25% Glass	25% Other	None Detected

Analyst: SHogrefe

Analysis Date: 5/28/2021

Approved Signatory: Johnathan Wilson

Date: 5/28/2021

SanAir Technologies Laboratory

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Name: Phoenix EnviroCorp
Address: 4020 Shipyard Blvd
Wilmington, NC 28403
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Analyst: Hogrefe, Sarah

Asbestos Bulk PLM EPA 600/R-93/116

SanAir ID / Description	Stereoscopic Appearance	Components % Fibrous	Components % Non-fibrous	Asbestos Fibers
052521-TG-11 / 21025973-011 Insulation Covering On Approx 2" Fiberglass Insulated Hot Wa	White Fibrous Heterogeneous	50% Cellulose 25% Glass	25% Other	None Detected
052521-TG-12 / 21025973-012 Insulation Covering On Approx 2" Fiberglass Insulated Hot Wa	White Fibrous Heterogeneous	50% Cellulose 25% Glass	25% Other	None Detected
052521-TG-13 / 21025973-013 Flange On Approx 2" Hot Water Make-up Pipe Located In The Fr	White Non-Fibrous Heterogeneous	20% Cellulose 5% Glass	75% Other	None Detected
052521-TG-14 / 21025973-014 Flange On Approx 2" Hot Water Make-up Pipe Located In The Fr	White Non-Fibrous Heterogeneous	20% Cellulose 5% Glass	75% Other	None Detected
052521-TG-15 / 21025973-015 Flange On Approx 2" Hot Water Make-up Pipe Located In The Fr	White Non-Fibrous Heterogeneous	20% Cellulose 5% Glass	75% Other	None Detected
052521-TG-16 / 21025973-016 Insulation Covering On "Chiller" Tank Located In The Front L	White Non-Fibrous Heterogeneous	30% Cellulose 5% Glass	65% Other	None Detected
052521-TG-17 / 21025973-017 Insulation Covering On "Chiller" Tank Located In The Front L	White Non-Fibrous Heterogeneous	25% Cellulose 5% Glass	70% Other	None Detected
052521-TG-18 / 21025973-018 Insulation Covering On "Chiller" Tank Located In The Front L	White Non-Fibrous Heterogeneous	5% Cellulose	95% Other	None Detected
052521-TG-19 / 21025973-019 Insulation Covering On Approx 6" Fiberglass Insulated Pipe C	White Fibrous Heterogeneous	50% Cellulose 25% Glass	25% Other	None Detected
052521-TG-20 / 21025973-020 Insulation Covering On Approx 6" Fiberglass Insulated Pipe C	White Non-Fibrous Heterogeneous	25% Cellulose 5% Glass	70% Other	None Detected

Analyst:

Analysis Date: 5/28/2021

Approved Signatory:

Date: 5/28/2021

SanAir Technologies Laboratory

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SanAir ID / Description	Stereoscopic Appearance	Components % Fibrous	Components % Non-fibrous	Asbestos Fibers
052521-TG-21 / 21025973-021 Insulation Covering On Approx 6" Fiberglass Insulated Pipe C	White Fibrous Heterogeneous	50% Cellulose 25% Glass	25% Other	None Detected
052521-TG-22 / 21025973-022 Flange On Approx 6" Fiberglass Insulated Pipe Connected To T	White Non-Fibrous Heterogeneous	5% Cellulose 5% Glass	90% Other	None Detected
052521-TG-23 / 21025973-023 Flange On Approx 6" Fiberglass Insulated Pipe Connected To T	White Non-Fibrous Heterogeneous	5% Cellulose 5% Glass	90% Other	None Detected
052521-TG-24 / 21025973-024 Flange On Approx 6" Fiberglass Insulated Pipe Connected To T	White Non-Fibrous Heterogeneous	5% Cellulose 5% Glass	90% Other	None Detected
052521-TG-25 / 21025973-025 Mastic On HVAC Ductwork Located In The Front Left Mechanical	White Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-26 / 21025973-026 Mastic On HVAC Ductwork Located In The Front Left Mechanical	White Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-27 / 21025973-027 Mastic On HVAC Ductwork Located In The Front Left Mechanical	White Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-28 / 21025973-028 Mastic On HVAC Ductwork Located In The Front Left Mechanical	Brown Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-29 / 21025973-029 Mastic On HVAC Ductwork Located In The Front Left Mechanical	Brown Non-Fibrous Homogeneous		100% Other	None Detected

Analyst: SHogrefe

Analysis Date: 5/28/2021

Approved Signatory: Johnathan Wilson

Date: 5/28/2021

SanAir Technologies Laboratory

SanAir ID Number
21025973
FINAL REPORT
5/28/2021 11:06:59 AM

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Project Number: 21-21-162-AB-I
P.O. Number:
Project Name: Coastal Carolina University-Kimbel Library
Collected Date: 5/25/2021
Received Date: 5/27/2021 10:00:00 AM

Analyst: Hogrefe, Sarah

Asbestos Bulk PLM EPA 600/R-93/116

SanAir ID / Description	Stereoscopic Appearance	Components % Fibrous	Components % Non-fibrous	Asbestos Fibers
052521-TG-30 / 21025973-030 Mastic On HVAC Ductwork Located In The Front Left Mechanical	Brown Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-31 / 21025973-031 Insulation On Approx 6" Chilled Water Pipe Located In The Fr, Insulation	Black Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-31 / 21025973-031 Insulation On Approx 6" Chilled Water Pipe Located In The Fr, Tar Paper	Black Fibrous Homogeneous	65% Cellulose	35% Other	None Detected
052521-TG-31 / 21025973-031 Insulation On Approx 6" Chilled Water Pipe Located In The Fr, Wrap	White Fibrous Homogeneous	95% Cellulose	5% Other	None Detected
052521-TG-32 / 21025973-032 Insulation On Approx 6" Chilled Water Pipe Located In The Fr, Insulation	Black Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-32 / 21025973-032 Insulation On Approx 6" Chilled Water Pipe Located In The Fr, Tar Paper	Black Fibrous Homogeneous	65% Cellulose	35% Other	None Detected
052521-TG-32 / 21025973-032 Insulation On Approx 6" Chilled Water Pipe Located In The Fr, Wrap	White Fibrous Homogeneous	95% Cellulose	5% Other	None Detected
052521-TG-33 / 21025973-033 Insulation On Approx 6" Chilled Water Pipe Located In The Fr, Insulation	Black Non-Fibrous Homogeneous		100% Other	None Detected

Analyst: SHogrefe

Analysis Date: 5/28/2021

Approved Signatory: Johnathan Wilson

Date: 5/28/2021

SanAir Technologies Laboratory

SanAir ID Number
21025973
FINAL REPORT
5/28/2021 11:06:59 AM

Name: Phoenix EnviroCorp
Address: 4020 Shipyard Blvd
Wilmington, NC 28403
Phone: 910-397-0370

Project Number: 21-21-162-AB-I
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Project Name: Coastal Carolina University-Kimbel Library
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Analyst: Hogrefe, Sarah

Asbestos Bulk PLM EPA 600/R-93/116

SanAir ID / Description	Stereoscopic Appearance	Components % Fibrous	Components % Non-fibrous	Asbestos Fibers
052521-TG-33 / 21025973-033 Insulation On Approx 6" Chilled Water Pipe Located In The Fr, Tar Paper	Black Fibrous Homogeneous	65% Cellulose	35% Other	None Detected
052521-TG-33 / 21025973-033 Insulation On Approx 6" Chilled Water Pipe Located In The Fr, Wrap	White Fibrous Homogeneous	95% Cellulose	5% Other	None Detected
052521-TG-34 / 21025973-034 Elbow On Approx 6" Chilled Water Pipe Located In The Front L, Foam	White Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-34 / 21025973-034 Elbow On Approx 6" Chilled Water Pipe Located In The Front L, Insulation	Grey Non-Fibrous Homogeneous	20% Glass	80% Other	None Detected
052521-TG-34 / 21025973-034 Elbow On Approx 6" Chilled Water Pipe Located In The Front L, Wrap	White Fibrous Homogeneous	90% Cellulose	10% Other	None Detected
052521-TG-35 / 21025973-035 Elbow On Approx 6" Chilled Water Pipe Located In The Front L, Insulation	Black Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-35 / 21025973-035 Elbow On Approx 6" Chilled Water Pipe Located In The Front L, Insulation	Grey Non-Fibrous Homogeneous	20% Glass	80% Other	None Detected
052521-TG-36 / 21025973-036 Elbow On Approx 6" Chilled Water Pipe Located In The Front L, Insulation	Black Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-36 / 21025973-036 Elbow On Approx 6" Chilled Water Pipe Located In The Front L, Insulation	Grey Non-Fibrous Homogeneous	20% Glass	80% Other	None Detected

Analyst: [signature] Approved Signatory: [signature]

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Analyst: Hogrefe, Sarah

Asbestos Bulk PLM EPA 600/R-93/116

SanAir ID / Description	Stereoscopic Appearance	Components % Fibrous	Components % Non-fibrous	Asbestos Fibers
052521-TG-36 / 21025973-036 Elbow On Approx 6" Chilled Water Pipe Located In The Front L, Wrap	White Fibrous Homogeneous	95% Cellulose	5% Other	None Detected
052521-TG-37 / 21025973-037 Flange On Approx 6" Chilled Water Pipe Located In The Front, Insulation	Black Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-37 / 21025973-037 Flange On Approx 6" Chilled Water Pipe Located In The Front, Insulation	Grey Non-Fibrous Homogeneous	20% Glass	80% Other	None Detected
052521-TG-37 / 21025973-037 Flange On Approx 6" Chilled Water Pipe Located In The Front, Wrap	White Fibrous Homogeneous	55% Cellulose	45% Other	None Detected
052521-TG-38 / 21025973-038 Flange On Approx 6" Chilled Water Pipe Located In The Front, Insulation	Black Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-38 / 21025973-038 Flange On Approx 6" Chilled Water Pipe Located In The Front, Wrap	White Fibrous Homogeneous	55% Cellulose	45% Other	None Detected
052521-TG-39 / 21025973-039 Flange On Approx 6" Chilled Water Pipe Located In The Front, Insulation	Black Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-39 / 21025973-039 Flange On Approx 6" Chilled Water Pipe Located In The Front, Insulation	Grey Non-Fibrous Homogeneous	20% Glass	80% Other	None Detected

Analyst: [signature]
Analysis Date: 5/28/2021

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Asbestos Bulk PLM EPA 600/R-93/116

	Stereoscopic	Components		
SanAir ID / Description	**Appearance**	**% Fibrous**	**% Non-fibrous**	**Asbestos Fibers**
052521-TG-39 / 21025973-039 Flange On Approx 6" Chilled Water Pipe Located In The Front, Wrap	White Fibrous Homogeneous	55% Cellulose	45% Other	None Detected
052521-TG-40 / 21025973-040 Insulation Covering On Approx 4" Soft/Fiberglass Insulated P	White Fibrous Heterogeneous	65% Cellulose 10% Glass	25% Other	None Detected
052521-TG-41 / 21025973-041 Insulation Covering On Approx 4" Soft/Fiberglass Insulated P	White Fibrous Heterogeneous	65% Cellulose 10% Glass	25% Other	None Detected
052521-TG-42 / 21025973-042 Insulation Covering On Approx 4" Soft/Fiberglass Insulated P	White Fibrous Heterogeneous	65% Cellulose 10% Glass	25% Other	None Detected
052521-TG-43 / 21025973-043 Flange On Approx 4" Soft/Fiberglass Insulated Pipe Connected, Insulation	Black Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-43 / 21025973-043 Flange On Approx 4" Soft/Fiberglass Insulated Pipe Connected, Wrap	White Non-Fibrous Homogeneous	5% Cellulose 5% Glass	90% Other	None Detected
052521-TG-44 / 21025973-044 Flange On Approx 4" Soft/Fiberglass Insulated Pipe Connected	White Non-Fibrous Homogeneous	20% Cellulose 5% Glass	75% Other	None Detected
052521-TG-45 / 21025973-045 Flange On Approx 4" Soft/Fiberglass Insulated Pipe Connected, Insulation	Black Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-45 / 21025973-045 Flange On Approx 4" Soft/Fiberglass Insulated Pipe Connected, Wrap	White Non-Fibrous Homogeneous	5% Cellulose 5% Glass	90% Other	None Detected

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Asbestos Bulk PLM EPA 600/R-93/116

SanAir ID / Description	Stereoscopic Appearance	Components % Fibrous	Components % Non-fibrous	Asbestos Fibers
052521-TG-46 / 21025973-046 Insulation On Approx 3" Hard Insulated Pipe Connected To B-1, Insulation	Black Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-46 / 21025973-046 Insulation On Approx 3" Hard Insulated Pipe Connected To B-1, Wrap	White Fibrous Homogeneous	45% Cellulose 5% Glass	50% Other	None Detected
052521-TG-47 / 21025973-047 Insulation On Approx 3" Hard Insulated Pipe Connected To B-1, Insulation	Black Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-47 / 21025973-047 Insulation On Approx 3" Hard Insulated Pipe Connected To B-1, Wrap	White Fibrous Homogeneous	45% Cellulose 5% Glass	50% Other	None Detected
052521-TG-48 / 21025973-048 Insulation On Approx 3" Hard Insulated Pipe Connected To B-1, Insulation	Black Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-48 / 21025973-048 Insulation On Approx 3" Hard Insulated Pipe Connected To B-1, Wrap	White Fibrous Homogeneous	45% Cellulose 5% Glass	50% Other	None Detected
052521-TG-49 / 21025973-049 Flange On Approx 3" Hard Insulated Pipe Connected To B-1, Insulation	Black Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-49 / 21025973-049 Flange On Approx 3" Hard Insulated Pipe Connected To B-1, Wrap	White Non-Fibrous Homogeneous	10% Cellulose 5% Glass	85% Other	None Detected

Analyst: SHogrefe

Analysis Date: 5/28/2021

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Asbestos Bulk PLM EPA 600/R-93/116

SanAir ID / Description	Stereoscopic Appearance	Components % Fibrous	% Non-fibrous	Asbestos Fibers
052521-TG-50 / 21025973-050 Flange On Approx 3" Hard Insulated Pipe Connected To B-1, Insulation	Black Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-50 / 21025973-050 Flange On Approx 3" Hard Insulated Pipe Connected To B-1, Wrap	White Non-Fibrous Homogeneous	10% Cellulose 5% Glass	85% Other	None Detected
052521-TG-51 / 21025973-051 Flange On Approx 3" Hard Insulated Pipe Connected To B-1, Insulation	Black Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-51 / 21025973-051 Flange On Approx 3" Hard Insulated Pipe Connected To B-1, Wrap	White Non-Fibrous Homogeneous	10% Cellulose 5% Glass	85% Other	None Detected
052521-TG-52 / 21025973-052 Insulation On Approx 4" Hard Insulated Pipe Connected To The, Insulation	White Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-52 / 21025973-052 Insulation On Approx 4" Hard Insulated Pipe Connected To The, Insulation	Black Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-52 / 21025973-052 Insulation On Approx 4" Hard Insulated Pipe Connected To The, Wrap	White Fibrous Homogeneous	50% Cellulose 5% Glass	45% Other	None Detected
052521-TG-53 / 21025973-053 Insulation On Approx 4" Hard Insulated Pipe Connected To The, Insulation	Black Non-Fibrous Homogeneous		100% Other	None Detected

Analyst: [signature]

Analysis Date: 5/28/2021

Approved Signatory: [signature]

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Asbestos Bulk PLM EPA 600/R-93/116

SanAir ID / Description	Stereoscopic Appearance	Components % Fibrous	Components % Non-fibrous	Asbestos Fibers
052521-TG-53 / 21025973-053 Insulation On Approx 4" Hard Insulated Pipe Connected To The, Wrap	White Fibrous Homogeneous	45% Cellulose 5% Glass	50% Other	None Detected
052521-TG-54 / 21025973-054 Insulation On Approx 4" Hard Insulated Pipe Connected To The, Insulation	Black Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-54 / 21025973-054 Insulation On Approx 4" Hard Insulated Pipe Connected To The, Wrap	White Fibrous Homogeneous	45% Cellulose 5% Glass	50% Other	None Detected
052521-TG-55 / 21025973-055 Flange On Approx 4" Hard Insulated Pipe Connected To The	White Non-Fibrous Homogeneous	10% Cellulose 5% Glass	85% Other	None Detected
052521-TG-56 / 21025973-056 Flange On Approx 4" Hard Insulated Pipe Connected To The	White Non-Fibrous Homogeneous	10% Cellulose 5% Glass	85% Other	None Detected
052521-TG-57 / 21025973-057 Flange On Approx 4" Hard Insulated Pipe Connected To The, Insulation	Black Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-57 / 21025973-057 Flange On Approx 4" Hard Insulated Pipe Connected To The, Wrap	White Fibrous Homogeneous	10% Cellulose 5% Glass	85% Other	None Detected
052521-TG-58 / 21025973-058 Insulation Covering Approx 2" Fiberglass Insulated Pipe Conn	Off-White Non-Fibrous Homogeneous	25% Cellulose 10% Glass	65% Other	None Detected
052521-TG-59 / 21025973-059 Insulation Covering Approx 2" Fiberglass Insulated Pipe Conn	White Non-Fibrous Homogeneous	10% Cellulose 5% Glass	85% Other	None Detected

Analyst:

Analysis Date: 5/28/2021

Approved Signatory:

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Analyst: Hogrefe, Sarah

Asbestos Bulk PLM EPA 600/R-93/116

SanAir ID / Description	Stereoscopic Appearance	Components % Fibrous	Components % Non-fibrous	Asbestos Fibers
052521-TG-60 / 21025973-060 Insulation Covering Approx 2" Fiberglass Insulated Pipe Conn	Off-White Non-Fibrous Homogeneous	25% Cellulose 10% Glass	65% Other	None Detected
052521-TG-61 / 21025973-061 Base Molding Located In The Front Left Mechanical Room	Grey Non-Fibrous Heterogeneous	25% Cellulose 10% Glass	65% Other	None Detected
052521-TG-62 / 21025973-062 Base Molding Located In The Front Left Mechanical Room	Grey Non-Fibrous Heterogeneous	25% Cellulose 10% Glass	65% Other	None Detected
052521-TG-63 / 21025973-063 Base Molding Located In The Front Left Mechanical Room	Grey Non-Fibrous Heterogeneous	25% Cellulose 10% Glass	65% Other	None Detected
052521-TG-64 / 21025973-064 HVAC System Expansion Joint Located In The Front Left Mechan, Membrane	Black Non-Fibrous Homogeneous	30% Synthetic	70% Other	None Detected
052521-TG-64 / 21025973-064 HVAC System Expansion Joint Located In The Front Left Mechan, Mastic	Yellow Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-65 / 21025973-065 HVAC System Expansion Joint Located In The Front Left Mechan, Membrane	Black Non-Fibrous Homogeneous	30% Synthetic	70% Other	None Detected
052521-TG-65 / 21025973-065 HVAC System Expansion Joint Located In The Front Left Mechan, Mastic	Yellow Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-66 / 21025973-066 HVAC System Expansion Joint Located In The Front Left Mechan, Membrane	Black Non-Fibrous Homogeneous	30% Synthetic	70% Other	None Detected

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Asbestos Bulk PLM EPA 600/R-93/116

SanAir ID / Description	Stereoscopic Appearance	Components % Fibrous	Components % Non-fibrous	Asbestos Fibers
052521-TG-66 / 21025973-066 HVAC System Expansion Joint Located In The Front Left Mechan, Mastic	Yellow Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-67 / 21025973-067 Ceiling Drywall/Joint Compound Located In The Front Left Mec, Drywall	Grey Non-Fibrous Homogeneous	5% Cellulose	95% Other	None Detected
052521-TG-67 / 21025973-067 Ceiling Drywall/Joint Compound Located In The Front Left Mec, Joint Compound	White Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-68 / 21025973-068 Ceiling Drywall/Joint Compound Located In The Front Left Mec, Drywall	Grey Non-Fibrous Homogeneous	5% Cellulose	95% Other	None Detected
052521-TG-68 / 21025973-068 Ceiling Drywall/Joint Compound Located In The Front Left Mec, Joint Compound	White Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-69 / 21025973-069 Ceiling Drywall/Joint Compound Located In The Front Left Mec, Drywall	Grey Non-Fibrous Homogeneous	5% Cellulose	95% Other	None Detected
052521-TG-69 / 21025973-069 Ceiling Drywall/Joint Compound Located In The Front Left Mec, Joint Compound	White Non-Fibrous Homogeneous		100% Other	None Detected
052521-TG-70 / 21025973-070 Ceiling Cavity Batt Insulation Backing Located In The Front	Brown Fibrous Homogeneous	85% Cellulose	15% Other	None Detected
052521-TG-71 / 21025973-071 Ceiling Cavity Batt Insulation Backing Located In The Front	Brown Fibrous Homogeneous	85% Cellulose	15% Other	None Detected

Analyst: [signature] Approved Signatory: [signature]

Analysis Date: 5/28/2021 Date: 5/28/2021

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Asbestos Bulk PLM EPA 600/R-93/116

SanAir ID / Description	Stereoscopic Appearance	Components % Fibrous	Components % Non-fibrous	Asbestos Fibers
052521-TG-72 / 21025973-072 Ceiling Cavity Batt Insulation Backing Located In The Front	Brown Fibrous Homogeneous	85% Cellulose	15% Other	None Detected

Analyst:
Analysis Date: 5/28/2021

Approved Signatory:
Date: 5/28/2021

<u>Disclaimer</u>

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Samples are held for a period of 60 days. Fibers smaller than 5 microns cannot be seen with this method due to scope limitations.

For NY state samples, method EPA 600/M4-82-020 is performed.

NYELAP Disclaimer:
Polarized- light microscopy is not consistently reliable in detecting asbestos in floor covering and similar non-friable organically bound materials. Quantitative transmission electron microscopy is currently the only method that can be used to determine if this material can be considered or treated as non-asbestos containing.

<u>Asbestos Certifications</u>
NVLAP lab code 200870-0
City of Philadelphia: ALL-460
PA Department of Environmental Protection Number: 68-05397
California License Number: 2915
Colorado License Number: AL-23143
Connecticut License Number: PH-0105
Massachusetts License Number: AA000222
Maine License Number: LB-0075, LA-0084
New York ELAP lab ID: 11983
Rhode Island License Number: PCM00126, PLM00126, TEM00126
Texas Department of State Health Services License Number: 300440
Commonwealth of Virginia 3333000323
Washington State License Number: C989
West Virginia License Number: LT000616
Vermont License: AL166318
Louisiana Department of Environmental Quality: 212253, Cert 05088

Revision Date: 8/14/2020

Phoenix EnviroCorp
4020 SHIPYARD BLVD.
WILMINGTON, NC 28403

CHAIN OF CUSTODY

LABORATORY TEST REQUEST

2102597 3

CONTACT: Tommie Green	PHONE: (910) 397-0370 FAX: (910) 313-6094 EMAIL: kmgreen@phoenixenvirocorp.com	DATE SHIPPED:	5/25/2021
PEC Job #: 21-21-162-AB-I	CLIENT'S JOB NAME:	Coastal Carolina University - Kimbel Library 376 University Boulevard, Conway, SC 29528	
SAMPLE TYPE: Asbestos Bulk (PLM) TEM	NUMBER OF SAMPLES: 48 24	TURN AROUND TIME SPECIFIED: _____ 2 Hr _____ 6 Hr __X__ 24 Hr _____ 48 Hr _____ 3-5 Day	

SPECIAL INSTRUCTIONS: 1.) Stop at first positive for each homogeneous area (HGA). 2.) List positive stops on analysis form. 3.) Separate all layers prior to analysis. 4.) Do not analyze ceramic tile; analyze any associated mastic, grout, mortar, backerboard, etc. . 5.) Do not analyze fiberglass. 6.) Confirm negative results for non-friable, organically bound material with one (1) TEM analysis per HGA. 7.) Any drywall or joint compound HGA that is > 1%, but < 5% shall be re-analyzed (separately) utilizing EPA 400 point count method. 8.) Please email results.

Sample #	Sample Area	Sample Date	HGA	Sq. Footage	Lab Analysis Requested
052521-TG-01	Insulation covering on approx 2" fiberglass insulated city water pipe located in the front left mechanical room	05/25/21	1	91 LF	PLM
052521-TG-02	Insulation covering on approx 2" fiberglass insulated city water pipe located in the front left mechanical room	05/25/21	1		PLM
052521-TG-03	Insulation covering on approx 2" fiberglass insulated city water pipe located in the front left mechanical room	05/25/21	1		PLM/TEM - NOB
052521-TG-04	Insulation covering on approx 3" fiberglass insulatied pipe connected to the city water pipe located in the front left mechanical room	05/25/21	2	58 LF	PLM
052521-TG-05	Insulation covering on approx 3" fiberglass insulatied pipe connected to the city water pipe located in the front left mechanical room	05/25/21	2		PLM
052521-TG-06	Insulation covering on approx 3" fiberglass insulatied pipe connected to the city water pipe located in the front left mechanical room	05/25/21	2		PLM/TEM - NOB
052521-TG-07	Flange on approx 3" pipe connected to the city water pipe located in the front left mechanical room	05/25/21	3		PLM
052521-TG-08	Flange on approx 3" pipe connected to the city water pipe located in the front left mechanical room	05/25/21	3		PLM
052521-TG-09	Flange on approx 3" pipe connected to the city water pipe located in the front left mechanical room	05/25/21	3		PLM/TEM - NOB
052521-TG-10	Insulation covering on approx 2" fiberglass insulated hot water make-up pipe located in the front left mechanical room	05/25/21	4	35 LF	PLM
052521-TG-11	Insulation covering on approx 2" fiberglass insulated hot water make-up pipe located in the front left mechanical room	05/25/21	4		PLM
052521-TG-12	Insulation covering on approx 2" fiberglass insulated hot water make-up pipe located in the front left mechanical room	05/25/21	4		PLM/TEM - NOB
052521-TG-13	Flange on approx 2" hot water make-up pipe located in the front left mechanical room	05/25/21	5		PLM
052521-TG-14	Flange on approx 2" hot water make-up pipe located in the front left mechanical room	05/25/21	5		PLM
052521-TG-15	Flange on approx 2" hot water make-up pipe located in the front left mechanical room	05/25/21	5		PLM/TEM - NOB
052521-TG-16	Insulation covering on "Chiller" tank located in the front left mechanical room	05/25/21	6	3 SF	PLM
052521-TG-17	Insulation covering on "Chiller" tank located in the front left mechanical room	05/25/21	6		PLM
052521-TG-18	Insulation covering on "Chiller" tank located in the front left mechanical room	05/25/21	6		PLM/TEM - NOB
052521-TG-19	Insulation covering on approx 6" fiberglass insulated pipe connected to the "Chiller" tank located in the front left mechanical room	05/25/21	7	65 LF	PLM
052521-TG-20	Insulation covering on approx 6" fiberglass insulated pipe connected to the "Chiller" tank located in the front left mechanical room	05/25/21	7		PLM

CHAIN OF CUSTODY RECORD

DATE	CONDITION OF SAMPLE	SAMPLES RECEIVED BY	SAMPLES RELEASED BY
5/25/2021	SEALED/GOOD	SIGNATURE AH 5.27.21 10.00am	SIGNATURE Tommie Green

Phoenix EnviroCorp
4020 SHIPYARD BLVD.
WILMINGTON, NC 28403

CHAIN OF CUSTODY

21025973

LABORATORY TEST REQUEST

CONTACT: Tommie Green	PHONE: (910) 397-0370 FAX: (910) 313-6094 EMAIL: kmgreen@phoenixenvirocorp.com	DATE SHIPPED:	5/25/2021
PEC Job #: 21-21-162-AB-I	CLIENT'S JOB NAME:	Coastal Carolina University - Kimbel Library 376 University Boulevard, Conway, SC 29528	
SAMPLE TYPE: Asbestos Bulk (PLM) TEM	NUMBER OF SAMPLES: 48 24	TURN AROUND TIME SPECIFIED: _____ 2 Hr _____ 6 Hr __X__ 24 Hr _____ 48 Hr _____ 3-5 Day	

SPECIAL INSTRUCTIONS: 1.) Stop at first positive for each homogeneous area (HGA). 2.) List positive stops on analysis form. 3.) Separate all layers prior to analysis. 4.) Do not analyze ceramic tile; analyze any associated mastic, grout, mortar, backerboard, etc. . 5.) Do not analyze fiberglass. 6.) Confirm negative results for non-friable, organically bound material with one (1) TEM analysis per HGA. 7.) Any drywall or joint compound HGA that is > 1%, but < 5% shall be re-analyzed (separately) utilizing EPA 400 point count method. 8.) Please email results.

Sample #	Sample Area	Sample Date	HGA	Sq. Footage	Lab Analysis Requested
052521-TG-21	Insulation covering on approx 6" fiberglass insulated pipe connected to the "Chiller" tank located in the front left mechanical room	05/25/21	7		PLM/TEM - NOB
052521-TG-22	Flange on approx 6" fiberglass insulated pipe connected to the "Chiller" tank located in the front left mechanical room	05/25/21	8		PLM
052521-TG-23	Flange on approx 6" fiberglass insulated pipe connected to the "Chiller" tank located in the front left mechanical room	05/25/21	8		PLM
052521-TG-24	Flange on approx 6" fiberglass insulated pipe connected to the "Chiller" tank located in the front left mechanical room	05/25/21	8		PLM/TEM - NOB
052521-TG-25	White mastic on HVAC ductwork located in the front left mechanical room	05/25/21	9	46 LF	PLM
052521-TG-26	White mastic on HVAC ductwork located in the front left mechanical room	05/25/21	9		PLM
052521-TG-27	White mastic on HVAC ductwork located in the front left mechanical room	05/25/21	9		PLM/TEM - NOB
052521-TG-28	Brown mastic on HVAC ductwork located in the front left mechanical room	05/25/21	10	20 LF	PLM
052521-TG-29	Brown mastic on HVAC ductwork located in the front left mechanical room	05/25/21	10		PLM
052521-TG-30	Brown mastic on HVAC ductwork located in the front left mechanical room	05/25/21	10		PLM/TEM - NOB
052521-TG-31	Insulation on approx 6" Chilled water pipe located in the front left mechanical room	05/25/21	11	26 LF	PLM
052521-TG-32	Insulation on approx 6" Chilled water pipe located in the front left mechanical room	05/25/21	11		PLM
052521-TG-33	Insulation on approx 6" Chilled water pipe located in the front left mechanical room	05/25/21	11		PLM/TEM - NOB
052521-TG-34	Elbow on approx 6" Chilled water pipe located in the front left mechanical room	05/25/21	12		PLM
052521-TG-35	Elbow on approx 6" Chilled water pipe located in the front left mechanical room	05/25/21	12		PLM
052521-TG-36	Elbow on approx 6" Chilled water pipe located in the front left mechanical room	05/25/21	12		PLM/TEM - NOB
052521-TG-37	Flange on approx 6" Chilled water pipe located in the front left mechanical room	05/25/21	13		PLM
052521-TG-38	Flange on approx 6" Chilled water pipe located in the front left mechanical room	05/25/21	13		PLM
052521-TG-39	Flange on approx 6" Chilled water pipe located in the front left mechanical room	05/25/21	13		PLM/TEM - NOB
052521-TG-40	Insulation covering on approx 4" soft/fiberglass insulated pipe connected to B-1 equipment located in the front left mechanical room	05/25/21	14	40 LF	PLM

CHAIN OF CUSTODY RECORD

DATE	CONDITION OF SAMPLE	SAMPLES RECEIVED BY	SAMPLES RELEASED BY
5/25/2021	SEALED/GOOD	SIGNATURE AH 5.27.21 10:00AM	SIGNATURE [signature]

Phoenix EnviroCorp
4020 SHIPYARD BLVD.
WILMINGTON, NC 28403

CHAIN OF CUSTODY

21025973

LABORATORY TEST REQUEST

CONTACT: Tommie Green	PHONE: (910) 397-0370 FAX: (910) 313-6094 EMAIL: kmgreen@phoenixenvirocorp.com	DATE SHIPPED: 5/25/2021
PEC Job #: 21-21-162-AB-I	CLIENT'S JOB NAME: Coastal Carolina University - Kimbel Library 376 University Boulevard, Conway, SC 29528	
SAMPLE TYPE: Asbestos Bulk (PLM) TEM	NUMBER OF SAMPLES: 48 24	TURN AROUND TIME SPECIFIED: ____ 2 Hr ____ 6 Hr __X__ 24 Hr ____ 48 Hr ____ 3-5 Day

SPECIAL INSTRUCTIONS: 1.) Stop at first positive for each homogeneous area (HGA). 2.) List positive stops on analysis form. 3.) Separate all layers prior to analysis. 4.) Do not analyze ceramic tile; analyze any associated mastic, grout, mortar, backerboard, etc. . 5.) Do not analyze fiberglass. 6.) Confirm negative results for non-friable, organically bound material with one (1) TEM analysis per HGA. 7.) Any drywall or joint compound HGA that is > 1%, but < 5% shall be re-analyzed (separately) utilizing EPA 400 point count method. 8.) Please email results.

Sample #	Sample Area	Sample Date	HGA	Sq. Footage	Lab Analysis Requested
052521-TG-41	Insulation covering on approx 4" soft/fiberglass insulated pipe connected to B-1 equipment located in the front left mechanical room	05/25/21	14		PLM
052521-TG-42	Insulation covering on approx 4" soft/fiberglass insulated pipe connected to B-1 equipment located in the front left mechanical room	05/25/21	14		PLM/TEM - NOB
052521-TG-43	Flange on approx 4" soft/fiberglass insulated pipe connected to B1 equipment located in the front left mechanical room	05/25/21	15		PLM
052521-TG-44	Flange on approx 4" soft/fiberglass insulated pipe connected to B1 equipment located in the front left mechanical room	05/25/21	15		PLM
052521-TG-45	Flange on approx 4" soft/fiberglass insulated pipe connected to B1 equipment located in the front left mechanical room	05/25/21	15		PLM/TEM - NOB
052521-TG-46	Insulation on approx 3" hard insulated pipe connected to B-1 equipment located in the front left mechanical room	05/25/21	16	47 LF	PLM
052521-TG-47	Insulation on approx 3" hard insulated pipe connected to B-1 equipment located in the front left mechanical room	05/25/21	16		PLM
052521-TG-48	Insulation on approx 3" hard insulated pipe connected to B-1 equipment located in the front left mechanical room	05/25/21	16		PLM/TEM - NOB
052521-TG-49	Flange on approx 3" hard insulated pipe connected to B-1 equipment located in the front left mechanical room	05/25/21	17		PLM
052521-TG-50	Flange on approx 3" hard insulated pipe connected to B-1 equipment located in the front left mechanical room	05/25/21	17		PLM
052521-TG-51	Flange on approx 3" hard insulated pipe connected to B-1 equipment located in the front left mechanical room	05/25/21	17		PLM/TEM - NOB
052521-TG-52	Insulation on approx 4" hard insulated pipe connected to the chilled water line located in the front left mechanical room	05/25/21	18	44 LF	PLM
052521-TG-53	Insulation on approx 4" hard insulated pipe connected to the chilled water line located in the front left mechanical room	05/25/21	18		PLM
052521-TG-54	Insulation on approx 4" hard insulated pipe connected to the chilled water line located in the front left mechanical room	05/25/21	18		PLM/TEM - NOB
052521-TG-55	Flange on approx 4" hard insulated pipe connected to the chilled water line located in the front left mechanical room	05/25/21	19		PLM
052521-TG-56	Flange on approx 4" hard insulated pipe connected to the chilled water line located in the front left mechanical room	05/25/21	19		PLM
052521-TG-57	Flange on approx 4" hard insulated pipe connected to the chilled water line located in the front left mechanical room	05/25/21	19		PLM/TEM - NOB
052521-TG-58	Insulation covering approx 2" fiberglass insulated pipe connected to the air handler located in the front left mechanical room	05/25/21	20	20 LF	PLM
052521-TG-59	Insulation covering approx 2" fiberglass insulated pipe connected to the air handler located in the front left mechanical room	05/25/21	20		PLM
052521-TG-60	Insulation covering approx 2" fiberglass insulated pipe connected to the air handler located in the front left mechanical room	05/25/21	20		PLM/TEM - NOB

CHAIN OF CUSTODY RECORD

DATE	CONDITION OF SAMPLE	SAMPLES RECEIVED BY	SAMPLES RELEASED BY
5/25/2021	SEALED/GOOD	SIGNATURE AM 5.27.21 10:05am	SIGNATURE [signature]

Phoenix EnviroCorp
4020 SHIPYARD BLVD.
WILMINGTON, NC 28403

CHAIN OF COUSTODY

LABORATORY TEST REQUEST

21025973

CONTACT: Tommie Green	PHONE: (910) 397-0370 FAX: (910) 313-6094 EMAIL: kmgreen@phoenixenvirocorp.com	DATE SHIPPED:	5/25/2021
PEC Job #: 21-21-162-AB-I	CLIENT'S JOB NAME:	Coastal Carolina University - Kimbel Library 376 University Boulevard, Conway, SC 29528	
SAMPLE TYPE: Asbestos Bulk (PLM) TEM	NUMBER OF SAMPLES: 48 24	TURN AROUND TIME SPECIFIED: ____ 2 Hr ____ 6 Hr __X__ 24 Hr ____ 48 Hr ____ 3-5 Day	

SPECIAL INSTRUCTIONS: 1.) Stop at first positive for each homogeneous area (HGA). 2.) List positive stops on analysis form. 3.) Separate all layers prior to analysis. 4.) Do not analyze ceramic tile; analyze any associated mastic, grout, mortar, backerboard, etc. . 5.) Do not analyze fiberglass. 6.) Confirm negative results for non-friable, organically bound material with one (1) TEM analysis per HGA. 7.) Any drywall or joint compound HGA that is > 1%, but < 5% shall be re-analyzed (separately) utilizing EPA 400 point count method. 8.) Please email results.

Sample #	Sample Area	Sample Date	HGA	Sq. Footage	Lab Analysis Requested
052521-TG-61	Base molding located in the front left mechanical room	05/25/21	21	100 LF	PLM
052521-TG-62	Base molding located in the front left mechanical room	05/25/21	21		PLM
052521-TG-63	Base molding located in the front left mechanical room	05/25/21	21		PLM/TEM - NOB
052521-TG-64	HVAC system expansion joint located in the front left mechanical room	05/25/21	22	10 LF	PLM
052521-TG-65	HVAC system expansion joint located in the front left mechanical room	05/25/21	22		PLM
052521-TG-66	HVAC system expansion joint located in the front left mechanical room	05/25/21	22		PLM/TEM - NOB
052521-TG-67	Ceiling drywall/joint compound located in the front left mechanical room	05/25/21	23	625 SF	PLM
052521-TG-68	Ceiling drywall/joint compound located in the front left mechanical room	05/25/21	23		PLM
052521-TG-69	Ceiling drywall/joint compound located in the front left mechanical room	05/25/21	23		PLM/TEM - NOB
052521-TG-70	Ceiling cavity batt insulation backing located in the front left mechanical room	05/25/21	24		PLM
052521-TG-71	Ceiling cavity batt insulation backing located in the front left mechanical room	05/25/21	24		PLM
052521-TG-72	Ceiling cavity batt insulation backing located in the front left mechanical room	05/25/21	24		PLM/TEM - NOB

CHAIN OF CUSTODY RECORD

DATE	CONDITION OF SAMPLE	SAMPLES RECEIVED BY	SAMPLES RELEASED BY
5/25/2021	SEALED/GOOD	SIGNATURE AM 5.27.21 10:00a	SIGNATURE Tommie Green

SanAir Technologies Laboratory

The Identification Specialists

Analysis Report prepared for Phoenix EnviroCorp

Report Date: 5/28/2021

Project Name: Coastal Carolina University-Kimbel Library

Project #: 21-21-162-AB-I

SanAir ID#: 21025980

NVLAP® TESTING

NVLAP LAB CODE 200870-0

1551 Oakbridge Dr. Suite B | Powhatan, Virginia 23139-8061
888.895.1177 | 804.897.1177 | fax: 804.897.0070 | IAQ@SanAir.com | SanAir.com

SanAir ID Number
21025980
FINAL REPORT
5/28/2021 5:00:00 PM

Name: Phoenix EnviroCorp
Address: 4020 Shipyard Blvd
Wilmington, NC 28403
Phone: 910-397-0370

Project Number: 21-21-162-AB-I
P.O. Number:
Project Name: Coastal Carolina University-Kimbel Library
Collected Date: 5/25/2021
Received Date: 5/27/2021 10:00:00 AM

Dear Tommie Green,

We at SanAir would like to thank you for the work you recently submitted. The 24 sample(s) were received on Thursday, May 27, 2021 via FedEx. The final report(s) is enclosed for the following sample(s): 052521-TG-03, 052521-TG-06, 052521-TG-09, 052521-TG-12, 052521-TG-15, 052521-TG-18, 052521-TG-21, 052521-TG-24, 052521-TG-27, 052521-TG-30, 052521-TG-33, 052521-TG-36, 052521-TG-39, 052521-TG-42, 052521-TG-45, 052521-TG-48, 052521-TG-51, 052521-TG-54, 052521-TG-57, 052521-TG-60, 052521-TG-63, 052521-TG-66, 052521-TG-69, 052521-TG-72.

These results only pertain to this job and should not be used in the interpretation of any other job. This report is only complete in its entirety. Refer to the listing below of the pages included in a complete final report.

Sincerely,

Sandra Sobrino

Sandra Sobrino
Asbestos & Materials Laboratory Manager
SanAir Technologies Laboratory

Final Report Includes:
- Cover Letter
- Analysis Pages
- Disclaimers and Additional Information

Sample conditions:
- 24 samples in Good condition.

SanAir Technologies Laboratory

SanAir ID Number
21025980
FINAL REPORT
5/28/2021 5:00:00 PM

Name: Phoenix EnviroCorp
Address: 4020 Shipyard Blvd
Wilmington, NC 28403
Phone: 910-397-0370

Project Number: 21-21-162-AB-I
P.O. Number:
Project Name: Coastal Carolina University-Kimbel Library
Collected Date: 5/25/2021
Received Date: 5/27/2021 10:00:00 AM

Analyst: Sobrino, Sandra

Asbestos Bulk TEM EPA NOB EPA 600/R-93/116

Sample	Appearance	% Other Material	% Non-Asbestos Fibers	Asbestos Types	% Total Asbestos
052521-TG-03 21025980-001 Insulation Covering On Approx 2" Fiberglass Insulated City W	Fibrous Heterogeneous White	100%	<1%	Chrysotile Total:	<1% <1%
052521-TG-06 21025980-002 Insulation Covering On Approx 3" Fiberglass Insulated Pipe C	Fibrous Heterogeneous White	100%		None Detected	
052521-TG-09 21025980-003 Flange On Approx 3" Pipe Connected To The City Water Pipe Lo	Non-Fibrous Heterogeneous White	100%		None Detected	
052521-TG-12 21025980-004 Insulation Covering On Approx 2" Fiberglass Insulated Hot Wa	Fibrous Heterogeneous White	100%		None Detected	
052521-TG-15 21025980-005 Flange On Approx 2" Hot Water Make-Up Pipe Located In The Fr	Fibrous Heterogeneous White	100%		None Detected	
052521-TG-18 21025980-006 Insulation Covering On "Chiller" Tank Located In The Front L	Non-Fibrous Heterogeneous Cream	100%		None Detected	

Analyst: Sandra Sobrino Approved Signatory: Sandra Sobrino

Analysis Date: 5/28/2021 Date: 5/28/2021

SanAir Technologies Laboratory

SanAir ID Number
21025980
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5/28/2021 5:00:00 PM

Name: Phoenix EnviroCorp
Address: 4020 Shipyard Blvd
Wilmington, NC 28403
Phone: 910-397-0370

Project Number: 21-21-162-AB-I
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Collected Date: 5/25/2021
Received Date: 5/27/2021 10:00:00 AM

Analyst: Sobrino, Sandra

Asbestos Bulk TEM EPA NOB EPA 600/R-93/116

Sample	Appearance	% Other Material	% Non-Asbestos Fibers	Asbestos Types	% Total Asbestos
052521-TG-21 21025980-007 Insulation Covering On Approx 6" Fiberglass Insulated Pipe C	Fibrous Heterogeneous White	100%		None Detected	
052521-TG-24 21025980-008 Flange On Approx 6" Fiberglass Insulated Pipe Connected To T	Non-Fibrous Heterogeneous White	100%		None Detected	
052521-TG-27 21025980-009 Mastic On HVAC Ductwork Located In The Front Left Mechanical	Non-Fibrous Heterogeneous Black	100%		None Detected	
052521-TG-30 21025980-010 Mastic On HVAC Ductwork Located In The Front Left Mechanical	Non-Fibrous Homogeneous Brown	100%		None Detected	
052521-TG-33 Insulation21025980-011 Insulation On Approx 6" Chilled Water Pipe Located In The Fr	Non-Fibrous Homogeneous Black	100%		None Detected	
052521-TG-33 Wrap21025980-011 Insulation On Approx 6" Chilled Water Pipe Located In The Fr	Fibrous Heterogeneous White	100%		None Detected	

Analyst: Sandra Sobrino
Analysis Date: 5/28/2021

Approved Signatory: Sandra Sobrino
Date: 5/28/2021

SanAir Technologies Laboratory

SanAir ID Number
21025980
FINAL REPORT
5/28/2021 5:00:00 PM

Name: Phoenix EnviroCorp
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Wilmington, NC 28403
Phone: 910-397-0370

Project Number: 21-21-162-AB-I
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Project Name: Coastal Carolina University-Kimbel Library
Collected Date: 5/25/2021
Received Date: 5/27/2021 10:00:00 AM

Analyst: Sobrino, Sandra

Asbestos Bulk TEM EPA NOB EPA 600/R-93/116

Sample	Appearance	% Other Material	% Non-Asbestos Fibers	Asbestos Types	% Total Asbestos
052521-TG-36 Elbow Fitting21025980-012 Elbow On Approx 6" Chilled Water Pipe Located In The Front L	Non-Fibrous Homogeneous White	100%		None Detected	
052521-TG-36 Wrap21025980-012 Elbow On Approx 6" Chilled Water Pipe Located In The Front L	Fibrous Heterogeneous White	100%		None Detected	
052521-TG-39 21025980-013 Flange On Approx 6" Chilled Water Pipe Located In The Front	Non-Fibrous Heterogeneous Various	100%		None Detected	
052521-TG-42 21025980-014 Insulation Covering On Approx 4" Soft/Fiberglass Insulated P	Fibrous Heterogeneous White	100%		None Detected	
052521-TG-45 21025980-015 Flange On Approx 4" Soft/Fiberglass Insulated Pipe Connected	Non-Fibrous Heterogeneous White	100%		None Detected	
052521-TG-48 21025980-016 Insulation On Approx 3" Hard Insulated Pipe Connected To B-1	Non-Fibrous Heterogeneous Black	100%		None Detected	

Analyst: Sandra Sobrino
Analysis Date: 5/28/2021

Approved Signatory: Sandra Sobrino
Date: 5/28/2021

SanAir Technologies Laboratory

SanAir ID Number
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FINAL REPORT
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Name: Phoenix EnviroCorp
Address: 4020 Shipyard Blvd
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Project Number: 21-21-162-AB-I
P.O. Number:
Project Name: Coastal Carolina University-Kimbel Library
Collected Date: 5/25/2021
Received Date: 5/27/2021 10:00:00 AM

Analyst: Sobrino, Sandra

Asbestos Bulk TEM EPA NOB EPA 600/R-93/116

Sample	Appearance	% Other Material	% Non-Asbestos Fibers	Asbestos Types	% Total Asbestos
052521-TG-51 21025980-017 Flange On Approx 3" Hard Insulated Pipe Connected To B-1	Non-Fibrous Homogeneous White	100%		None Detected	
052521-TG-54 21025980-018 Insulation On Approx 4" Hard Insulted Pipe Connected To The	Non-Fibrous Heterogeneous Black	100%		None Detected	
052521-TG-57 21025980-019 Flange On Approx 4" Hard Insulated Pipe Connected To The	Non-Fibrous Heterogeneous White	100%		None Detected	
052521-TG-60 21025980-020 Insulation Covering Approx 2" Fiberglass Insulated Pipe Conn	Non-Fibrous Heterogeneous White	100%		None Detected	
052521-TG-63 21025980-021 Base Molding Located In The Front Left Mechanical Room	Non-Fibrous Heterogeneous Grey	100%		None Detected	
052521-TG-66 21025980-022 HVAC System Expansion Joint Located In The Front Left Mechan	Non-Fibrous Homogeneous Black	100%		None Detected	

Analyst: Sandra Sobrino
Analysis Date: 5/28/2021

Approved Signatory: Sandra Sobrino
Date: 5/28/2021

SanAir Technologies Laboratory

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5/28/2021 5:00:00 PM

Name: Phoenix EnviroCorp
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Project Number: 21-21-162-AB-I
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Project Name: Coastal Carolina University-Kimbel Library
Collected Date: 5/25/2021
Received Date: 5/27/2021 10:00:00 AM

Analyst: Sobrino, Sandra

Asbestos Bulk TEM EPA NOB EPA 600/R-93/116

Sample	Appearance	% Other Material	% Non-Asbestos Fibers	Asbestos Types	% Total Asbestos
052521-TG-69 Drywall21025980-023 Ceiling Drywall/Joint Compound Located In The Front Left Mec	Non-Fibrous Homogeneous White	100%		None Detected	
052521-TG-69 Joint Compound21025980-023 Ceiling Drywall/Joint Compound Located In The Front Left Mec	Non-Fibrous Homogeneous White	100%		None Detected	
052521-TG-72 21025980-024 Ceiling Cavity Batt Insulation Backing Located In The Front	Fibrous Heterogeneous Black	100%		None Detected	

Analyst: Sandra Sobrino
Analysis Date: 5/28/2021

Approved Signatory: Sandra Sobrino
Date: 5/28/2021

Disclaimer

The final report cannot be reproduced, except in full, without written authorization from SanAir. The accuracy of the results is dependent upon the client's sampling procedure and information provided to the laboratory by the client. SanAir assumes no responsibility for the sampling procedure and will provide evaluation reports based solely on the sample and information provided by the client. This report may not be used by the client to claim product endorsement by NVLAP or any other agency of the U.S. government.

Phoenix EnviroCorp
4P20 SHIPYARD BLVD
WILMINGTON NC 28403

CHAIN OF CUSTODY

21025920

LABORATORY TEST REQUEST

ACT: Tommie Green	PHONE: (910) 397-0370 FAX: (910) 313-6094 EMAIL: kmgreen@phoenixenvirocorp.com	DATE SHIPPED:	5/25/20
#: 21-21-162-AB-I	CLIENT'S JOB NAME:	Coastal Carolina University - Kimbel Library 376 University Boulevard, Conway, SC 29528	
SAMPLE TYPE: Asbestos Bulk (PLM) TEM	NUMBER OF SAMPLES: 48 24	TURN AROUND TIME SPECIFIED: ____ 2 Hr ____ 6 Hr __X__ 24 Hr ____ 48 Hr ____ 3-5 Day	

SPECIAL INSTRUCTIONS: 1.) Stop at first positive for each homogeneous area (HGA). 2.) List positive stops on analysis form. 3.) Separate all layers prior to analysis. 4.) Do not analyze ceramic tile; analyze any associated mastic, grout, mortar, backerboard, etc. . 5.) Do not analyze fiberglass. 6.) Confirm negative results for non-friable, organically bound material with one (1) TEM analysis per HGA. 7.) Any drywall or joint compound HGA that is > 1%, but < 5% shall be re-analyzed (separately) utilizing EPA 400 point count method. 8.) Please email results.

ample #	Sample Area	Sample Date	HGA	Sq. Footage	Lab Analysis Requested
1-TG-01	Insulation covering on approx 2" fiberglass insulated city water pipe located in the front left mechanical room	05/25/21	1	91 LF	PLM
1-TG-02	Insulation covering on approx 2" fiberglass insulated city water pipe located in the front left mechanical room	05/25/21	1		PLM
1-TG-03	Insulation covering on approx 2" fiberglass insulated city water pipe located in the front left mechanical room	05/25/21	1		PLM/TEM - N
52521-TG-04	Insulation covering on approx 3" fiberglass insulatied pipe connected to the city water pipe located in the front left mechanical room	05/25/21	2	58 LF	PLM
52521-TG-05	Insulation covering on approx 3" fiberglass insulatied pipe connected to the city water pipe located in the front left mechanical room	05/25/21	2		PLM
052521-TG-06	Insulation covering on approx 3" fiberglass insulatied pipe connected to the city water pipe located in the front left mechanical room	05/25/21	2		PLM/TEM - NOB
052521-TG-07	Flange on approx 3" pipe connected to the city water pipe located in the front left mechanical room	05/25/21	3		PLM
52521-TG-08	Flange on approx 3" pipe connected to the city water pipe located in the front left mechanical room	05/25/21	3		PLM
21-TG-09	Flange on approx 3" pipe connected to the city water pipe located in the front left mechanical room	05/25/21	3		PLM/TEM - NOB
1-TG-10	Insulation covering on approx 2" fiberglass insulated hot water make-up pipe located in the front left mechanical room	05/25/21	4	35 LF	PLM
1-TG-11	Insulation covering on approx 2" fiberglass insulated hot water make-up pipe located in the front left mechanical room	05/25/21	4		PLM
1-TG-12	Insulation covering on approx 2" fiberglass insulated hot water make-up pipe located in the front left mechanical room	05/25/21	4		PLM/TEM - N
2521-TG-13	Flange on approx 2" hot water make-up pipe located in the front left mechanical room	05/25/21	5		PLM
052521-TG-14	Flange on approx 2" hot water make-up pipe located in the front left mechanical room	05/25/21	5		PLM
052521-TG-15	Flange on approx 2" hot water make-up pipe located in the front left mechanical room	05/25/21	5		PLM/TEM - NOB
052521-TG-16	Insulation covering on "Chiller" tank located in the front left mechanical room	05/25/21	6	3 SF	PLM
52521-TG-17	Insulation covering on "Chiller" tank located in the front left mechanical room	05/25/21	6		PLM
521-TG-18	Insulation covering on "Chiller" tank located in the front left mechanical room	05/25/21	6		PLM/TEM - NOB
1-TG-19	Insulation covering on approx 6" fiberglass insulated pipe connected to the "Chiller" tank located in the front left mechanical room	05/25/21	7	65 LF	PLM
1-TG-20	Insulation covering on approx 6" fiberglass insulated pipe connected to the "Chiller" tank located in the front left mechanical room	05/25/21	7		PLM

CHAIN OF CUSTODY RECORD

DATE	CONDITION OF SAMPLE	SAMPLES RECEIVED BY	SAMPLES RELEASED BY
5/25/2021	SEALED/GOOD	SIGNATURE AH 5-27-21 10:00A	SIGNATURE

Phoenix EnviroCorp
4020 SHIPYARD BLVD
WILMINGTON NC 28403

CHAIN OF CUSTODY

21025920

LABORATORY TEST REQUEST

CONTACT: Tommie Green	PHONE: (910) 397-0370 FAX: (910) 313-6094 EMAIL: kmgreen@phoenixenvirocorp.com	DATE SHIPPED:	5/25/2021
Job #: 21-21-162-AB-I	CLIENT'S JOB NAME:	Coastal Carolina University - Kimbel Library 376 University Boulevard, Conway, SC 29528	
SAMPLE TYPE: Asbestos Bulk (PLM) TEM	NUMBER OF SAMPLES: 48 24	TURN AROUND TIME SPECIFIED: ____ 2 Hr ____ 6 Hr __X__ 24 Hr ____ 48 Hr ____ 3-5 Day	

SPECIAL INSTRUCTIONS: 1.) Stop at first positive for each homogeneous area (HGA). 2.) List positive stops on analysis form. 3.) Separate layers prior to analysis. 4.) Do not analyze ceramic tile; analyze any associated mastic, grout, mortar, backerboard, etc. . 5.) Do not analyze fiberglass. 6.) Confirm negative results for non-friable, organically bound material with one (1) TEM analysis per HGA. 7.) Any drywall or joint compound HGA that is > 1%, but < 5% shall be re-analyzed (separately) utilizing EPA 400 point count method. 8.) Please email results.

Sample #	Sample Area	Sample Date	HGA	Sq. Footage	Lab Analysis Requested
52521-TG-21	Insulation covering on approx 6" fiberglass insulated pipe connected to the "Chiller" tank located in the front left mechanical room	05/25/21	7		PLM/TEM - NOB
1 TG-22	Flange on approx 6" fiberglass insulated pipe connected to the "Chiller" tank located in the front left mechanical room	05/25/21	8		PLM
1 TG-23	Flange on approx 6" fiberglass insulated pipe connected to the "Chiller" tank located in the front left mechanical room	05/25/21	8		PLM
1-TG-24	Flange on approx 6" fiberglass insulated pipe connected to the "Chiller" tank located in the front left mechanical room	05/25/21	8		PLM/TEM - NOB
1 TG-25	White mastic on HVAC ductwork located in the front left mechanical room	05/25/21	9	46 LF	PLM
TG-26	White mastic on HVAC ductwork located in the front left mechanical room	05/25/21	9		PLM
2521-TG-27	White mastic on HVAC ductwork located in the front left mechanical room	05/25/21	9		PLM/TEM - N
52521-TG-28	Brown mastic on HVAC ductwork located in the front left mechanical room	05/25/21	10	20 LF	PLM
52521-TG-29	Brown mastic on HVAC ductwork located in the front left mechanical room	05/25/21	10		PLM
52521-TG-30	Brown mastic on HVAC ductwork located in the front left mechanical room	05/25/21	10		PLM/TEM - NOB
1-TG-31	Insulation on approx 6" Chilled water pipe located in the front left mechanical room	05/25/21	11	26 LF	PLM
1-TG-32	Insulation on approx 6" Chilled water pipe located in the front left mechanical room	05/25/21	11		PLM
1 TG-33	Insulation on approx 6" Chilled water pipe located in the front left mechanical room	05/25/21	11		PLM/TEM - N
1-TG-34	Elbow on approx 6" Chilled water pipe located in the front left mechanical room	05/25/21	12		PLM
G-35	Elbow on approx 6" Chilled water pipe located in the front left mechanical room	05/25/21	12		PLM
21-TG-36	Elbow on approx 6" Chilled water pipe located in the front left mechanical room	05/25/21	12		PLM/TEM - N
52521-TG-37	Flange on approx 6" Chilled water pipe located in the front left mechanical room	05/25/21	13		PLM
052521-TG-38	Flange on approx 6" Chilled water pipe located in the front left mechanical room	05/25/21	13		PLM
2521-TG-39	Flange on approx 6" Chilled water pipe located in the front left mechanical room	05/25/21	13		PLM/TEM - NOB
1 TG-40	Insulation covering on approx 4" soft/fiberglass insulated pipe connected to B-1 equipment located in the front left mechanical room	05/25/21	14	40 LF	PLM

CHAIN OF CUSTODY RECORD

DATE	CONDITION OF SAMPLE	SAMPLES RECEIVED BY	SAMPLES RELEASED BY
5/25/2021	SEALED/GOOD	SIGNATURE AMS 27 21 10:00AM	SIGNATURE Tommie Green

Phoenix EnviroCorp
4020 SHIPYARD BLVD
WILMINGTON, NC 28403

CHAIN OF CUSTODY

21075920

LABORATORY TEST REQUEST

ONTACT: Tommie Green	PHONE: (910) 397-0370 FAX: (910) 313-6094 EMAIL: kmgreen@phoenixenvirocorp.com	DATE SHIPPED:	5/25/2021
ob #: 21-21-162-AB-I	CLIENT'S JOB NAME:	Coastal Carolina University - Kimbel Library 376 University Boulevard, Conway, SC 29528	
E TYPE: Asbestos Bulk (PLM) TEM	NUMBER OF SAMPLES: 48 24	TURN AROUND TIME SPECIFIED: ____ 2 Hr ____ 6 Hr __X__ 24 Hr ____ 48 Hr ____ 3-5 Day	

IAL INSTRUCTIONS: 1.) Stop at first positive for each homogeneous area (HGA). 2.) List positive stops on analysis form. 3.) Separate yers prior to analysis. 4.) Do not analyze ceramic tile; analyze any associated mastic, grout, mortar, backerboard, etc. . 5.) Do not lyze fiberglass. 6.) Confirm negative results for non-friable, organically bound material with one (1) TEM analysis per HGA. 7.) Any ywall or joint compound HGA that is > 1%, but < 5% shall be re-analyzed (separately) utilizing EPA 400 point count method. 8.) Please mail results.

Sample #	Sample Area	Sample Date	HGA	Sq. Footage	Lab Analysis Requested
52521-TG-41	Insulation covering on approx 4" soft/fiberglass insulated pipe connected to B-1 equipment located in the front left mechanical room	05/25/21	14		PLM
1-TG-42	Insulation covering on approx 4" soft/fiberglass insulated pipe connected to B-1 equipment located in the front left mechanical room	05/25/21	14		PLM/TEM - NOB
1-TG-43	Flange on approx 4" soft/fiberglass insulated pipe connected to B1 equipment located in the front left mechanical room	05/25/21	15		PLM
1-TG-44	Flange on approx 4" soft/fiberglass insulated pipe connected to B1 equipment located in the front left mechanical room	05/25/21	15		PLM
1-TG-45	Flange on approx 4" soft/fiberglass insulated pipe connected to B1 equipment located in the front left mechanical room	05/25/21	15		PLM/TEM - NO
1-TG-46	Insulation on approx 3" hard insulated pipe connected to B-1 equipment located in the front left mechanical room	05/25/21	16	47 LF	PLM
1-TG-47	Insulation on approx 3" hard insulated pipe connected to B-1 equipment located in the front left mechanical room	05/25/21	16		PLM
52521-TG-48	Insulation on approx 3" hard insulated pipe connected to B-1 equipment located in the front left mechanical room	05/25/21	16		PLM/TEM - N
52521-TG-49	Flange on approx 3" hard insulated pipe connected to B-1 equipment located in the front left mechanical room	05/25/21	17		PLM
052521-TG-50	Flange on approx 3" hard insulated pipe connected to B-1 equipment located in the front left mechanical room	05/25/21	17		PLM
52521-TG-51	Flange on approx 3" hard insulated pipe connected to B-1 equipment located in the front left mechanical room	05/25/21	17		PLM/TEM - NOB
1-TG-52	Insulation on approx 4" hard insulated pipe connected to the chilled water line located in the front left mechanical room	05/25/21	18	44 LF	PLM
1-TG 53	Insulation on approx 4" hard insulated pipe connected to the chilled water line located in the front left mechanical room	05/25/21	18		PLM
-TG-54	Insulation on approx 4" hard insulated pipe connected to the chilled water line located in the front left mechanical room	05/25/21	18		PLM/TEM - NO
1-TG-55	Flange on approx 4" hard insulated pipe connected to the chilled water line located in the front left mechanical room	05/25/21	19		PLM
TG-56	Flange on approx 4" hard insulated pipe connected to the chilled water line located in the front left mechanical room	05/25/21	19		PLM
1-TG-57	Flange on approx 4" hard insulated pipe connected to the chilled water line located in the front left mechanical room	05/25/21	19		PLM/TEM - NO
52521-TG-58	Insulation covering approx 2" fiberglass insulated pipe connected to the air handler located in the front left mechanical room	05/25/21	20	20 LF	PLM
52521-TG-59	Insulation covering approx 2" fiberglass insulated pipe connected to the air handler located in the front left mechanical room	05/25/21	20		PLM
2521-TG-60	Insulation covering approx 2" fiberglass insulated pipe connected to the air handler located in the front left mechanical room	05/25/21	20		PLM/TEM - NOB

CHAIN OF CUSTODY RECORD

DATE	CONDITION OF SAMPLE	SAMPLES RECEIVED BY	SAMPLES RELEASED BY
25 2021	SEALED/GOOD	SIGNATURE AH 5.27.21 10.00Am	SIGNATURE Tommie Green

Phoenix EnviroCorp
4020 SHIPYARD BLVD
WILMINGTON, NC 28403

CHAIN OF CUSTODY

21025980

LABORATORY TEST REQUEST

CONTACT: Tommie Green	PHONE: (910) 397-0370 FAX: (910) 313-6094 EMAIL: kmgreen@phoenixenvirocorp.com	DATE SHIPPED:	5/25/2021
PEC Job #: 21-21-162-AB-I	CLIENT'S JOB NAME:	Coastal Carolina University - Kimbel Library 376 University Boulevard, Conway, SC 29528	
SAMPLE TYPE: Asbestos Bulk (PLM) TEM	NUMBER OF SAMPLES: 48 24	TURN AROUND TIME SPECIFIED: ____ 2 Hr ____ 6 Hr __X__ 24 Hr ____ 48 Hr ____ 3-5 Day	

SPECIAL INSTRUCTIONS: **1.) Stop at first positive for each homogeneous area (HGA). 2.) List positive stops on analysis form. 3.) Separate all layers prior to analysis. 4.) Do not analyze ceramic tile; analyze any associated mastic, grout, mortar, backerboard, etc. . 5.) Do not analyze fiberglass. 6.) Confirm negative results for non-friable, organically bound material with one (1) TEM analysis per HGA. 7.) Any drywall or joint compound HGA that is > 1%, but < 5% shall be re-analyzed (separately) utilizing EPA 400 point count method. 8.) Please email results.**

Sample #	Sample Area	Sample Date	HGA	Sq. Footage	Lab Analysis Requested
052521-TG-61	Base molding located in the front left mechanical room	05/25/21	21	100 LF	PLM
052521-TG-62	Base molding located in the front left mechanical room	05/25/21	21		PLM
052521-TG-63	Base molding located in the front left mechanical room	05/25/21	21		PLM/TEM - NOB
052521-TG-64	HVAC system expansion joint located in the front left mechanical room	05/25/21	22	10 LF	PLM
052521-TG-65	HVAC system expansion joint located in the front left mechanical room	05/25/21	22		PLM
052521-TG-66	HVAC system expansion joint located in the front left mechanical room	05/25/21	22		PLM/TEM - NOB
052521-TG-67	Ceiling drywall/joint compound located in the front left mechanical room	05/25/21	23	625 SF	PLM
052521-TG-68	Ceiling drywall/joint compound located in the front left mechanical room	05/25/21	23		PLM
052521-TG-69	Ceiling drywall/joint compound located in the front left mechanical room	05/25/21	23		PLM/TEM - NOB
052521-TG-70	Ceiling cavity batt insulation backing located in the front left mechanical room	05/25/21	24		PLM
052521-TG-71	Ceiling cavity batt insulation backing located in the front left mechanical room	05/25/21	24		PLM
052521-TG-72	Ceiling cavity batt insulation backing located in the front left mechanical room	05/25/21	24		PLM/TEM - NOB

CHAIN OF CUSTODY RECORD

DATE	CONDITION OF SAMPLE	SAMPLES RECEIVED BY	SAMPLES RELEASED BY
5/25/2021	SEALED/GOOD	SIGNATURE AMS 27 2110.com	SIGNATURE Tommie Green

January 8, 2021

To whom it may concern:

Due to an unforeseen printer outage the SC Department of Health and Environmental Control Asbestos Program cannot issue a Standard Asbestos License

MP-00184 exp. March 8, 2022.

for license number: PD-00123 exp. March 9, 2022.

Please accept this correspondence as a temporary acknowledgment

of Management Planner / Project Designer licensing status.

Tommie Green will be issued a standard license card once our systems are fully operational.

Keep this letter with you all the time during work at the job site.

If you have any questions, please call the Asbestos Section at 803-898-4289.

Sincerely,

Jennifer Lynn Boryk

Jennifer Lynn Boryk
Manager, Asbestos Section
Bureau of Air Quality

United States Department of Commerce
National Institute of Standards and Technology

NVLAP®

Certificate of Accreditation to ISO/IEC 17025:2017

NVLAP LAB CODE: 200870-0

SanAir Technologies Laboratory, Inc.
Powhatan, VA

is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:

Asbestos Fiber Analysis

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated January 2009).

2021-04-01 through 2022-03-31
Effective Dates

For the National Voluntary Laboratory Accreditation Program

NVLAP® National Voluntary Laboratory Accreditation Program

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

SanAir Technologies Laboratory, Inc.
1551 Oakbridge Drive
Suite B
Powhatan, VA 23139
Ms. Sandra Sobrino
Phone: 804-897-1177 Fax: 804-897-0070
Email: ssobrino@sanair.com
http://www.sanair.com

ASBESTOS FIBER ANALYSIS

NVLAP LAB CODE 200870-0

Bulk Asbestos Analysis

Code	Description
18/A01	EPA -- 40 CFR Appendix E to Subpart E of Part 763, Interim Method of the Determination of Asbestos in Bulk Insulation Samples
18/A03	EPA 600/R-93/116: Method for the Determination of Asbestos in Bulk Building Materials

Airborne Asbestos Analysis

Code	Description
18/A02	U.S. EPA's "Interim Transmission Electron Microscopy Analytical Methods-Mandatory and Nonmandatory-and Mandatory Section to Determine Completion of Response Actions" as found in 40 CFR, Part 763, Subpart E, Appendix A.

For the National Voluntary Laboratory Accreditation Program

REPORT OF
GEOTECHNICAL EXPLORATION

Kimbel Information Commons

Conway, South Carolina
S&ME Project No. 1633-09-251

Prepared For:

Coastal Carolina University
Post Office Box 261954
Conway, South Carolina 29528-6054

Prepared By:

S&ME

1330 Highway 501 Business
Conway, South Carolina 29526

November 5, 2009

November 5, 2009

Coastal Carolina University
Post Office Box 261954
Conway, South Carolina 29528-6054

Attention: Mr. Mark Avant, E.I.T, LEED AP

Reference: **Report of Geotechnical Exploration**
Kimbel Information Commons
Conway, South Carolina
S&ME Project No. 1633-09-251

Dear Mr. Avant:

S&ME, Inc. has completed the subsurface exploration for the referenced project after receiving authorization to proceed from you on September 30, 2009. Our exploration was conducted in general accordance with our Proposal No. 1633-0294-09, dated September 30, 2009.

The purpose of this study was to characterize the surface and subsurface soils on the proposed site, and to provide recommendations for site preparation and earthwork and foundation support.

This report describes our understanding of the project, presents the results of the field exploration and laboratory testing, and discusses our conclusions and recommendations. S&ME, Inc. appreciates this opportunity to be of service to you. Please call if you have questions concerning this report or any of our services.

Respectfully submitted,

S&ME, Inc.

SOUTH CAROLINA LICENSED PROFESSIONAL ENGINEER No. 27400 JOSEPH D. LAPS 11/5/09

Joseph D. Laps, P.E.
Project Engineer

Ron Forest, Jr., P.E.
Senior Engineer

SOUTH CAROLINA CERTIFICATE OF AUTHORIZATION S&ME, INC. No. C00473

TABLE OF CONTENTS

EXECUTIVE SUMMARY

For your convenience, this report is summarized in outline form below. This brief summary should not be used for design or construction purposes without reviewing the more detailed information presented in the remainder of this report.

1. **Soil Conditions**: The soil profile generally consists of clayey sands and silty sands interpreted as fill material (Stratum I) to depths of up to 3 feet. Below Stratum I, the test locations encountered a stratum of interbedded clayey sand, poorly graded sand with silt, and poorly graded sand (Stratum II) to a depth of 12 feet below the surface. Beginning at a depth of 12 feet, an upper stratum of sandy lean clay (Stratum III) was encountered to depths of 16 to 17 feet, underlain by a stratum of clayey sand and sandy lean clay with shell fragments (Stratum IV) to depths of 27 to 33 feet. Beneath Stratum IV, a lower stratum of cemented sands with shell fragments (Stratum V) was encountered to 37 feet. These deeper cemented shelly sands were underlain by stiff to very stiff clays of the Pee Dee Formation (Stratum VI) to termination of drilling depth at 50 feet.

2. **Ground Water**: At the time of drilling, water was encountered at depths of approximately 3.5 to 5 feet below the ground surface. Water level at least 24 hours after drilling was observed to range from about 3.6 to 4.4 feet below the ground surface in borings B-1 through B-3.

3. **Liquefaction Concern**: Liquefaction within the sands of Stratum II during the design earthquake is likely between depths of 4 to 12 feet with an average liquefiable layer thickness of 8 feet. Surface settlements due to volumetric compaction of the liquefied sands are estimated to be on the order of about 3 to 5 inches. Surface rupture, lateral spreading, and loss of bearing capacity during the specified earthquake appear to be a significant seismic hazard at the site.

4. **Seismic Site Class**: Based on the soil profile Seismic Site Class E is appropriate for the structures assuming that deep foundations are used to penetrate the liquefiable zone. The following seismic design coefficients for Site Class E are provided: S_{DS} = 0.61g, S_{D1} = 0.40g, and Peak Ground Acceleration (PGA) = 0.24g. For a structure having an Occupancy Category classification of I, II, or III both the S_{DS} and S_{D1} values obtained are consistent with Seismic Design Category D as defined in section 1613.5.6 of the Code.

5. **Foundations**: Due to the relatively high building loads, the potentially liquefiable sands encountered, and the very soft clays of Stratum III, a deep foundation system consisting of 16-inch diameter augered, cast-in-place, reinforced concrete piles extended to a depth of 42 feet below the existing ground surface is recommended for support of the structure. A working capacity of 50 tons per pile is recommended for design if a traditional auger cast pile system is used, and a working capacity of 58 tons per pile is recommended if an auger cast displacement pile system is used.

1. INTRODUCTION

The purpose of this exploration was to obtain subsurface information to allow us to characterize the subsurface conditions at the site and to develop recommendations concerning grading, foundation design, and other related construction issues. This report describes our understanding of the project, presents the results of the field exploration and laboratory testing, and discusses our conclusions and recommendations.

The scope of our geotechnical services did not include an environmental assessment for determining the presence or absence of wetlands, or hazardous or toxic materials or design of mechanically stabilized earth walls or other retaining walls.

A site plan showing the approximate boring locations is included in Appendix A. The boring logs, discussion of the field investigative procedures, and a legend to soil classification and symbols are included in Appendix B. Appendix C contains the results of the laboratory testing. Lateral pile analysis figures are included in Appendix D.

2. SITE AND PROJECT DESCRIPTION

2.1 Project Description

Project information was provided during several phone conversations with Mr. James Rice, AIA of SGA Architecture between October 15, 2009 and October 30, 2009. We were also provided us with a conceptual site plan from Mr. Rice in an email dated October 29, 2009. The proposed site is located at the Kimbel Library at Coastal Carolina University in Conway, South Carolina as shown on Figure 1 in Appendix A.

The conceptual site plan provided indicates the expansion to the existing Kimbel Library at the front entrance, with approximately 9,000 square feet in plan area and two stories in height. Associated concrete walkways and landscaping will be constructed around the proposed expansion.

Structural design information for the structure was provided to by Perry Derrick of Kyzer & Timmerman, indicating that the proposed structure may have individual column loads of about 150 kips or less and wall loads of about 5 kips per linear foot or less. We have also assumed that the building pad will require approximately 12 inches of new fill.

3. EXPLORATION PROCEDURES

3.1 Field Exploration

From October 9 through October 16, 2009, representatives of S&ME, Inc. visited the site several times. Using the information provided, we performed the following tasks:

- We performed a site walkover, observing features of topography, existing structures, ground cover, and surface soils at the project site.

- We established three Standard Penetration Test (SPT) boring locations across the site by roughly measuring distances and turning right angles as interpreted from the site layout plan. The Test Location Sketch is attached in Appendix A as Figure 2.

- We advanced three SPT borings (B-1 through B-3) within the building footprint, each to a depth of 50 feet by mud rotary methods.

- In conjunction with the penetration testing, split-spoon disturbed soil samples were recovered for laboratory classification and taken to our laboratory for further testing.

- The subsurface water level at each boring was measured in the field at the time of drilling and at least 24 hours after drilling.

A description of the field tests performed during the exploration as well as the SPT logs are attached in Appendix B.

3.2 Laboratory Testing

After the recovered soil samples were brought to our laboratory, a geotechnical professional examined and/or tested each sample to estimate its distribution of grain sizes, plasticity, organic content, moisture condition, color, presence of lenses and seams, and apparent geologic origin in general accordance with ASTM D 2488, "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)".

The resulting classifications are presented on the SPT boring logs, included in Appendix B. Similar soils were grouped into representative strata on the logs. The strata contact lines represent approximate boundaries between soil types. The actual transitions between soil types in the field are likely more gradual in both the vertical and horizontal directions than those which are indicated on the logs.

We performed the following quantitative ASTM-standardized laboratory tests on samples obtained from various depths and locations to help classify the soils and formulate our conclusions and recommendations. The laboratory tests performed included the following:

- Atterberg limits (ASTM D 4318) of three soil samples, to determine soil plasticity.

- Particle size analysis (ASTM D 422) of three soil samples, to determine the grain size distribution of the soil.

- Natural moisture content (ASTM D 2216) of three soil samples, to evaluate the in situ moisture content of the soil.

The laboratory data sheets and procedures for the above listed tests are attached to this report in Appendix C.

4. SURFACE CONDITIONS AND GEOLOGY

The principal access to the site is from James P Blanton Circle along the western property boundary. The existing Kimbel Library is located to the east, Kearns Hall is located to the south, and an open grassed area is located to the north. The majority of the site is currently undeveloped and serves as a walkway to the existing library.

4.1 Topography

From visual observation and the provided site plan, the project site appeared to be relatively level to gently sloping along the outer boundaries. A project-specific topographic map was not provided. The site appears to be relatively flat with topographic relief appearing to be less than one foot across the majority of the site.

4.2 Existing Structures

The existing Kimbel Library is located to the east and is a two-story structure measuring approximately 24,000 square feet in plan area. Several concrete walkways traverse the project site and serve as a main entrance to the Kimbel Library. Several small benches were also observed on the walkway near the entrance to the library. No other existing permanent structures were observed on the project site at the time of our walkover. Underground stormwater drainage was observed within the footprint of the proposed building. Utility markings for irrigation, sewer, water, and power were also observed throughout the proposed building footprint.

4.3 Ground Cover and Vegetation

At the time of our exploration, the majority of the site was currently being used as a main walkway leading to the Kimbel Library and ground cover consisted of concrete sidewalks and groomed short grass growth. Some sparse tree growth consisting of crepe myrtle, gum, and pine trees were observed in the within the proposed building footprint.

4.4 Organic Topsoil & Concrete

Organic topsoil was encountered in borings B-1 and B-3. The topsoil thickness ranged from about 4 to 6 inches. Thicker zones of topsoil may be encountered in other areas of the site. B-2 was performed in the concrete walkway and concrete thickness was observed to be 5.5 inches in thickness. No construction debris was encountered in our soil test borings.

4.5 Local Physiographic Conditions and Geology

The site lies within the Coastal Terraces Region of the Lower Coastal Plain of South Carolina. These sediments overlie crystalline (metamorphic) bedrock to a thickness of approximately 1,100 feet in the site area.

The topography of this region is dominated by a series of archaic beach terraces, exposed by uplifting of the local area over the last one million years. The lower coastal plain terraces are relatively young Quaternary features, exhibit only minor surface erosion, and can be traced large distances on the basis of surface elevation. Each terrace forms a thin veneer over older, consolidated marine shelf or terrestrial Coastal Plain residual soils that are Cretaceous to Tertiary in age.

Materials comprising the terraces typically consist of a strand or beach redge deposit of clean sands at the seaward margin. Between the strand and the toe of the next inland terrace are mainly finely interlayered clays and sands termed backbarrier deposits. In most areas, the terrace deposits are sufficiently old for a fully developed residual soil profile to have formed from the parent material, but old swamp deposits, stumps, and buried tress have in some areas been covered by the terraces and are usually not evident at the surface.

Over wide areas in Horry County, seams of poorly consolidated silts or clays occur near the base of the terrace sediments. Locally termed "blue mayonnaise," these sediments were weathered or eroded from the underlying Pee Dee Formation and redeposited a short distance away in a low-energy environment. Erosion and redeposition of these soils largely leached out the calcareous cement binding the soil grains of the intact soils together, and the redeposited soils have often not been subject to confining stresses significantly in excess of their own weight. Under these conditions, the in-place soils often exhibit little strength and can be highly compressible.

Shell sand or coquina often occurs below the soft clays in beds ranging up to 10 feet in thickness. Where recovered in split-spoon samplers, these soils consist mostly of loose to medium dense fine to medium sands with some silt and clay and occasional phosphate nodules. Soils are typically blue to gray in color. Recovered samples are often highly structured but weakly cemented masses of shell. Samples react vigorously to diluted muratic acid reflecting the calcium carbonate cement between the particles, but SPT N-values are often low due to disruption of the soil structure by the sampling tool. These materials are locally termed the Waccamaw or Bear Bluff formations and are early Pleistocene (750,000 years) and late Tertiary (3 to 5 million years) in age, respectively.

The Pee Dee Formation consists of a thick, massive bedded, dark gray to green, micaceous calcareous clay-sand or sand-clay. Samples recovered in borings are typically sands with considerable amounts of moderately to highly plastic fines. Ledges of thin limestone are often encountered about every 6 to 8 feet in soil test borings and range from 6 inches to 4 feet thick. The Pee Dee Formation is estimated to be late Cretaceous age. This layer generally forms the bearing layer for deep foundations supporting heavy structures in the area, and is rarely penetrated fully by geotechnical borings.

5. SUBSURFACE CONDITIONS

The generalized subsurface conditions at the site are described below. For more detailed descriptions and stratifications at a test location, the respective Boring Logs should be reviewed in Appendix B.

5.1 Interpreted Subsurface Profiles

One subsurface cross-sectional profile of the site soils is attached in Appendix A as Figure 3. The cross-section orientation in plan view is shown on Figure 2. The profile is shown in Figure 3 generally runs west to east across the site and depict soil conditions penetrated by our soil borings looking in a northerly direction.

The strata indicated in the profile are characterized in the following section. Note that the profile is not to scale. The subsurface profile was prepared for illustrative purposes only. Subsurface stratifications may be more gradual than indicated, and conditions may vary between test locations.

5.2 Description of Subsurface Soils

This section describes soil conditions observed across the site, as represented by the profile A-A' in Figure 3 of Appendix A. Below the topsoil and concrete, the site generally consists of clayey sands and silty sands interpreted as fill material (Stratum I) to a depth of about 3 feet. Below Stratum I, the test locations encountered a stratum of interbedded clayey sand, poorly graded sand with silt, and poorly graded sand (Stratum II) to a depth of 12 feet below the surface. Beginning at a depth of 12 feet, a stratum of sandy lean clay (Stratum III) was encountered to depths of 16 to 17 feet, underlain by a stratum of clayey sand and sandy lean clay with shell fragments (Stratum IV) to depths of 27 to 33 feet. Beneath Stratum IV, a lower stratum of cemented sands with shell fragments (Stratum V) was encountered to a depth of 37 feet. These deeper cemented shelly sands were underlain by stiff to very stiff overconsolidated clays of the Pee Dee Formation (Stratum VI) to the termination of drill depth at 50 feet.

5.2.1 Stratum I: Near Surface Sands (Fill)

Underlying the topsoil within borings B-1 and B-3 and below the concrete in boring B-2, a stratum of fill soils consisting of silty sands and clayey sands were observed to a depth of 3 feet. Soils consisted of mostly fine to medium sand and some low to medium plasticity fines. The sands of this stratum were predominately brown to tan in color and typically moist to wet. SPT N-values ranged from 3 to 4 blows per foot (bpf) in borings B-1 and B-2, indicating a very loose relative density. Boring B-3 resulted in an SPT N-value of 15 bpf, indicating a medium dense relative density. Soils of this stratum were interpreted to be fill materials placed during previous construction at the site.

5.2.2 Stratum II: Liquefiable Sands

Underlying the fill soils of Stratum I, our borings encountered interbedded clayey sands, poorly-graded sands, poorly-graded sand with silt, and silty sands to a depth of 12 feet. These soils were moist to saturated and predominately tan to brown in color. These soils exhibited SPT N-values ranging from Weight of Hammer (W-O-H) to 10 blows per foot (bpf), indicating a very loose to loose relative density.

Natural moisture contents of these soils, tested at various locations and depths, ranged from 23.8 to 31.8 percent. Fines contents of the tested soils ranged from 1.8 to 2.2 percent. Minus No. 40 sieve size material exhibited essentially non-plastic behavior.

In the event of the design earthquake, portions of this stratum lying below the ground-water table would be likely to experience liquefaction, as is further discussed in Section 6.3 of this report.

5.2.3 Stratum III: Compressible Clays

Underlying Stratum II, sandy lean clays were encountered beginning at depths of about 12 feet and extending to depths ranging from 16 to 17 feet. The soils of this stratum were saturated and predominately gray in color. The SPT N-values within this clayey stratum were Weight of Hammer (W-O-H), indicating a very soft consistency.

Natural moisture content of the soil recovered from within boring B-3 at a depth of 13.5 to 15 feet, was 49.8 percent. Fines content of the tested soils indicated 72.8 percent passing the No. 200 sieve. Minus No. 40 sieve size material exhibited a liquid limit value of 35 percent and a plastic limit value of 23 percent. Plasticity Index value was 13 percent, indicating medium plasticity. The Liquidity Index value determined by comparison of plasticity indices to the in-place moisture content of the tested soil indicated a ratio of 1.4, implying the soils have not been preconsolidated in excess of the applied overburden stresses.

These soils lie mostly below the water table at this site and most of these soils will be entirely saturated upon application of load. Consolidation is likely to be relatively slow since the soils appear to be stratified horizontally within this clay interval to only a limited degree in most of the recovered samples, and drainage paths from impervious layers will tend to be long. Primary consolidation will thus constitute a distinct phase of settlement apart from immediate compression, and will require a marked length of time to occur after load application. Secondary compression may also be significant in Stratum III and therefore, would need to be considered in design unless deep foundations are used.

In the event of the design earthquake, this stratum would be unlikely to experience liquefaction.

5.2.4 Stratum IV: Clayey Sands and Lean Clay with Shell Fragments

Underlying the clays of Stratum III in all the test locations, a mixture of clayey sands, sandy lean clay, and shell locally termed "shell hash" was encountered starting at approximately 16 to 17 feet and extending to depths ranging from 27 to 33 feet. The soils of this stratum were saturated and predominately green or gray in color. These soils were also moderately reactive to diluted muriatic acid indicating a moderate degree of cementation. Fines content is visually estimated to range from about 25 to 75 percent within this layer. SPT N-values within this stratum ranged from 2 to 13 bpf indicating a very loose to loose relative density and soft to stiff consistency.

In the event of the design earthquake, this stratum would be unlikely to experience liquefaction due to the calcareous nature of the material and interparticle cementation effects.

5.2.5 Stratum V: Clayey Sands with Cemented Sands and Shells

In all the test locations, clayey sands with cemented sands and shells were encountered beneath the shell hash and sandy clays of Stratum IV beginning at depths of 27 to 33 feet and extending to a depth of about 37 feet. The soils of this stratum were saturated and predominately gray to light gray in color. These soils were also highly reactive to diluted muriatic acid indicating a high degree of cementation. This stratum is very similar to Stratum IV; however, the material of Stratum V exhibited a higher degree of cementation, contained sand to gravel sized cemented particles, and appeared to exhibit a significantly lower fines content. The recovered soil samples were also less cohesive than the soils of Stratum IV. SPT N-values within this stratum ranged from 4 to 8 bpf, indicating a very loose to loose relative density.

In the event of the design earthquake, this stratum would be unlikely to experience liquefaction due to the calcareous nature of the material and interparticle cementation effects.

5.2.6 Stratum VI: Clays with Cemented Lenses (Pee Dee Formation)

Beneath Stratum V, overconsolidated sandy lean clays were encountered beneath the clayey sands of Stratum V beginning at a depth of 37 feet and extending to the boring termination depth of 50 feet. The soils of this stratum were moist to wet and predominately gray in color. These soils were also moderately to highly reactive to diluted muriatic acid indicating a high degree of cementation.

SPT N-values within this stratum ranged from 15 to 28 bpf in the lean clays of this stratum, indicating a very stiff consistency. Cemented lenses were encountered within this stratum in all borings at a depth of about 37 feet. The thickness of these cemented lenses ranged from 6 to 18 inches. SPT N-values of these cemented lenses were greater than 50 bpf, indicating a very hard consistency.

Soils within this stratum will not contribute significantly to settlement due to their depth, strength, and overconsolidation associated with the Pee Dee Formation, and will form the primary bearing layer for deep foundation support.

5.2.7 Subsurface Water

At the time of drilling, water was encountered at depths of approximately 3.5 to 5 feet below the ground surface. We visited the site approximately 24 hours after the time of drilling to re-measure water levels within the borings. The water level after 24 hours was found to range from 3.6 to 4.4 feet below the ground surface. Water levels may fluctuate seasonally at the site, being influenced by rainfall variation, tidal effects, and other factors. Site construction activities can also influence water elevations.

The above description of subsurface conditions is relatively brief and general. More detailed information may be obtained from review of the individual exploration records contained in Appendix B of this report.

6. SEISMIC SITE CLASS AND DESIGN PARAMETERS

Seismic-induced ground shaking at the foundation is the effect taken into account by seismic-resistant design provisions of the 2006 International Building Code (IBC). Other effects, including landslides and soil liquefaction, must also be considered.

6.1 Seismic Site Class

We classified the site as one of the site classes defined in IBC Section 1613.5.2 (Table 1613.5.2) using the procedures described in Section 1613.5.5.1. The site class is used in conjunction with mapped spectral accelerations S_S and S_1 to determine Site Coefficients F_A and F_V in IBC Section 1613.5.4, Tables 1613.5.3(1) and 1613.5.3(2).

The initial step in site class definition is to check for the four conditions described for Site Class F, which would require a site specific evaluation to determine site coefficients F_A and F_V. Soils vulnerable to potential failure include: 1) quick and highly sensitive clays or collapsible weakly cemented soils; 2) peats and highly organic clays; 3) very high plasticity clays; and 4) very thick soft/medium stiff clays, which were not observed in the boring.

One other determining characteristic, liquefaction potential under seismic conditions, was assessed. As an initial step, soils were assessed qualitatively for liquefaction susceptibility based on their age, stratum, mode of deposition, degree of cementation, and size composition. This assessment considered observed liquefaction behavior in various soils in areas of previous seismic activity. Our liquefaction analysis, which is more fully described in Section 6.3 below, indicated that the liquefaction of saturated, cohesionless soils varying in thickness from 6 to 8 feet appears likely to occur at this site within Stratum II between depths of 4 and 12 feet. Based on the potential for induced liquefaction under earthquake shaking, Site Class F was deemed to apply at this site.

The 2006 IBC generally requires a site-specific evaluation for Site Class F conditions, but allows an exception for structures having fundamental periods of vibration equal to or less than 0.5 seconds. For these stiff structures, which include most buildings below 4 to 5 stories, a site-specific evaluation is not required to determine spectral accelerations for liquefiable soils. Rather, the site class may be determined in accordance with the soil profile, assuming no liquefaction, and the corresponding values of F_A and F_V may be determined from the tables contained in the code provisions.

Progressing under this exception, based on N-values recorded at boring locations, we determined that site response factors F_A and F_V corresponding to Site Class E would be applicable to determine spectral values for design. This recommendation is provided based on an average weighted SPT N-value over the total boring length (extrapolated to 100 feet in depth), as computed using the N method formula in Section 1613.5.3 of the 2006 IBC.

For a structure having an Occupancy Category classification of I, II, or III both the S_{DS} and S_{D1} values obtained are consistent with Seismic Design Category D as defined in section 1613.5.6 of the Code. Regardless of whether the maps or the site specific method is used to define spectral coefficients, liquefaction occurrence and/or mitigation will need to be addressed for any Design Category D structure.

6.2 Seismic Design Coefficients for Site Class E

Selection of the base shear values for structural design for earthquake loading is the responsibility of the structural engineer. However, for the purpose of evaluating seismic hazards at this site, we have evaluated earthquake design factors from Section 1613 of the 2006 International Building Code.

Based upon the code design earthquake with a 2 percent probability of return in 50 years, the mapped spectral acceleration for short periods (S_S) is 0.66g, and the mapped spectral acceleration for a 1-second period (S_1) is 0.18g. Since the mapped S_S values for the site do not exceed 1.25g, and S_1 values do not exceed 0.5g, the site coefficients, F_A and F_V, may be obtained from Tables 1613.5.3(1) and 1613.5.3(2). The coefficient F_A is interpolated to be 1.39 and coefficient F_V is interpolated to be 3.25, assuming Site Class E, as explained previously. Using these values, the maximum spectral response acceleration parameters are as follows:

- $S_{MS} = 0.91g$
- $S_{M1} = 0.59g$
- $S_{DS} = 0.61g$
- $S_{D1} = 0.40g$
- PGA = 0.24g

If it is desired to try and improve the seismic site class, or the site spectral acceleration coefficients for this project, we can perform Multi-Channel Analysis of Surface Waves (MASW) for an additional fee, as discussed in our original proposal.

6.3 Liquefaction of Bearing Soils

Liquefaction of saturated, loose, cohesionless soils occurs when they are subject to earthquake loading that causes the pore pressures to increase, and effective overburden stresses to decrease, to the point where large soil deformation or even transformation from a solid to a liquid state results.

To evaluate liquefaction potential, we performed analyses at borings B-1, B-2, and B-3, considering the soil profiles and the characteristics of the soil and ground water observed in each boring. Fines content values for the various soil layers were evaluated from the laboratory tests and SPT data, to estimate the liquefaction potential. When considering the design earthquake as specified by the IBC 2006, liquefaction was estimated to be likely at this site over various thickness intervals between depths of about 4 to 12 feet.

Liquefaction potential of the soils encountered in our soundings was assessed using the procedures described by T. L. Youd, I. M. Idriss, et al, "Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils," Journal of Geotechnical and Geoenvironmental Engineering, American Society of Civil Engineers (2001) vol. 127, No. 10, pp. 817-833; and updated by R. B. Seed, K. O. Cetin, et.al., "Recent Advances in Soil Liquefaction Engineering: A Unified and Consistent Framework", 26th Annual ASCE Los Angeles Geotechnical Spring Seminar Keynote Presentation, 2003.

In this approach, the cyclic resistance ratio (CRR) of the soils is computed from CPT point stresses corrected for overburden stresses. A further correction is made to the point stress values for fines content using the Soil Behavior Type Index I_c value, developed by P. K. Robertson. CRR values were then compared to the Cyclic Stress Ratio computed from peak ground acceleration, overburden stress, subsurface water elevation, and nonlinear shear mass participation. Corrections to the CRR were made for earthquake magnitude. The factor of safety against liquefaction was defined as the ratio of the forces resisting liquefaction (CRR), divided by the cyclic stress ratio (CSR).

6.4 Post-Liquefaction Surface Rupture

Potential impacts of liquefaction which need to be considered include loss of bearing capacity and loss of lateral support to foundations, lateral spreading of the surface, and post-liquefaction settlement.

Within Stratum II, potentially liquefiable sand layers approximately 6 to 8 feet thick are overlain by about 4 feet of liquefaction resistant soils. Ishihara (1985) correlated observations of damage to structures related to liquefaction to the thickness of the surficial layer of non-liquefiable soils and to the thickness of the liquefiable layer. For a peak ground acceleration of 0.24g or less, a layer 4 feet thick overlying a 8 foot thick liquefiable layer, would be likely to experience surface damage due to liquefaction under the design earthquake including the loss of bearing capacity and lateral support to foundations.

Based on this, we consider general bearing capacity loss or significant reduction in allowable bearing capacity under seismic loading to be significant risks for a structure founded at the surface. Therefore, deep foundations are required for this structure.

6.5 Settlements Due to Volumetric Compression

Settlement of sands due to volumetric compression of liquefied soils depends on the induced cyclic stresses from the earthquake, the vertical effective stress at the depth of the layer being examined, and the equivalent clean sand corrected SPT value. A rigorous evaluation of surface settlement due to earthquake motion was beyond our current scope, but settlements were in general terms evaluated by comparing corrected SPT values within the liquefied zone to empirical data developed by K. Tokimatsu and H. B. Seed, "Evaluation of Settlements in Sands for Earthquake Shaking," Journal of Soil Mechanics and Foundation Division, American Society of Civil Engineers (1987) vol. 113, SM 8, pp. 861-879. Tokimatsu and Seed plot volumetric strain vs. CSR at sites where liquefaction was observed and deformations monitored.

By multiplying the average estimated volumetric strain times the thickness of the liquefied zone, cumulative settlements under the design earthquake would be on the order of about 3 to 5 inches, for a cumulative liquefiable layer thickness of up to about 6 to 8 feet.

Settlements occurring due to volumetric strains within the liquefied soils are likely to be highly variable across the site, although the thickness of non-liquefiable soils above the liquefiable layer will help reduce this effect to some degree. Differential settlement of slabs or structures bearing on the surface may therefore approach approximately three-quarters of the total settlement in the event of a seismic event, or about 2 to 4 inches.

7. CONCLUSIONS AND RECOMMENDATIONS

The conclusions and recommendations included in this section are based on the project information outlined previously and the data obtained during our exploration. If the construction scope is altered, the proposed building locations are changed, or if conditions are encountered during construction that differ from those encountered by the borings, then S&ME, Inc. should be retained to review the following recommendations based upon the new information and make any necessary changes.

7.1 Consideration of Foundation Types

Structural loads for columns supporting the structure at this site could not be supported by either conventional spread footings or by a reinforced mat foundation without excessive risk of unacceptable short term settlement of the loose sands and high long term settlement of the compressible clays underlying the structure. In addition, borings encountered potentially liquefiable sands of up to 8 feet in thickness at depths ranging from approximately 4 to 12 feet below the existing surface with potential for loss of bearing capacity during seismic shaking, and a layer of soft high plasticity clays at depths of about 12 to 17 feet below the surface with potential for high static settlements. Taking these factors into account, we consider support of the proposed structures with shallow individual footings or reinforced mat foundations not to be feasible at this site. The deep foundation alternative we considered is augered, cast-in-place, reinforced concrete piles (ACP's). Alternatively, augered cast-in place, reinforced concrete displacement piles (ACDP's) are often used in this area, and are typically a cleaner operation and provide approximately 1.2 times the frictional capacity of the traditional ACP.

7.2 Auger Cast Pile (ACP) & Auger Cast Displacement Pile (ACDP)

ACP's and ACDP's have the advantage of being relatively economical to install, especially at small diameters, and have a comparatively high axial capacity with regard to the soil conditions observed at this site. Either of these pile types appears to be feasible to install at this site. Some constructability issues for this foundation type are discussed in section 7.2.1 of this report.

Auger cast displacement piles are constructed with a hollow-stem, continuous flight auger similar to conventional auger cast piles. However, due to the relatively high "crowd" pressures imparted by the high displacement drill rig, the auger is screwed into the soil in contrast to more or less complete drilling out of the hole and complete removal of the displaced soil as is done in traditional auger cast piles. The high-displacement method provides some improvement or densification of the surrounding soils by the displacement action of the auger scrolls. When the auger reaches the desired depth, grout is pumped through the center of the auger while the auger is extracted from the hole. A reinforcing cage or central bar are inserted into the grout immediately following auger removal, to add tensile and/or lateral load carrying capacity. Auger-cast displacement piles typically have higher axial capacities and do not generate the amount of auger spoils than the conventional auger-cast piles. These piles have been successfully employed on other projects in Horry County.

7.2.1 Difficult Drilling Conditions

It is anticipated that with the proper equipment, ACPs and ACDPs could be advanced to the desired depth range, although drilling may slow down considerably while cemented lenses are being penetrated.

Penetration of the cemented material at the top of the Pee Dee Formation or through cemented lenses or seams occurring within the Pee Dee Formation will require reinforced (e.g. Kennemetal) bits with cutting teeth in good condition is used to advance the augers. Drilling may slow down considerably while the cemented material is being penetrated. However, the presence of subsurface cemented pockets of material makes it possible that the some of the foundation piles could terminate early due to auger refusal, rather than at a consistent, assigned depth. This was considered during the development of our design recommendations. Based on past projects, it is more likely for an ACDP to refuse on the cemented lenses than a traditional ACP.

Any early refusal of the piles will need to be addressed by the Geotechnical Engineer at the time of construction. The auger refusal criterion is recommended to be defined as an auger advancement rate of 1 inch per minute. We based our capacity calculations upon the soils conditions observed at boring location B-3, because it represents the weakest conditions.

7.2.2 ACP and ACDP Capacities

Axial capacities versus depth were estimated for individual 16-inch diameter ACP and ACDP based upon the subsurface conditions encountered in the borings. A combination of both end bearing and skin friction is needed to develop a reasonable pile capacity without extending the piles below the termination depth of the borings. Substantial end bearing occurs at a depth of about 42 feet below the ground surface, which is about 5 feet into the top of the Pee Dee Formation. Therefore, we recommend a design installation depth of 42 feet. Some piles may refuse at about 37 feet of penetration, either within or upon the cemented lens.

We also checked the capacity of both types of piles under the design earthquake assuming full liquefaction and volumetric compression of the susceptible soils between the depths of 4 and 12 feet. For this case, we considered negative skin friction for the layer above the liquefiable zone, positive skin friction for the zone below liquefiable soils, and set the skin friction in the liquefiable layer to zero. End bearing was considered unchanged. Liquefaction of the sands within Stratum I was determined to have negligible effect on the design capacity of the piles.

ACP and ACDP capacities should be verified at the start of construction by performing at least one static load test, ideally to failure, or to at least two times the design load, using the "quick load test method" of ASTM D-1143 – Standard Method of Testing Piles Under Static Axial Compressive Load. The load test pile should be instrumented with electronic strain gages to develop load transfer data throughout the length of the pile.

The results of the testing can be used to verify production pile capacities and lengths. The grout factor for the test piles should be comparable to that for the production piles.

We performed axial capacity analyses for two pile types, ACP and ACDP. The axial capacities for both types of piles are shown in Table 1 below.

Table 1 – ACP and ACDP Capacities

Pile Type	Allowable Capacity* (tons)	Ultimate Capacity (tons)	Uplift Allowable Capacity* (tons)	Embedment Depth** (feet)
16-inch ACP	50	100	70	42
16-inch ACDP	58	116	86	42

* Allowable capacity assumes a factor of safety of 2.0 and at least 1 static load test.
** Embedment depth is from the existing ground surface at the time that this exploration was performed.

The soil coefficients used in our axial capacity analyses were developed using published correlations relating soil skin friction and end bearing unit capacities to SPT N-value.

Soils in the upper five feet of the soil profile were considered not to contribute to pile resistance or downdrag. Also, soils within one pile diameter above the pile tip are generally considered not to contribute to side friction capacity, and were ignored in computation of ultimate pile capacity.

7.2.3 ACP and ACDP Capacity Reductions and Group Effects

Auger cast piles are essentially small-diameter drilled shafts. Therefore, for "large groups" of shafts or auger cast piles where each pile in the group is completely surrounded by other piles at a spacing of no less than 3 pile diameters center-to-center, a reduction factor would typically be applied to the estimated single pile capacities given above. The reduction factor may range from 0.7 to 1.0, and depends upon the pile spacing. If the piles are spaced at least 6 diameters apart (8 feet for a 16-inch diameter pile), then no reduction factor for group effects is needed. Intermediate reduction factors may be used for small groups of piles. The actual capacity for each pile and each group of piles will be somewhat dependent upon the final pile layout configuration that is selected.

We also evaluated the potential for a block failure of the pile groups assuming the pile group to act as an equivalent shallow footing bearing at a depth equal to 2/3 of the pile lengths. Our evaluation indicated that block failure of the pile groups are unlikely and no reduction for group effect due to block failure is required. Once the pile configuration of the typical pile caps has been determined, S&ME should be contacted to evaluate potential capacity reductions due to group effects and block failure of the pile groups.

7.3 Lateral Pile Reactions for Assumed Loads

Our lateral pile analyses were performed using the computer program LPILE PLUS ©. This program performs a beam-column analysis of single piles, which are subjected to given lateral and axial loading, and assumes a non-linear soil response. Individual 16-inch diameter ACPs and ACDPs embedded 42 feet below existing grades were analyzed. A vertical load equivalent to the allowable axial compressive capacity (50 tons for ACPs and 58 tons for ACDPs) was applied to the modeled auger cast pile. Lateral loads ranging from 10 to 60 kips were applied at the pile head to evaluate the resulting lateral deflection and bending moment at the pile head along the pile. The single pile analysis modeled fixed head restraint conditions with a constant elastic modulus (i.e., no reduced stiffness to account for non-linear bending stiffness).

No adjustment was made to the p-y curves to reflect group action. The lateral deflection versus depth curves, moment versus depth curves, shear force versus depth curves, pile-head deflection versus lateral load curves, and lateral load versus maximum bending moment curves output from the program are attached to this report in Appendix D. Lateral deflection and maximum bending moment of a typical 16-inch diameter auger cast pile was estimated for the assumed lateral shear loads to consider possible non-uniform loading of individual pile reaction within a group for both static and cyclic loading conditions. The cyclic loading analyses assumed a non-cracked pile cross-section to model lateral displacement.

We have not performed a structural analysis of the proposed pile. Since we performed our analysis using a constant elastic modulus for the pile, which in reality has a non-linear modulus, the moment capacity of the pile should be checked to verify that the pile is not cracking. We note that beyond a deflection of about 0.5 in. the constant modulus assumption may underestimate the deflection since the actual stiffness will likely be less than that estimated by a constant modulus.

Lateral loads anticipated for heavy load columns have not been provided. The lateral load that can be withstood by a typical pile will be limited by the maximum allowable shear stress for the pile material and the radius of curvature introduced by bending. For purpose of preliminary assessment of the auger cast pile sections described above, lateral resistance at the pile heads were computed for imposed lateral deflections of ¼ inches and 1 inch and provided in Table 2 below.

Table 2 – Lateral Loads for Fixed Head Conditions, 16-inch diameter ACP and ACDP (Static and Dynamic Cases)

Pile Type: 16 inch Dia. 50 ft Depth	**Applied Load (tons)**	**Deflection (inches)**	**Static Lateral Load (kips)**	**Dynamic Lateral Load (kips)**	**Maximum Shear Force (kips)**	**Maximum Bending Moment (in-kips)**
ACP / ACDP	50 / 58	¼	18	13	18	920
ACP / ACDP	50 / 58	1	53	28	53	3,200

Depth to essential fixity or the critical depth of a 16-inch diameter auger cast pile and auger cast displacement pile under fixed head condition appears to be about 34 feet for both the static and cyclic loading conditions. Point of fixity was defined as the second point of zero deflection of the pile under the applied lateral shear force. Beyond this depth pile length does not influence lateral resistance.

The structural integrity of the ACP's and ACDP's has not been considered in this report, and proper steel reinforcement of the piles will need to be designed by the structural engineer.

7.4 Settlement of Auger Cast Piles

Pile settlement consists of two components: axial compression of the piles themselves (termed "elastic shortening"), and consolidation settlement of the piles due to deformation within the soil column. The side friction of a single auger cast pile is typically fully-mobilized at vertical displacements of 0.1 to 1.0 percent of the pile diameter in cohesionless soil, taking into account the elastic shortening of the pile itself (Reese & O'Neill, 1988). For a single 16-inch diameter pile, this would typically equate to less than ¼ inch of vertical displacement associated with elastic shortening.

Settlement of pile groups is typically greater than for individual piles. Group settlements may be estimated using the equivalent footing method, assuming the enclosed area by the group to act similar to a spread footing that bears at an elevation equal to two-thirds the pile length below the surface. To use this method requires that the size of the pile group, number and spacing of piles, and axial load on the group be known. However, since the "equivalent footing" would bear within the Pee Dee Formation, settlements of the pile groups would be likely to be very small, on the order of 1 inch or less.

We should be contacted to estimate the total group settlements as well as check the differential settlement between adjacent dissimilar groups (if applicable) once the actual pile loads and the configurations of the pile groups have been finally determined.

7.5 Auger Cast Pile Construction and Testing Protocol

1. A minimum of four index piles should be installed at representative locations within the site chosen by the geotechnical engineer prior to production pile installation. The index pile installation should be witnessed by the geotechnical engineer or his representative.

2. Index piles and the pile installation equipment should be the same as to be used in production.

3. Following installation, index piles may be abandoned or used in production pile caps as desired. If used as production piles, the reinforcing cage should match the design requirements.

4. It is recommended that at least one axial compressive load test be performed at one selected location in the footprint of the buildings The test pile location should

be selected after installation of the index piles. The purpose of the axial compressive load testing is to verify that the estimated capacity of the piles at this location as indicated by the borings is in fact available, and the test should be performed in accordance with ASTM D 1143 using the hydraulic jack loading procedure.

a) The testing should be performed by the pile installation contractor and under the observation of the geotechnical engineer (S&ME). At each location, the test pile and associated reaction piles should be constructed to the diameter and depths of the production piles specified for that area.

b) During axial compressive testing, the test pile should be loaded to at least 2.0 times the single-pile allowable design capacity. It is desirable to load the piles to 3.0 times the single pile capacity if the contractor is able. A group of four reaction piles, each equally spaced at least 5 to 6 pile diameters away from the test pile, is anticipated to provide sufficient uplift frictional capacity to obtain the desired force against the test pile. If twice the allowable pile capacity is achieved for the test pile, then the allowable working design capacities may be considered verified. If less than twice the allowable pile capacity is achieved for the test pile, then the geotechnical engineer (S&ME) should be consulted to re-evaluate the pile design capacities based upon the test pile results.

5. A minimum grout strength of 5,000 psi is recommended for construction of the auger cast piles. Grout properties are critical in installing piles that will perform satisfactorily. The grout should include additives that will adequately control setting shrinkage. The grout must be fluid enough to be pumped easily and must flow without excessive pressure losses.

   a) One set of 6 grout cylinders should be cast by S&ME, Inc. personnel per every 30 cubic yards of grout delivered to the site, or at least twice per day of production.

   b) Grout pressure should be monitored during pumping.

6. A sufficient volume of grout should be continuously pumped under sufficient head to prevent suction from developing as the augers are withdrawn from the borehole. Suction could cause the soil to mix with the grout, loss of bearing capacity, or hole collapse. A head of at least 10 feet of grout above the injection point should be maintained at all times to help prevent collapse of the pile.

7. Auger withdrawal rate should not exceed 10 feet per minute. Sudden pulls of the auger, which may cause “necking” or collapse of the hole should be avoided.

8. Pile reinforcing may consist of bundled steel rods, rolled steel sections, or reinforcing bar cages as determined by the structural engineer. All reinforcing

should be installed before the grout sets up, normally within 10 minutes of auger withdrawal. Center the reinforcing steel in the hole with centering devices.

9. Equipment for controlling and measuring the flow rate of grout should be calibrated before the commencement of construction. The pump calibration curve of stroke vs. volume should be provided to the S&ME, Inc. testing representative on-site, in order to facilitate volumetric calculations.

   a) The volume of grout pumped into each pile should be recorded and compared to the theoretical volume of pile by the testing representative.

   b) Where the ratio of actual volume to theoretical volume is less than 1.2 for ACPs or less than 1.15 for ACDPs, the pile will need to be redrilled unless otherwise directed by the geotechnical engineer.

10. Have the geotechnical engineer (S&ME) observe each cleaned pile cap excavation prior to concrete placement. Also, have the geotechnical engineer observe any undercut areas in pile cap excavations prior to backfilling, in order to confirm that the poor soils have been removed and that the exposed subgrade is suitable for support of foundations.

11. We recommend that at least one set of four ASTM C 31 cylinder specimens be cast by S&ME per every 50 cubic yards of structural concrete placed as pile caps or mats, in order to verify achievement of the design compressive strength. We also recommend that S&ME be present on-site to observe all concrete placements.

7.6 Lateral Earth Pressures

The equivalent fluid pressures given below should be used to design the pile caps. Under static conditions, the equivalent at-rest fluid pressure should be used to design fixed soil-retaining structures. The values given in the following table assume placement and compaction of backfill around these structures in accordance with the compaction recommendations given in the next section of this report. These values assume backfill generally classified as SP soils according to the Unified Soil Classification system.

Table 3 – Lateral Earth Pressure Coefficients

Support Condition	Angle of Internal Friction (φ')	Cohesion (c)	Moist Unit Weight (γ)	DRAINED	
				Static Earth Pressure Coefficient (K)	Dynamic Earth Pressure Coefficient (K)
Active Condition (K_a)	30°	0	120 pcf	0.33	0.51
At-Rest (K_o)	30°	0	120 pcf	0.50	0.75
Passive (K_p)	30°	0	120 pcf	3.00	2.55

a. The above values represent a fully-drained soil condition at or near the optimum moisture content. Where backfill soils are not fully drained, the lateral soil pressure must consider hydrostatic forces below the water level, and submerged soil unit weight.

b. A coefficient of sliding friction (tan δ) of 0.25 may be used in computation of the lateral sliding resistance.

7.7 Floor Slab Design

The slab design used in this area under Seismic Site Class F conditions typically consists of either a grade beam system tied into the columns supported by piles, or a post-tensioned tendon reinforced slab-on-grade. These systems are typically designed to span across cavities formed beneath the slab due to settlement, or liquefaction during an earthquake. It was beyond the scope of this exploration to provide design parameters for post-tensioned slabs on grade.

The following general recommendations are provided for grade slabs:

1. A vapor barrier such as "Visqueen," or equivalent, should be placed over the subgrade prior to placing concrete to limit moisture infiltration into finished spaces.

2. Place a blanket of at least 4 inches of compacted granular soils or stone below the floor slab to provide a capillary break between the subgrade and the slab concrete in finished spaces. Granular soils should have 5 percent fines (soil smaller than 0.075 mm) or less.

3. All exposed slab subgrade surfaces should be proofrolled under the supervision of the geotechnical engineer or his representative with a heavily loaded dump truck or pan. Observe all slab subgrades prior to concrete placement. Areas of rutting or pumping soils may require selective undercutting or further stabilization prior to concrete placement.

7.8 Surface Preparation

Site preparation over most of the site will include stripping of surface vegetation, removal of organic laden topsoil, rootmat, roots, stumps, and similar organic materials, and implementation and maintenance of drainage. The following recommendations are provided regarding site preparation and earthwork:

1. Drainage should be implemented and maintained as soon as possible prior to construction. This will reduce the potential for damage to the subgrade during earthwork operations and should help maintain stabilization of the subgrade.

2. Strip surface vegetation, trash, root balls, root mats, pavements, and organic material, where encountered, and dispose of outside the future pavement and building pad footprints. Organic soils containing more than about 5 percent organics should be removed from the proposed construction areas.

3. Loose sands containing what appeared to be old fill were encountered by our soil test borings in the upper soil profile at the site. Existing sandy, loose soils within the building pad should be densified with a heavy, vibratory roller prior to placement of new fill. Moisture conditioning by the addition of water or drying of soils may be required prior to densification, depending on field conditions.

4. Following implementation of site drainage and stripping, the subgrade surface should be proofrolled under the observation of the geotechnical engineer (S&ME) or his authorized representative by making repeated passes with a fully-loaded dump truck or earth-moving pan. The proofrolling should be conducted only during dry weather and after drainage has been implemented and allowed time to function in order to avoid degrading the surface. Areas of rutting or pumping soils indicated by the proofroll may require selective undercutting or further stabilization prior to fill placement.

7.9 Fill Placement and Compaction Recommendations

Where new fill soils are to be placed on the site, the following recommendations apply:

1. Before beginning to place fill, sample and test each proposed fill material to determine suitability for use, maximum dry density, optimum moisture content, and natural moisture content. It is recommended that any imported fill soils used to build up the pads for the structures and pavement meet the following minimum requirements: plasticity index of 6 percent or less; clay/silt fines content of not greater than 25 percent.

2. Where fill soil is required, structural fill should be compacted throughout to at least 98 percent of the standard Proctor maximum dry density (ASTM D 698). Compacted soils must not exhibit pumping or rutting under equipment traffic. Loose lifts of fill should be no more than 8 inches in thickness prior to compaction. Structural fill should extend at least 5 feet from the edge of pavements before either sloping or being allowed to exhibit a lower level of compaction.

3. All fill placement should be witnessed by an experienced S&ME soils technician working under the guidance of the geotechnical engineer. In general, at least one field density test for every 2,500 square feet should be conducted for each lift of soil in large area fills, with a minimum of 2 tests per lift. At least one field density test should be conducted per each 50 cubic feet of fill placed in confined areas such as isolated undercuts and in trenches, with a minimum of 1 test per lift. At least one field density test should be conducted for each 250 linear feet of road alignment backfill, with a minimum of 1 test per lift per section.

8. LIMITATIONS OF REPORT

This report has been prepared in accordance with generally accepted geotechnical engineering practice for specific application to this project. The conclusions and recommendations in this report are based on the applicable standards of our practice in this geographic area at the time this report was prepared. No other warranty, express or implied, is made.

The analyses and recommendations submitted herein are based, in part, upon the data obtained from the subsurface exploration. The nature and extent of variations of the soils at the site to those encountered at our boring locations will not become evident until construction. If variations appear evident, then we will re-evaluate the recommendations of this report. In the event that any changes in the nature, design, or location of the structure are planned, the conclusions and recommendations contained in this report will not be considered valid unless the changes are reviewed and conclusions modified or verified in writing by the submitting engineers.

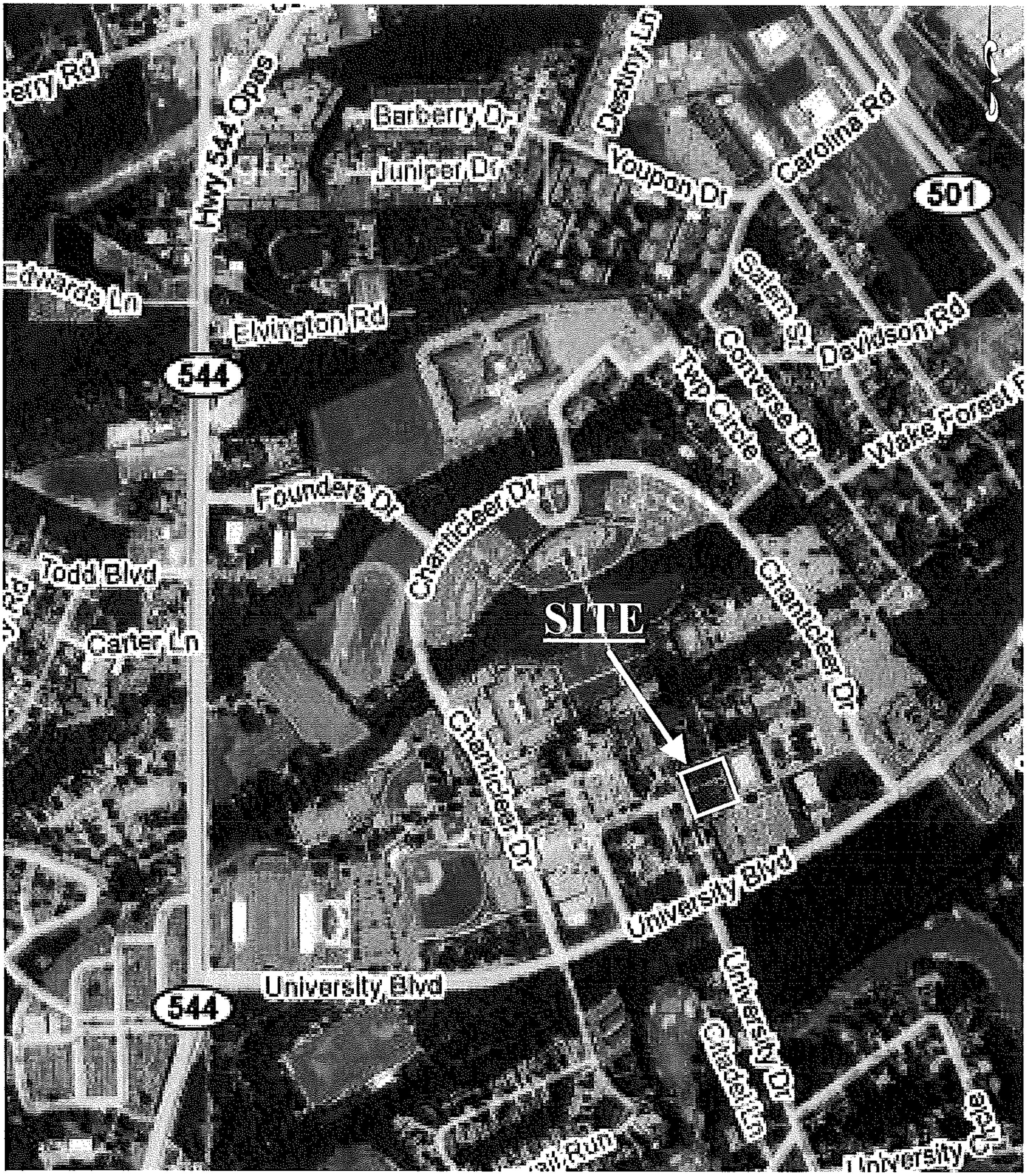
Assessment of site environmental conditions; sampling of soils, ground water or other materials for environmental contaminants; identification of jurisdictional wetlands, rare or endangered species, geological hazards or potential air quality and noise impacts were beyond the scope of this geotechnical exploration.

APPENDIX A

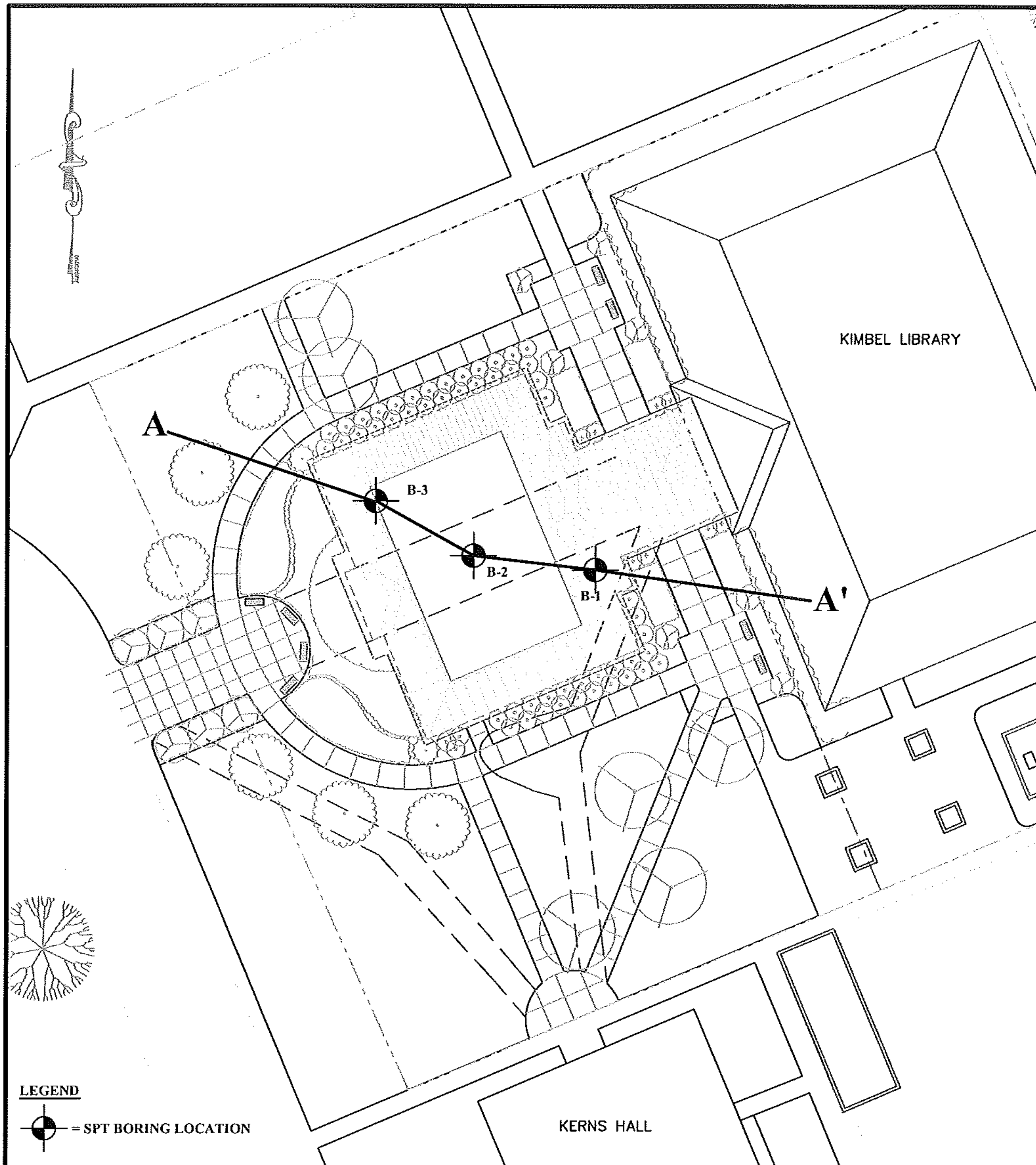
SITE VICINITY MAP

TEST LOCATION SKETCH

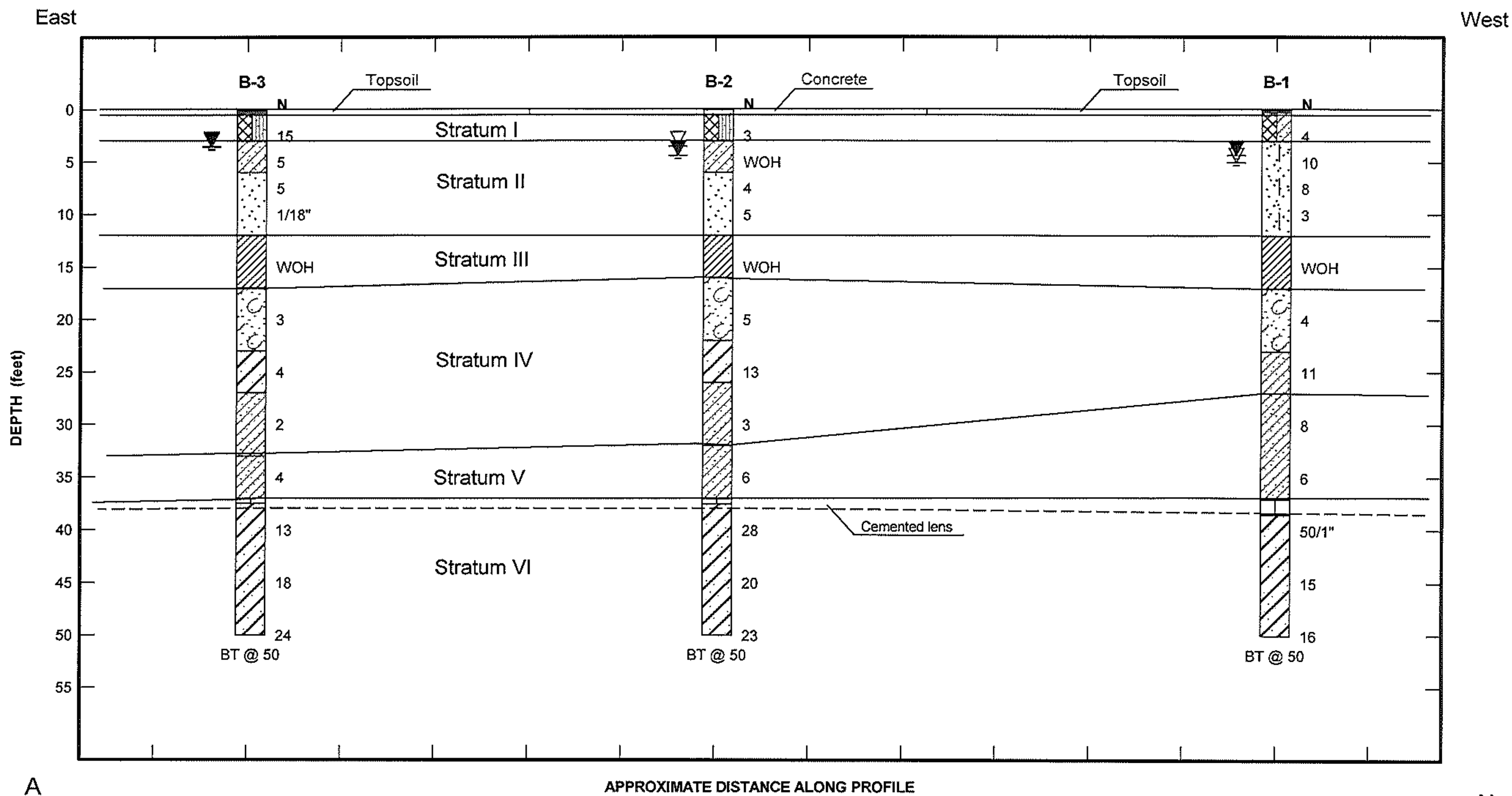
INTERPRETED SUBSURFACE PROFILE



SCALE: NTS	S&ME	Site Vicinity Plan CCU – Kimbel Information Commons Conway, South Carolina	FIGURE NO 1
SOURCE: Mapquest.com			
DRAWN BY: JDL			
DATE: October, 2009		JOB NO. 1633-09-251	



Scale: NTS	S&ME	Test Location Sketch CCU - Kimbel Information Commons Conway, South Carolina	FIGURE NO
Checked By: RPF			2
Drawn By: JDL			
Date: October, 2009		Project No: 1633-09-251	



Fill
Topsoil
SP/SM, Poorly-graded Sand with Silt
CL, Low Plasticity Clay
Shell Hash
SC, Clayey Sand
Limestone
Sandy Lean Clay, CL
Concrete
SP, Poorly-graded Sand
SM, Silty Sand

LEGEND:
Stratum I - Near Surface Sands (Fill)
Stratum II - Liquefiable Sands
Stratum III - Compressible Clays
Stratum IV - Clayey Sands and Lean Clay with Shell Fragments
Stratum V - Clayey Sands with Cemented Sands and Shells
Stratum VI - Clays with Cemented Lenses (Pee Dee Formation)

N = Standard Penetration Test resistance value (blows per foot). The depicted stratigraphy is shown for illustrative purposes only. The actual subsurface conditions will vary between boring locations.

JOB NO: 1633-09-251	S&ME	**1330 U.S. Highway 501 Bus.**	Diagram: Profile A-A'	Figure:
DATE: 11/3/09		**Conway, South Carolina 29526**	Project: CCU - Kimbel Information Commons Location: Conway, South Carolina	3

APPENDIX B

SUMMARY OF EXPLORATION PROCEDURES

SOIL CLASSIFICATION LEGEND

SPT BORING LOGS

SUMMARY OF EXPLORATION PROCEDURES

The American Society for Testing and Materials (ASTM) publishes standard methods to explore soil, rock and ground water conditions in Practice D-420-98, "*Standard Guide to Site Characterization for Engineering Design and Construction Purposes.*" The boring and sampling plan must consider the geologic or topographic setting. It must consider the proposed construction. It must also allow for the background, training, and experience of the geotechnical engineer. While the scope and extent of the exploration may vary with the objectives of the client, each exploration includes the following key tasks:

- Reconnaissance of the Project Area
- Preparation of Exploration Plan
- Layout and Access to Field Sampling Locations
- Field Sampling and Testing of Earth Materials
- Laboratory Evaluation of Recovered Field Samples
- Evaluation of Subsurface Conditions

The standard methods do not apply to all conditions or to every site. Nor do they replace education and experience, which together make up engineering judgment. Finally, ASTM D 420 does not apply to environmental investigations.

RECONNAISSANCE OF THE PROJECT AREA

Where practical, we reviewed available topographic maps, county soil surveys, reports of nearby investigations and aerial photographs when preparing the boring and sampling plan. Then we walked over the site to note land use, topography, ground cover, and surface drainage. We observed general access to proposed sampling points and noted any existing structures.

Checks for Hazardous Conditions - State law requires that we notify the Palmetto Utility Protection Service (PUPS) before we drill or excavate at any site. PUPS is operated by the major water, sewer, electrical, telephone, CATV, and natural gas suppliers of South Carolina. PUPS forwarded our location request to the participating utilities. Location crews then marked buried lines with colored flags within 72 hours. They did not mark utility lines beyond junction boxes or meters. We checked proposed sampling points for conflicts with marked utilities, overhead power lines, tree limbs, or man-made structures during the site walkover.

BORING AND SAMPLING

Soil Test Boring with Rotary Wash

Soil sampling and penetration testing were performed in general accordance with ASTM D1586, *"Standard Test Method for Penetration Test and Split Barrel Sampling of Soils.* A rotary drilling process was used to advance the hole and a heavy drilling fluid was circulated in the bore holes to stabilize the sides and flush the cuttings. At regular intervals, drilling tools were removed and soil samples were obtained with a standard 1.4 inch I. D., two-inch O. D., split barrel sampler. The sampler was first seated six inches to penetrate any loose cuttings, then driven an additional 12 inches with blows of a 140-pound hammer falling 30 inches. The number of hammer blows required to drive the sampler through the two final six inch increments was recorded as the penetration resistance (SPT N) value. The N-value, when properly interpreted by qualified professional staff, is an index of the soil strength and foundation support capability.

Water Level Determination

Subsurface water levels in the boreholes were measured during the onsite exploration by measuring depths from the existing grade to the current water level using a tape.

Backfilling of Borings

Once subsurface water levels were obtained, boring spoils and loose cuttings created during the drilling process were backfilled into the open bore hole. Bore holes were backfilled to the existing ground surface.

SOIL CLASSIFICATION CHART

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

S&ME

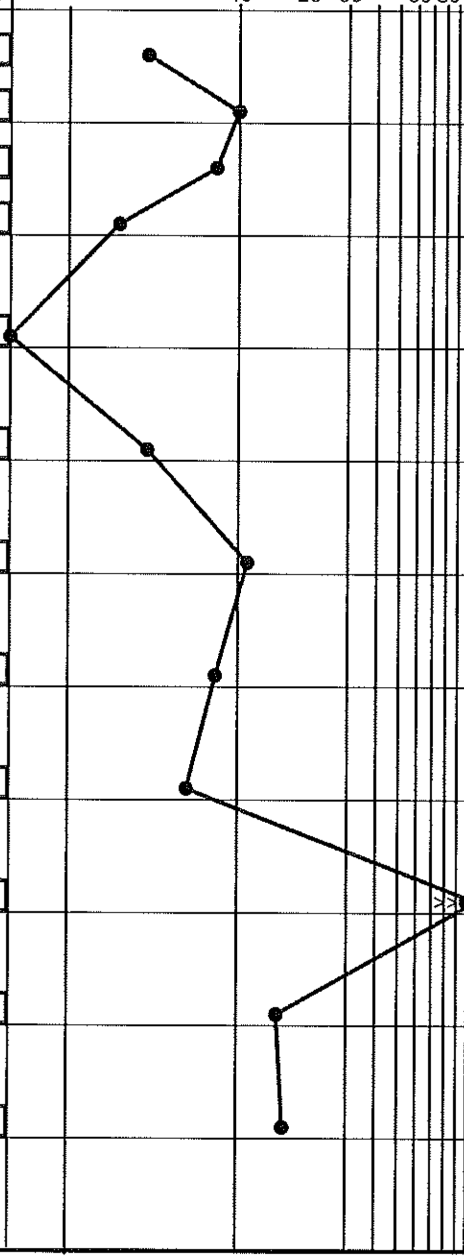
PROJECT:	CCU - Kimbel Information Commons Conway, South Carolina 1633-09-251	BORING LOG B-1

DATE DRILLED:	10/13/2009	ELEVATION:	unknown
DRILLING METHOD:	Mud Rotary	BORING DEPTH:	50 feet
LOGGED BY:	JDL	WATER LEVEL:	5 feet at TOB; 4.3 feet after 24 hrs.
DRILLER:	George Bridger	DRILL RIG:	CME 45-B

NOTES:

DEPTH (feet)	MATERIAL DESCRIPTION	SAMPLE NO.	N VALUE
	TOPSOIL (Approximately 4")	1	4
5	CLAYEY SAND (SC) - FILL - Mostly fine to medium sand, some low to medium plasticity fines, tan, moist, very loose.	2	10
	POORLY GRADED SAND WITH SILT (SP-SM) - Mostly fine to medium sand, few low to medium plasticity fines, brown, moist to saturated, loose to very loose.	3	8
10		4	3
15	LEAN CLAY WITH SAND (CL) - Mostly medium plasticity fines, some fine sand, gray, saturated, very soft.	5	WOH
20	CLAYEY SAND (SC) - SHELL HASH - Mostly fine to medium sand and sand-sized shell particles, some low to medium plasticity fines, gray, saturated, very loose.	6	4
25	CLAYEY SAND (SC) - Mostly fine to medium sand, some low to medium plasticity fines, green to gray, wet, medium dense.	7	11
30	CLAYEY SAND (SC) - Mostly fine to medium sand, some low to medium plasticity fines, some shell and cemented particles, light gray, saturated, loose.	8	8
35		9	6
	- Cemented Limestone Lens (Approxmiately 18 inches thick).		
40	SANDY LEAN CLAY (CL) - PEE DEE FORMATION - Mostly low to medium plasticity fines, some fine to medium sand, gray, moist to wet, stiff to very stiff.	10	50/ 1"
45		11	15
50		12	16
	- Boring terminated at 50 feet.		

STANDARD PENETRATION TEST DATA (blows/ft)



NOTES:

1. *THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.*
2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

S&ME

PROJECT:	CCU - Kimbel Information Commons Conway, South Carolina 1633-09-251	BORING LOG B-2

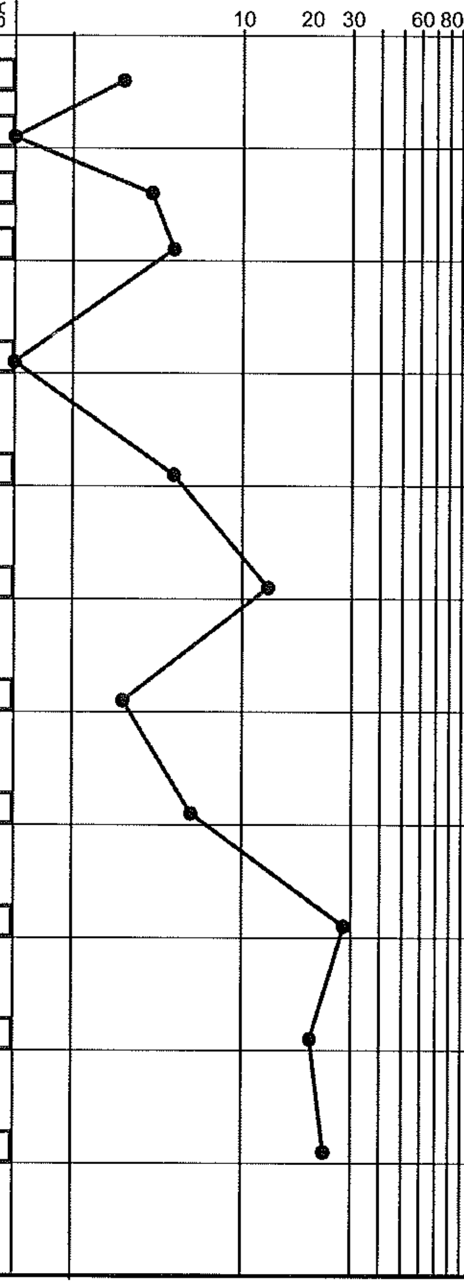
DATE DRILLED:	10/13/2009	ELEVATION:	unknown
DRILLING METHOD:	Mud Rotary	BORING DEPTH:	50 feet
LOGGED BY:	JDL	WATER LEVEL:	3.5 feet at TOB; 4.4 feet after 24 hrs.
DRILLER:	George Bridger	DRILL RIG:	CME 45-B

NOTES:

DEPTH (feet)	MATERIAL DESCRIPTION
	CONCRETE (Approximately 5.5 inches thick)
5	SILTY SAND (SM) - FILL - Mostly fine to medium sand, some low to medium plasticity fines, brown, moist to wet, medium dense.
	CLAYEY SAND (SC) - Mostly fine to medium sand, some medium to high plastic fines, tan, wet to saturated, loose.
10	POORLY GRADED SAND (SP) - Mostly fine to medium sand, trace fines, brown, moist to saturated, loose to very loose.
15	LEAN CLAY WITH SAND (CL) - Mostly medium plasticity fines, some fine sand, gray, saturated, very soft.
20	CLAYEY SAND (SC) - SHELL HASH - Mostly fine to medium sand and sand-sized shell particles, some low to medium plasticity fines, gray, saturated, loose.
25	SANDY LEAN CLAY (CL) - Mostly medium plastic fines, some fine sand, gray, saturated, stiff.
30	CLAYEY SAND (SC) - Mostly fine to medium sand, some low to medium plasticity fines, gray, saturated, very loose.
35	CLAYEY SAND (SC) - Mostly fine to medium sand, some low to medium plasticity fines, some shell and cemented particles, light gray, saturated, loose.
	- Cemented Limestone Lens (Approxmiately 6 inches thick).
40 / 45	SANDY LEAN CLAY (CL) - PEE DEE FORMATION - Mostly low to medium plasticity fines, some fine to medium sand, gray, moist to wet, very stiff.
50	- Boring terminated at 50 feet.

SAMPLE NO.	N VALUE
1	3
2	WOH
3	4
4	5
5	WOH
6	5
7	13
8	3
9	6
10	28
11	20
12	23

STANDARD PENETRATION TEST DATA (blows/ft)



BORING LOG 1633-09-251.GPJ WITH CPT.GDT 11/3/09

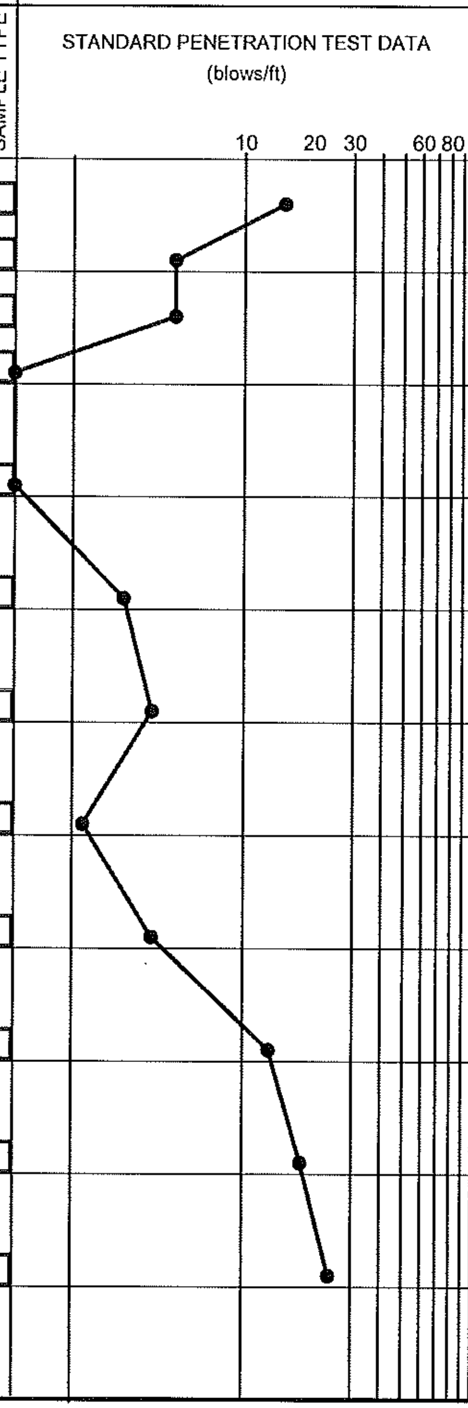
NOTES:

1. *THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.*
2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

S&ME

PROJECT:	CCU - Kimbel Information Commons Conway, South Carolina 1633-09-251	BORING LOG	B-3
DATE DRILLED: 10/13/2009	ELEVATION: unknown	NOTES:	
DRILLING METHOD: Mud Rotary	BORING DEPTH: 50 feet		
LOGGED BY: JDL	WATER LEVEL: 3.5 feet at TOB; 3.6 feet after 24 hrs.		
DRILLER: George Bridger	DRILL RIG: CME 45-B		

DEPTH (feet)	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	N VALUE
0	TOPSOIL (Approximately 6")				
	SILTY SAND (SM) - FILL - Mostly fine to medium sand, some low to medium plasticity fines, brown, moist to wet, medium dense.	▼		1	15
5				2	5
	CLAYEY SAND (SC) - Mostly fine to medium sand, some low to medium plasticity fines, tan, moist, loose.			3	5
10	POORLY GRADED SAND (SP) - Mostly fine to medium sand, trace fines, brown, moist to saturated, loose to very loose.			4	1/18"
15	LEAN CLAY WITH SAND (CL) - Mostly medium plasticity fines, some fine sand, gray, saturated, very soft.			5	WOH
20	CLAYEY SAND (SC) - SHELL HASH - Mostly fine to medium sand and sand-sized shell particles, some low to medium plasticity fines, gray, saturated, very loose.			6	3
25	SANDY LEAN CLAY (CL) - Mostly medium plasticity fines, some fine sand, gray, saturated, soft.			7	4
30	CLAYEY SAND (SC) - Mostly fine to medium sand, some low to medium plasticity fines, gray, wet, very loose.			8	2
35	CLAYEY SAND (SC) - Mostly fine to medium sand, some low to medium plasticity fines, some shell and cemented particles, light gray, saturated, very loose.			9	4
	- Cemented Limestone Lens (Approxmiately 6 inches thick).				
40	SANDY LEAN CLAY (CL) - PEE DEE FORMATION - Mostly low to medium plasticity fines, some fine to medium sand, gray, moist to wet, very stiff.			10	13
45				11	18
50	- Boring terminated at 50 feet.			12	24



BORING LOG 1633-09-251.GPJ WITH CPT.GDT 11/3/09

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S&ME

APPENDIX C

SUMMARY OF LABORATORY PROCEDURES

LABORATORY TEST RESULTS

SUMMARY OF LABORATORY PROCEDURES

Examination of Recovered Soil Samples

Soil and field records were reviewed in the laboratory by the geotechnical professional. Soils were classified in general accordance with the visual-manual method described in ASTM D 2488, "*Standard Practice for Description and Identification of Soils (Visual-Manual Method)*". Representative soil samples were selected for classification testing to provide grain size and plasticity data to allow classification of the samples in general accordance with the Unified Soil Classification System method described in ASTM D 2487, "*Standard Practice for Classification of Soils for Engineering Purposes*". The geotechnical professional also prepared the final boring and sounding records enclosed with this report.

Moisture Content Testing of Soil Samples by Oven Drying

Moisture content was determined in general conformance with the methods outlined in ASTM D 2216, "*Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil or Rock by Mass.*" This method is limited in scope to Group B, C, or D samples of earth materials which do not contain appreciable amounts of organic material, soluble solids such as salt or reactive solids such as cement. This method is also limited to samples which do not contain contamination.

A representative portion of the soil was divided from the sample using one of the methods described in Section 9 of ASTM D 2216. The split portion was then placed in a drying oven and heated to approximately 110 degrees C overnight or until a constant mass was achieved after repetitive weighing. The moisture content of the soil was then computed as the mass of water removed from the sample by drying, divided by the mass of the sample dry, times 100 percent. No attempt was made to exclude any particular particle size from the portion split from the sample.

Liquid and Plastic Limits Testing

Atterberg limits of the soils was determined generally following the methods described by ASTM D 4318, "*Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.*" Albert Atterberg originally defined "limits of consistency" of fine grained soils in terms of their relative ease of deformation at various moisture contents. In current engineering usage, the *liquid limit* of a soil is defined as the moisture content, in percent, marking the upper limit of viscous flow and the boundary with a semi-liquid state. The *plastic limit* defines the lower limit of plastic behavior, above which a soil behaves plastically below which it retains its shape upon drying. The *plasticity index* (PI) is the range of water content over which a soil behaves plastically. Numerically, the PI is the difference between liquid limit and plastic limit values.

Representative portions of fine grained Group A, B, C, or D samples were prepared using the wet method described in Section 10.1 of ASTM D 4318. The liquid limit of each sample was determined using the multipoint method (Method A) described in Section 11. The liquid limit is by definition the moisture content where 25 drops of a hand operated liquid limit device are required to close a standard width groove cut in a soil sample placed in the device. After each test, the moisture content of the sample was adjusted and the sample replaced in the device. The test was repeated to provide a minimum of three widely spaced combinations of N versus moisture content. When plotted on semi-log paper, the liquid limit moisture content was determined by straight line interpolation between the data points at N equals 25 blows.

The plastic limit was determined using the procedure described in Section 17 of ASTM D 4318. A selected portion of the soil used in the liquid limit test was kneaded and rolled by hand until it could no longer be rolled to a 3.2 mm thread on a glass plate. This procedure was repeated until at least 6 grams of material was accumulated, at which point the moisture content was determined using the methods described in ASTM D 2216.

Grain Size Analysis of Samples

The distribution of particle sizes greater than 75 mm was determined in general accordance with the procedures described by ASTM D 421, "*Standard Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants", and D 422, "Standard Test Method for Particle Size Analysis of Soils*," except that the hydrometer portion of the test standard was not utilized. During preparation samples were divided into two portions. The material coarser than the No. 30 U.S. sieve size fraction was dry sieved through a nest of standard sieves as described in Article 6. Material passing the No. 30 sieve was independently passed through a nest of sieves down to the No. 200 size.

Percent Fines Determination of Samples

A selected specimen of soils was washed over a No. 200 sieve after being thoroughly mixed and dried. This test was conducted in general accordance with ASTM D 1140, "*Standard Test Method for Amount of Material Finer Than the No. 200 Sieve.*" Method A, using water to wash the sample through the sieve without soaking the sample for a prescribed period of time, was used and the percentage by weight of material washing through the sieve was deemed the "percent fines" or percent clay and silt fraction.

Laboratory Determination of Water Content

ASTM D 2216 ☑ AASHTO T 265 ☐ *Quality Assurance*

S&ME, Inc. Myrtle Beach 1330 Highway 501 Business; Conway, SC 29526

Project #:	**1633-09-251**	Report Date:	10/20/2009
Project Name:	Kimbel Information Commons	Test Date(s):	10/15/2009
Client Name:	Coastal Carolina University		
Client Address:	Post OfficeBox 261954; Conway, SC 29528		
Sample by:	J. Laps	Sample Date(s):	10/14/2009
Sampling Method:	Boreholes	Lab #:	2310

Method: **A (1%)** ☐ **B (0.1%)** ☑ *Balance ID.* *Calibration Date:*

Boring No.	Sample No.	Sample Depth	Tare #	Tare Weight	Tare Wt.+ Wet Wt	Tare Wt. + Dry Wt	Water Weight	Percent Moisture	Note
		ft.		grams	grams	grams	grams	%	
B-2	S-3	6.0'-7.5'	III	83.40	362.90	295.40	67.50	**31.8%**	
B-3	S-4	8.5'-10.0'	C	89.00	320.50	276.00	44.50	**23.8%**	
B-3	S-5	13.5'-15.0'	GGG	83.80	196.60	159.10	37.50	**49.8%**	

Notes / Deviations / References

AASHTO T 265: Laboratory Determination of Moisture Content of Soils

ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

Joseph Laps		Project Engineer	10-30-09
Technical Responsibility	*Signature*	*Position*	*Date*

Form No: TR-D422-WH-1
Revision No. 0
Revision Date: 07/14/08

Sieve Analysis of Soils

ASTM D 422

Quality Assurance

S&ME, Inc. - Myrtle Beach 1330 Highway 501 Business; Conway, SC 29526

Project #:	**1633-09-251**	Report Date:	10/20/2009
Project Name:	Kimbel Information Commons	Test Date(s):	10/15/2009
Client Name:	Coastal Carolina University		
Client Address:	Post Office Box 261954; Conway, SC 29528		

Boring #	B-2	Sample #:	S-3	Sample Date:	10/14/2009
Location:	Boreholes	Lab #:	2310	Depth:	6.0'-7.5'

Sample Description: Brown Poorly Graded Sand (SP)

Description of Sand & Gravel Particles: Rounded ☐ Angular ☒
Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Particle Size Analysis / Without Hydrometer Analysis				*Material Excluded:*	
Tare No.	**III**	Tare Wt.	**83.4**	Mass of Sample after Wash + Tare Wt.	
Total Sample Wet Wt. + Tare Wt.			**362.9**	Mass of Sample after Wash	
Total Sample Dry Wt. + Tare Wt.			**295.4**	Mass passing #200	
Total Sample Dry Weight			**212.0**	% Passing #200 **(D1140)**	

Sieve Size		**Retained Weight**	**% Retained Between Sieves**	**% Retained**	**% Passing**	**SPECS**
				Cumulative		
Standard	*mm.*	*Cumulative*	*Individual*	***Total Sample***		
2.0"	50.00	0.0	0.0%	0.0%	**100.0%**	
1.5"	37.50	0.0	0.0%	0.0%	**100.0%**	
1.0"	25.00	0.0	0.0%	0.0%	**100.0%**	
3/4"	19.00	0.0	0.0%	0.0%	**100.0%**	
1/2"	12.50	0.0	0.0%	0.0%	**100.0%**	
3/8"	9.50	0.0	0.0%	0.0%	**100.0%**	
#4	4.75	0.3	0.1%	0.1%	**99.9%**	
#10	2.000	1.1	0.4%	0.5%	**99.5%**	
#30	0.600	46.1	21.2%	21.7%	**78.3%**	
#40	0.425	100.0	25.4%	47.2%	**52.8%**	
#60	0.250	183.6	39.4%	86.6%	**13.4%**	
#100	0.150	206.5	10.8%	97.4%	**2.6%**	
#200	0.075	208.1	0.7%	98.2%	**1.8%**	
Pan	<0.075			**% Passing #200 (D1140) =**		**1.8%**

D2487	Maximum Particle Size	9.5 mm	Medium Sand	< 2.00 mm and > 0.425 mm (#40)	46.7%
Gravel	< 75 mm and > 4.75 mm (#4)	0.1%	Fine Sand	< 0.425 mm and > 0.075 mm (#200)	51.0%
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	0.4%	% Silt & Clay	< 0.075 mm	1.8%

Notes / Deviations / References:

Joseph Laps		Project Engineer	10-30-09
Technical Responsibility	*Signature*	*Position*	*Date*

Form No: TR-D422-WH-1Ga
Revision No. 0
Revision Date: 07/14/08

Sieve Analysis of Soils

ASTM D 422

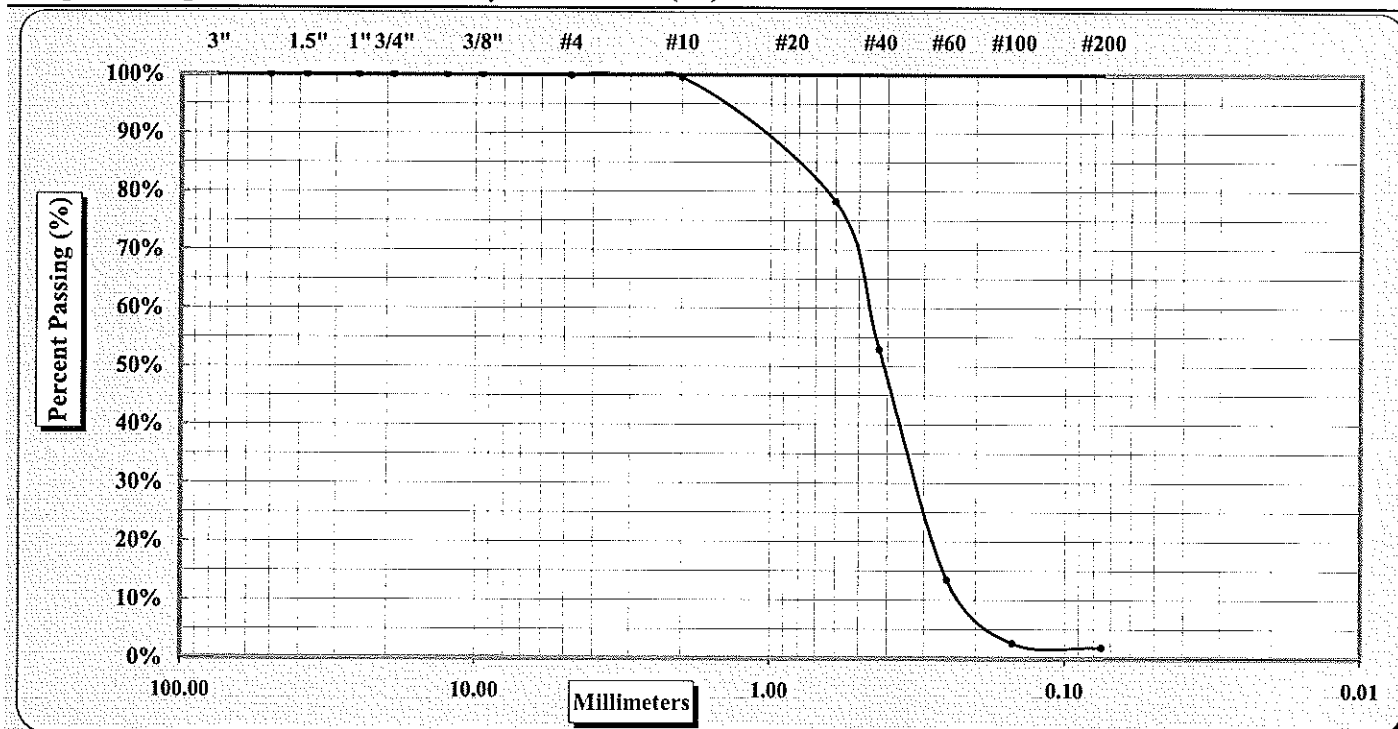
Quality Assurance

S&ME, Inc. - Myrtle Beach 1330 Highway 501 Business; Conway, SC 29526

Project #:	**1633-09-251**	Report Date:	10/20/2009
Project Name:	Kimbel Information Commons	Test Date(s):	10/15/2009
Client Name:	Coastal Carolina University		
Client Address:	Post Office Box 261954; Conway, SC 29528		

Boring #	B-2	Sample #:	S-3	Sample Date:	10/14/2009
Location:	Boreholes	Lab #:	2310	Depth:	6.0'-7.5'

Sample Description: Brown Poorly Graded Sand (SP)



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	9.5 mm	Coarse Sand	0.4%	Fine Sand	51.0%
Gravel	0.1%	Medium Sand	46.7%	Silt & Clay	1.8%
Liquid Limit	--	Plastic Limit	NP	Plastic Index	--
Specific Gravity	--- Cc = 1.025	Cu =	1.958	Moisture Content	31.8%
Coarse Sand	0.4%	Medium Sand	46.7%	Fine Sand	51.0%

Description of Sand & Gravel Particles: Rounded ☐ Angular ☒
Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Notes / Deviations / References:

Joseph Laps	[signature]	Project Engineer	10-30-09
Technical Responsibility	*Signature*	*Position*	*Date*

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Form No. TR-D4318-T89-90 | Client code | Client Test # | state #
Revision No. 0
Revision Date: 11/20/07

Liquid Limit, Plastic Limit, and Plastic Index

S&ME

Another code | ASTM D 4318 ☒ | AASHTO T 89 ☐ | AASHTO T 90 ☐ | Quality Assurance

S&ME, Inc. Myrtle Beach 1330 Highway 501 Business; Conway, SC 29526

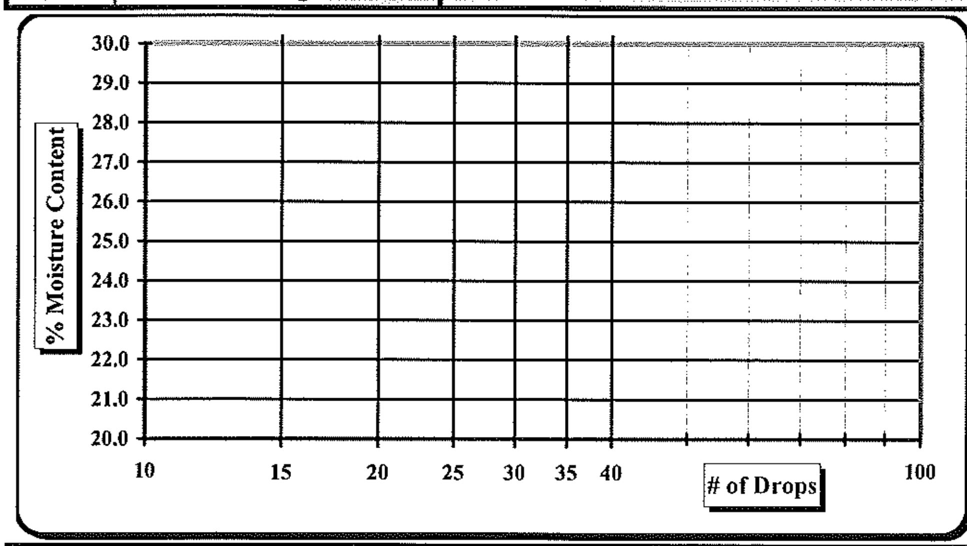
Project #:	**1633-09-251**	Report Date:	10/20/2009
Project Name:	Kimbel Information Commons	Test Date(s)	10/15/2009
Client Name:	Coastal Carolina University		
Client Address:	Post Office Box 261954; Conway, SC 29528		

Boring #:	B-2	Sample #:	S-3	Sample Date:	10/14/2009
Location:	Boreholes	Lab #:	2310	Depth:	6.0'-7.5'

Sample Description: Brown Poorly Graded Sand (SP)

Type and Specification	S&ME ID #	Cal Date:	Type and Specification	S&ME ID #	Cal Date:
Balance (0.01 g)	007-008	2/14/2009	Grooving tool	11304	7/8/2009
LL Apparatus	18801	7/24/2009			
Oven	17745	4/9/2009			

Pan #		Liquid Limit						Plastic Limit		
	Tare #:	1	2	3	4	5	6	7	8	9
A	Tare Weight									
B	Wet Soil Weight + A								NP	
C	Dry Soil Weight + A									
D	Water Weight (B-C)									
E	Dry Soil Weight (C-A)									
F	% Moisture (D/E)*100									
N	# OF DROPS							Moisture Contents determined by ASTM D 2216		
LL	LL = F * FACTOR									
Ave.	Average									



One Point Liquid Limit

N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.99	29	1.018
24	0.995	30	1.022
25	1.000		

NP, Non-Plastic	☒
Liquid Limit	
Plastic Limit	NP
Plastic Index	
Group Symbol	SP
Multipoint Method	☑
One-point Method	☑

Wet Preparation ☐ Dry Preparation ☑ Air Dried ☑

Notes / Deviations / References:

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils

Joseph Laps		Project Engineer	10-30-09
Technical Responsibility	*Signature*	*Position*	*Date*

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Sieve Analysis of Soils

ASTM D 422

Quality Assurance

S&ME, Inc. - Myrtle Beach 1330 Highway 501 Business; Conway, SC 29526

Project #:	**1633-09-251**	Report Date:	10/20/2009
Project Name:	Kimbel Information Commons	Test Date(s):	10/15/2009
Client Name:	Coastal Carolina University		
Client Address:	Post Office Box 261954; Conway, SC 29528		

Boring #	B-3	Sample #:	S-4	Sample Date:	10/14/2009
Location:	Boreholes	Lab #:	2310	Depth:	8.5'-10.0'

Sample Description: Brown Poorly Graded Sand (SP)

Description of Sand & Gravel Particles: Rounded ☐ Angular ☒
Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Particle Size Analysis / Without Hydrometer Analysis				*Material Excluded:*	
Tare No.	C	Tare Wt.	**89.0**	Mass of Sample after Wash + Tare Wt.	
Total Sample Wet Wt. + Tare Wt.			**320.5**	Mass of Sample after Wash	
Total Sample Dry Wt. + Tare Wt.			**276.0**	Mass passing #200	
Total Sample Dry Weight			**187.0**	% Passing #200 **(D1140)**	

Sieve Size		**Retained Weight**	**% Retained Between Sieves**	**% Retained**	**% Passing**	**SPECS**
Standard	*mm.*	*Cumulative*	*Individual*	*Cumulative Total Sample*		
2.0"	50.00	0.0	0.0%	0.0%	**100.0%**	
1.5"	37.50	0.0	0.0%	0.0%	**100.0%**	
1.0"	25.00	0.0	0.0%	0.0%	**100.0%**	
3/4"	19.00	0.0	0.0%	0.0%	**100.0%**	
1/2"	12.50	0.0	0.0%	0.0%	**100.0%**	
3/8"	9.50	0.0	0.0%	0.0%	**100.0%**	
#4	4.75	0.8	0.4%	0.4%	**99.6%**	
#10	2.000	16.6	8.4%	8.9%	**91.1%**	
#30	0.600	100.7	45.0%	53.9%	**46.1%**	
#40	0.425	109.8	4.9%	58.7%	**41.3%**	
#60	0.250	127.2	9.3%	68.0%	**32.0%**	
#100	0.150	175.7	25.9%	94.0%	**6.0%**	
#200	0.075	182.8	3.8%	97.8%	**2.2%**	
Pan	<0.075	183.4		**% Passing #200 (D1140) =**		**2.2%**

D2487	Maximum Particle Size	9.5 mm	Medium Sand	< 2.00 mm and > 0.425 mm (#40)	49.8%
Gravel	< 75 mm and > 4.75 mm (#4)	0.4%	Fine Sand	< 0.425 mm and > 0.075 mm (#200)	39.0%
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	8.4%	% Silt & Clay	< 0.075 mm	2.2%

Notes / Deviations / References:

Joseph Laps	[signature]	Project Engineer	10-30-09
Technical Responsibility	*Signature*	*Position*	*Date*

Form No: TR-D422-WH-1Ga
Revision No. 0
Revision Date: 07/14/08

Sieve Analysis of Soils

S&ME

ASTM D 422

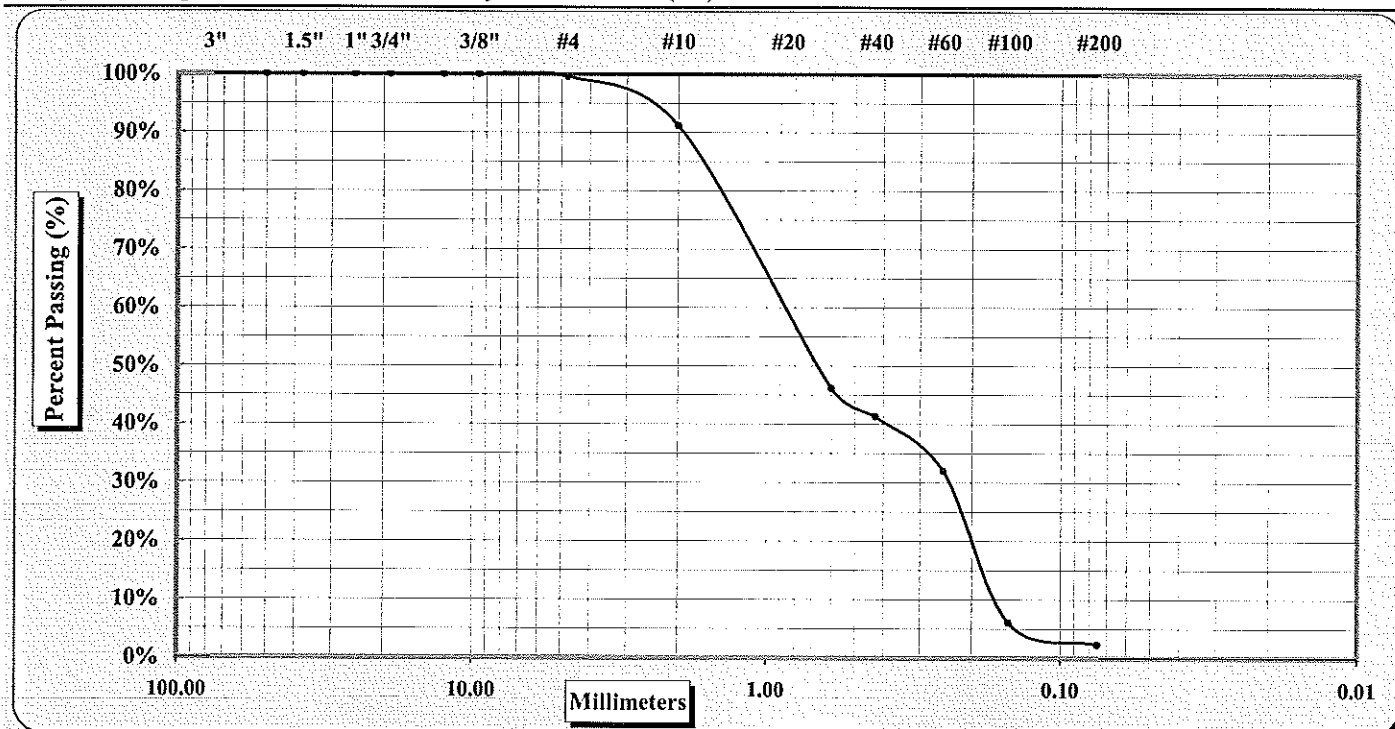
Quality Assurance

S&ME, Inc. - Myrtle Beach 1330 Highway 501 Business; Conway, SC 29526

Project #:	**1633-09-251**	Report Date:	10/20/2009
Project Name:	Kimbel Information Commons	Test Date(s):	10/15/2009
Client Name:	Coastal Carolina University		
Client Address:	Post Office Box 261954; Conway, SC 29528		

Boring #	B-3	Sample #:	S-4	Sample Date:	10/14/2009
Location:	Boreholes	Lab #:	2310	Depth:	8.5'-10.0'

Sample Description: Brown Poorly Graded Sand (SP)



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	9.5 mm	Coarse Sand	8.4%	Fine Sand	39.0%
Gravel	0.4%	Medium Sand	49.8%	Silt & Clay	2.2%
Liquid Limit	--	Plastic Limit	NP	Plastic Index	--
Specific Gravity	--- Cc = 0.471	Cu =	4.588	Moisture Content	23.8%
Coarse Sand	8.4%	Medium Sand	49.8%	Fine Sand	39.0%

Description of Sand & Gravel Particles: Rounded ☐ Angular ☒
Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Notes / Deviations / References:

Joseph Laps		Project Engineer	10-30-09
Technical Responsibility	*Signature*	*Position*	*Date*

Form No. TR-D4318-T89-90 Client code Client Test # state #
Revision No. 0
Revision Date: 11/20/07

Liquid Limit, Plastic Limit, and Plastic Index

S&ME

Another code ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐ *Quality Assurance*

S&ME, Inc. Myrtle Beach 1330 Highway 501 Business; Conway, SC 29526

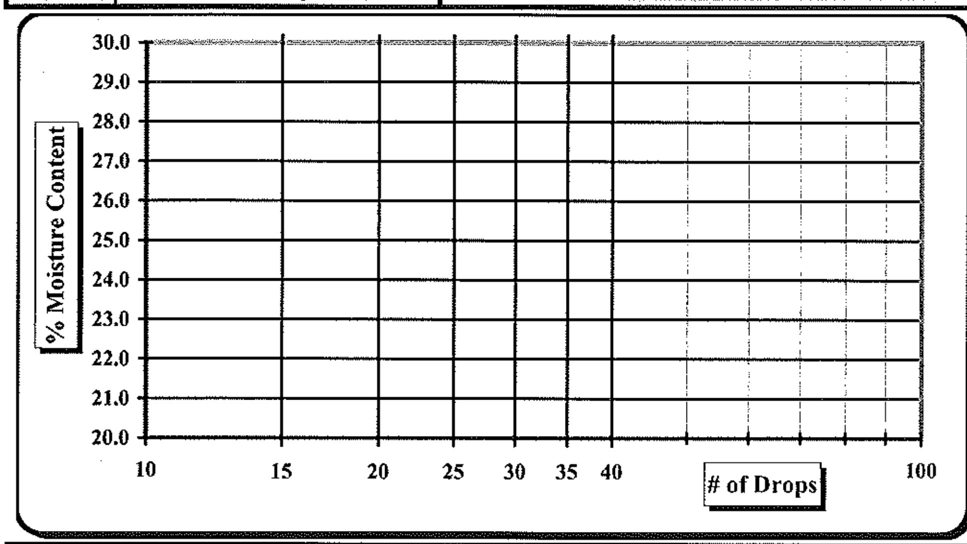
Project #:	**1633-09-251**	Report Date:	10/20/2009
Project Name:	Kimbel Information Commons	Test Date(s)	10/15/2009
Client Name:	Coastal Carolina University		
Client Address:	Post Office Box 261954; Conway, SC 29528		

Boring #:	B-3	Sample #:	S-4	Sample Date:	10/14/2009
Location:	Boreholes	Lab #:	2310	Depth:	8.5'-10.0'

Sample Description: Brown Poorly Graded Sand (SP)

Type and Specification	*S&ME ID #*	*Cal Date:*	*Type and Specification*	*S&ME ID #*	*Cal Date:*
Balance (0.01 g)	007-008	2/14/2009	Grooving tool	11304	7/8/2009
LL Apparatus	18801	7/24/2009			
Oven	17745	4/9/2009			

Pan #		Liquid Limit						Plastic Limit		
	Tare #:	1	2	3	4	5	6	7	8	9
A	Tare Weight									
B	Wet Soil Weight + A								NP	
C	Dry Soil Weight + A									
D	Water Weight (B-C)									
E	Dry Soil Weight (C-A)									
F	% Moisture (D/E)*100									
N	# OF DROPS							*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	*Average*									



One Point Liquid Limit

N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.99	29	1.018
24	0.995	30	1.022
25	1.000		

NP, Non-Plastic	☒
Liquid Limit	
Plastic Limit	**NP**
Plastic Index	
Group Symbol	**SP**
Multipoint Method	☑
One-point Method	☑

Wet Preparation ☐ Dry Preparation ☑ Air Dried ☑

Notes / Deviations / References:

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils

Joseph Laps	[signature]	Project Engineer	10-30-09
Technical Responsibility	*Signature*	*Position*	*Date*

Form No: TR-D422-WH-1
Revision No. 0
Revision Date: 07/14/08

Sieve Analysis of Soils

ASTM D 422

Quality Assurance

S&ME, Inc. - Myrtle Beach 1330 Highway 501 Business; Conway, SC 29526

Project #:	**1633-09-251**	Report Date:	10/20/2009
Project Name:	Kimbel Information Commons	Test Date(s):	10/15/2009
Client Name:	Coastal Carolina University		
Client Address:	Post Office Box 261954; Conway, SC 29528		

Boring #	B-3	Sample #:	S-5	Sample Date:	10/14/2009
Location:	Boreholes	Lab #:	2310	Depth:	13.5'-15.0'

Sample Description: Gray Lean Clay with Sand (CL)

Description of Sand & Gravel Particles: Rounded ☐ Angular ☒
Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Particle Size Analysis / Without Hydrometer Analysis				*Material Excluded:*	
Tare No.	**GGG**	Tare Wt.	**83.8**	Mass of Sample after Wash + Tare Wt.	
Total Sample Wet Wt. + Tare Wt.			**196.6**	Mass of Sample after Wash	
Total Sample Dry Wt. + Tare Wt.			**159.1**	Mass passing #200	
Total Sample Dry Weight			**75.3**	% Passing #200 **(D1140)**	

Sieve Size		**Retained Weight**	**% Retained Between Sieves**	**% Retained**	**% Passing**	**SPECS**
				Cumulative		
Standard	*mm.*	*Cumulative*	*Individual*	*Total Sample*		
2.0"	50.00	0.0	0.0%	0.0%	**100.0%**	
1.5"	37.50	0.0	0.0%	0.0%	**100.0%**	
1.0"	25.00	0.0	0.0%	0.0%	**100.0%**	
3/4"	19.00	0.0	0.0%	0.0%	**100.0%**	
1/2"	12.50	0.0	0.0%	0.0%	**100.0%**	
3/8"	9.50	0.0	0.0%	0.0%	**100.0%**	
#4	4.75	0.0	0.0%	0.0%	**100.0%**	
#10	2.000	0.5	0.7%	0.7%	**99.3%**	
#30	0.600	1.6	1.5%	2.1%	**97.9%**	
#40	0.425	2.3	0.9%	3.1%	**96.9%**	
#60	0.250	3.5	1.6%	4.6%	**95.4%**	
#100	0.150	6.4	3.9%	8.5%	**91.5%**	
#200	0.075	20.5	18.7%	27.2%	**72.8%**	
Pan	<0.075	24.3		**% Passing #200 (D1140) =**		**72.8%**

D2487	Maximum Particle Size	4.75 mm	Medium Sand	< 2.00 mm and > 0.425 mm (#40)	2.4%
Gravel	< 75 mm and > 4.75 mm (#4)	0.0%	Fine Sand	< 0.425 mm and > 0.075 mm (#200)	24.2%
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	0.7%	% Silt & Clay	< 0.075 mm	72.8%

Notes / Deviations / References:

Joseph Laps		Project Engineer	10-30-09
Technical Responsibility	*Signature*	*Position*	*Date*

Form No: TR-D422-WH-1Ga
Revision No. 0
Revision Date: 07/14/08

Sieve Analysis of Soils

ASTM D 422

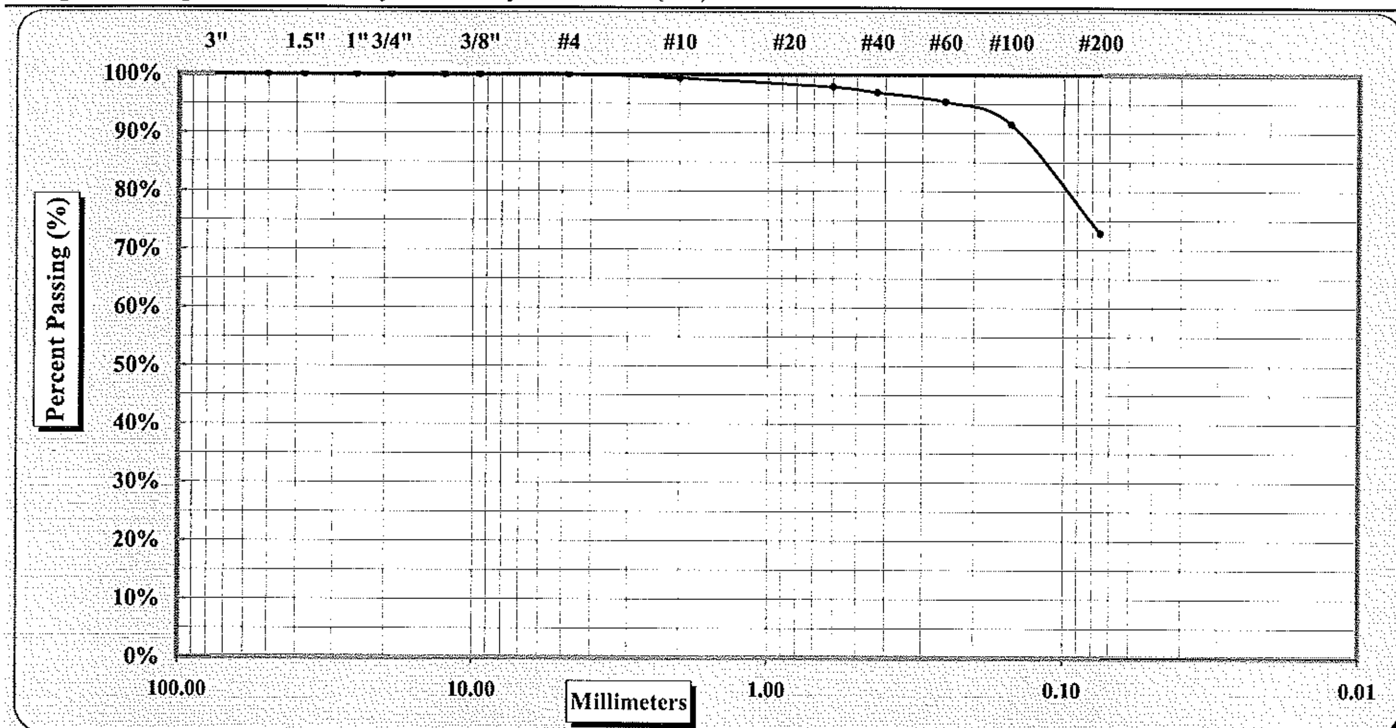
Quality Assurance

S&ME, Inc. - Myrtle Beach 1330 Highway 501 Business; Conway, SC 29526

Project #:	**1633-09-251**	Report Date:	10/20/2009
Project Name:	Kimbel Information Commons	Test Date(s):	10/15/2009
Client Name:	Coastal Carolina University		
Client Address:	Post Office Box 261954; Conway, SC 29528		

Boring #	B-3	Sample #:	S-5	Sample Date:	10/14/2009
Location:	Boreholes	Lab #:	2310	Depth:	13.5'-15.0'

Sample Description: Gray Lean Clay with Sand (CL)



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Coarse Sand	0.7%	Fine Sand	24.2%
Gravel	0.0%	Medium Sand	2.4%	Silt & Clay	72.8%
Liquid Limit	35	Plastic Limit	23	Plastic Index	12
Specific Gravity	---			Moisture Content	49.8%
Coarse Sand	0.7%	Medium Sand	2.4%	Fine Sand	24.2%

Description of Sand & Gravel Particles: Rounded ☐ Angular ☒
Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Notes / Deviations / References:

Joseph Laps	[signature]	Project Engineer	10-30-09
Technical Responsibility	*Signature*	*Position*	*Date*

Form No. TR-D4318-T89-90 *Client code* *Client Test #* *state #*
Revision No. 0
Revision Date: 11/20/07

Liquid Limit, Plastic Limit, and Plastic Index

S&ME

Another code *ASTM D 4318* ☒ *AASHTO T 89* ☐ *AASHTO T 90* ☐ *Quality Assurance*

S&ME, Inc. Myrtle Beach 1330 Highway 501 Business; Conway, SC 29526

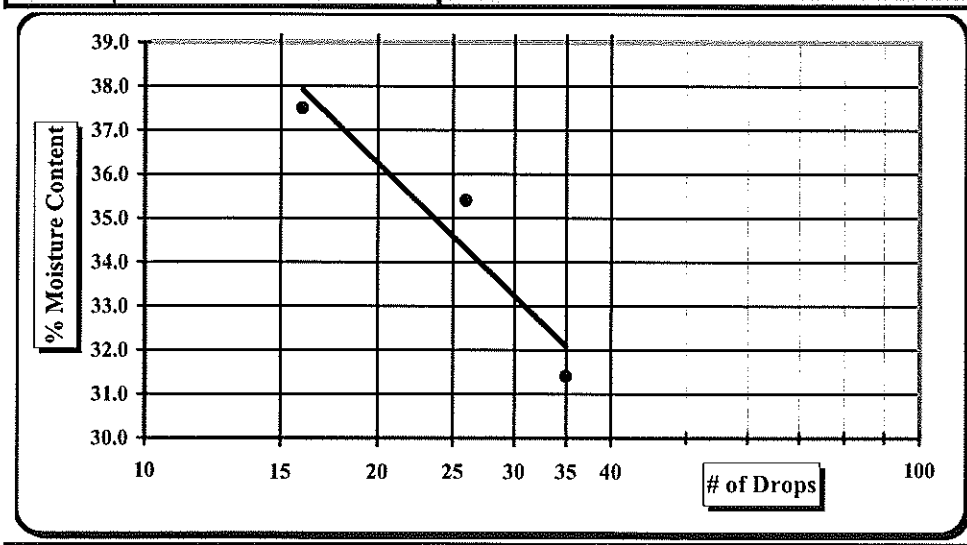
Project #:	**1633-09-251**	Report Date:	10/20/2009
Project Name:	Kimbel Information Commons	Test Date(s)	10/15/2009
Client Name:	Coastal Carolina University		
Client Address:	Post Office Box 261954; Conway, SC 29528		

Boring #:	B-3	Sample #:	S-5	Sample Date:	10/14/2009
Location:	Boreholes	Lab #:	2310	Depth:	13.5'-15.0'

Sample Description: Gray Lean Clay with Sand (CL)

Type and Specification	*S&ME ID #*	*Cal Date:*	*Type and Specification*	*S&ME ID #*	*Cal Date:*
Balance (0.01 g)	007-008	2/14/2009	Grooving tool	11304	7/8/2009
LL Apparatus	18801	7/24/2009			
Oven	17745	4/9/2009			

Pan #		Liquid Limit						Plastic Limit		
	Tare #:	82	100	120	4	5	6	60	64	9
A	Tare Weight	14.27	14.93	14.65				14.60	14.61	
B	Wet Soil Weight + A	22.56	22.74	25.83				19.97	20.16	
C	Dry Soil Weight + A	20.58	20.70	22.78				18.95	19.12	
D	Water Weight (B-C)	1.98	2.04	3.05				1.02	1.04	
E	Dry Soil Weight (C-A)	6.31	5.77	8.13				4.35	4.51	
F	% Moisture (D/E)*100	31.4%	35.4%	37.5%				23.4%	23.1%	
N	# OF DROPS	35	26	16				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	*Average*							**23.3%**		



One Point Liquid Limit

N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.99	29	1.018
24	0.995	30	1.022
25	1.000		

NP, Non-Plastic	☐
Liquid Limit	35
Plastic Limit	23
Plastic Index	12
Group Symbol	CL
Multipoint Method	☑
One-point Method	☑

Wet Preparation ☐ Dry Preparation ☑ Air Dried ☑

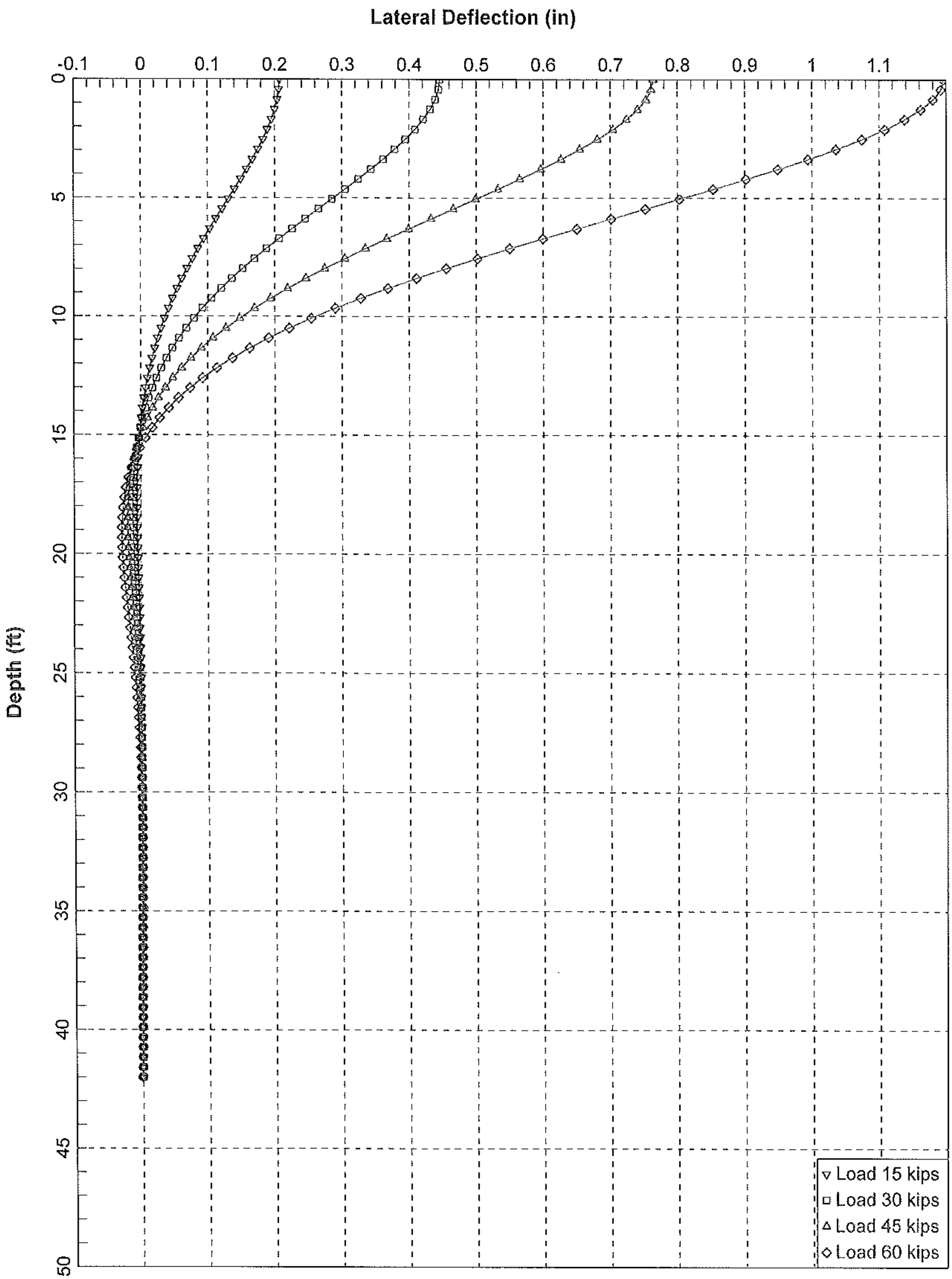
Notes / Deviations / References:

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils

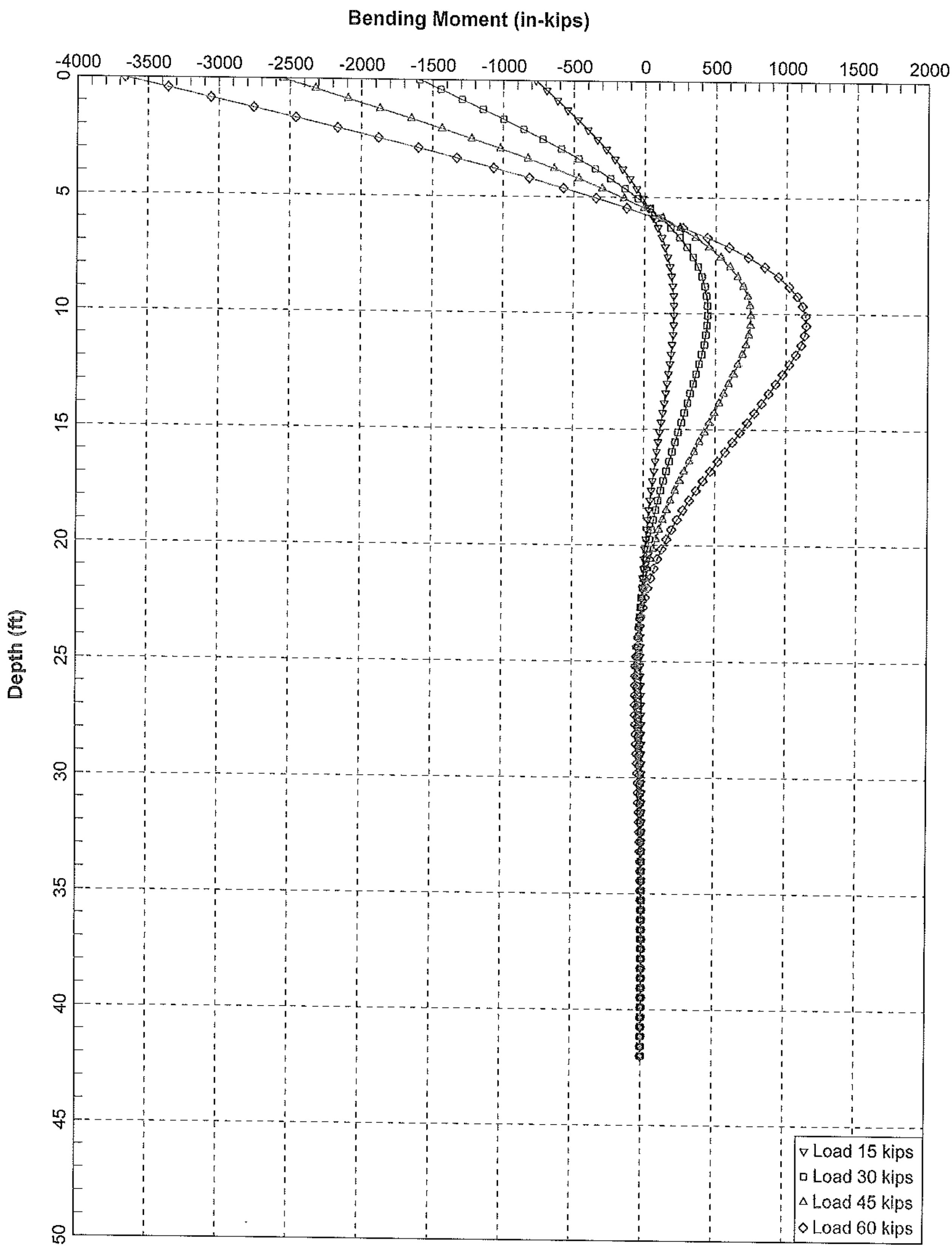
Joseph Laps	[signature]	Project Engineer	10-30-09
Technical Responsibility	*Signature*	*Position*	*Date*

APPENDIX D

LATERAL PILE ANALYSIS FIGURES



16-inch Diameter ACP - 50 ton, 42' Embedment - Fixed Head, Static



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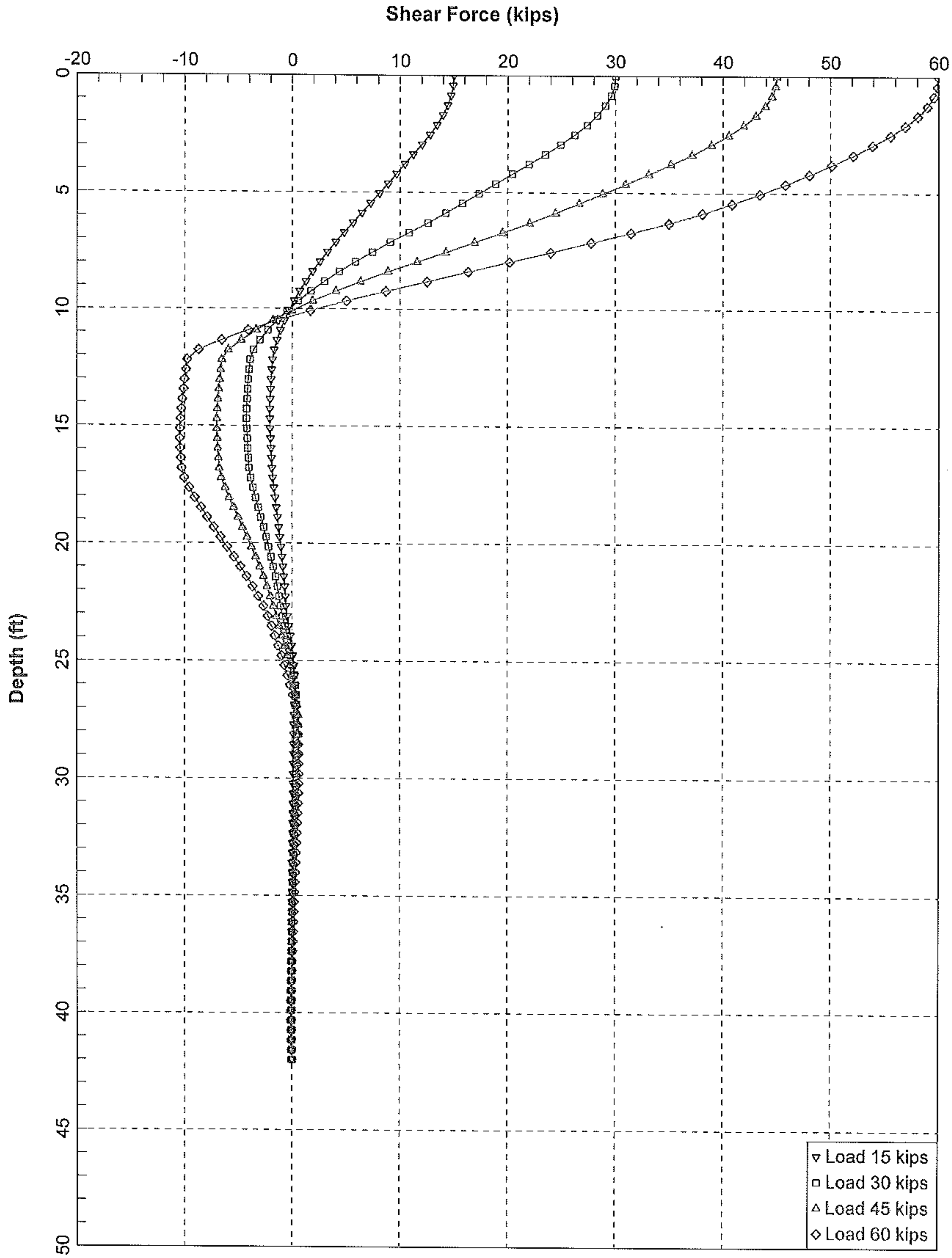
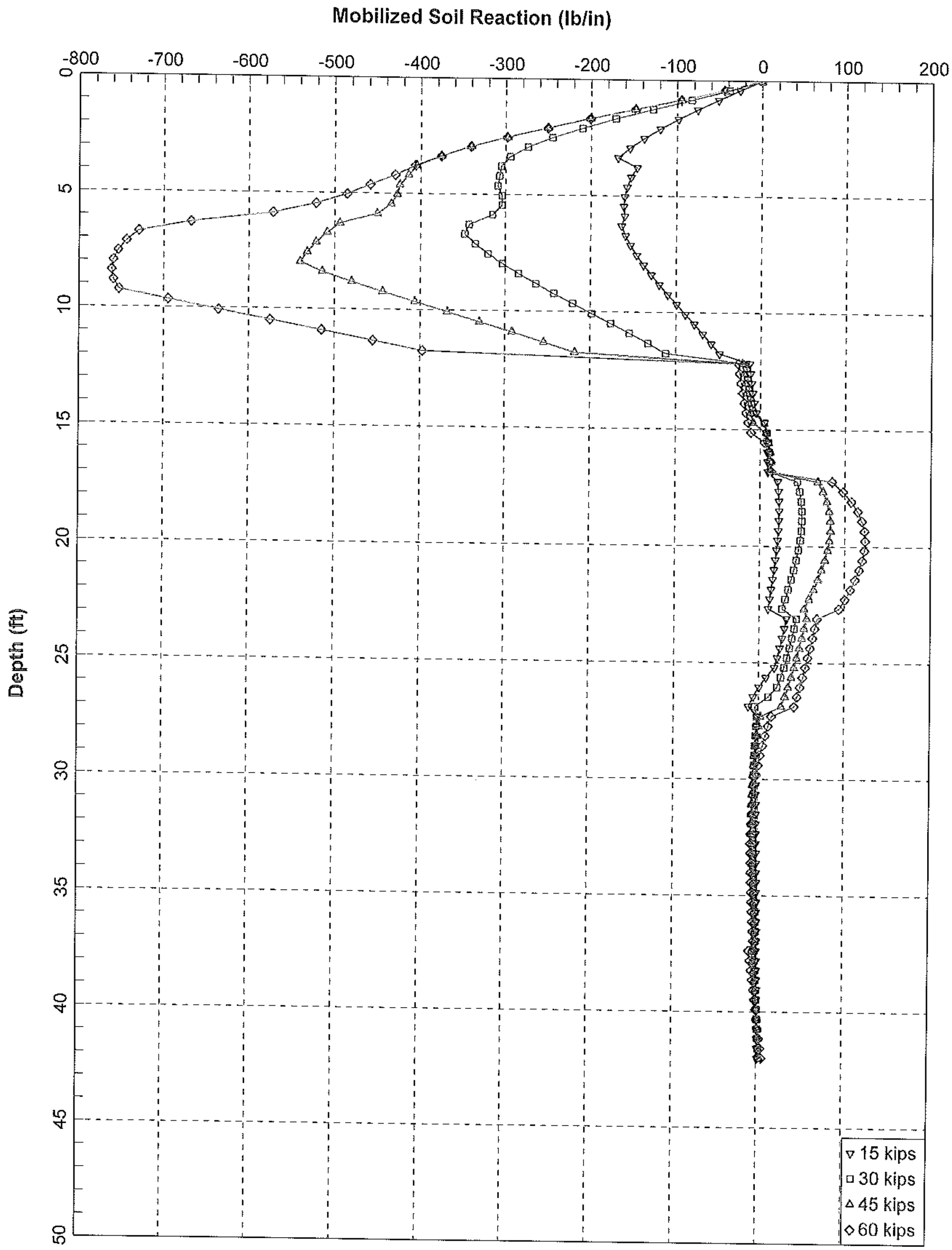
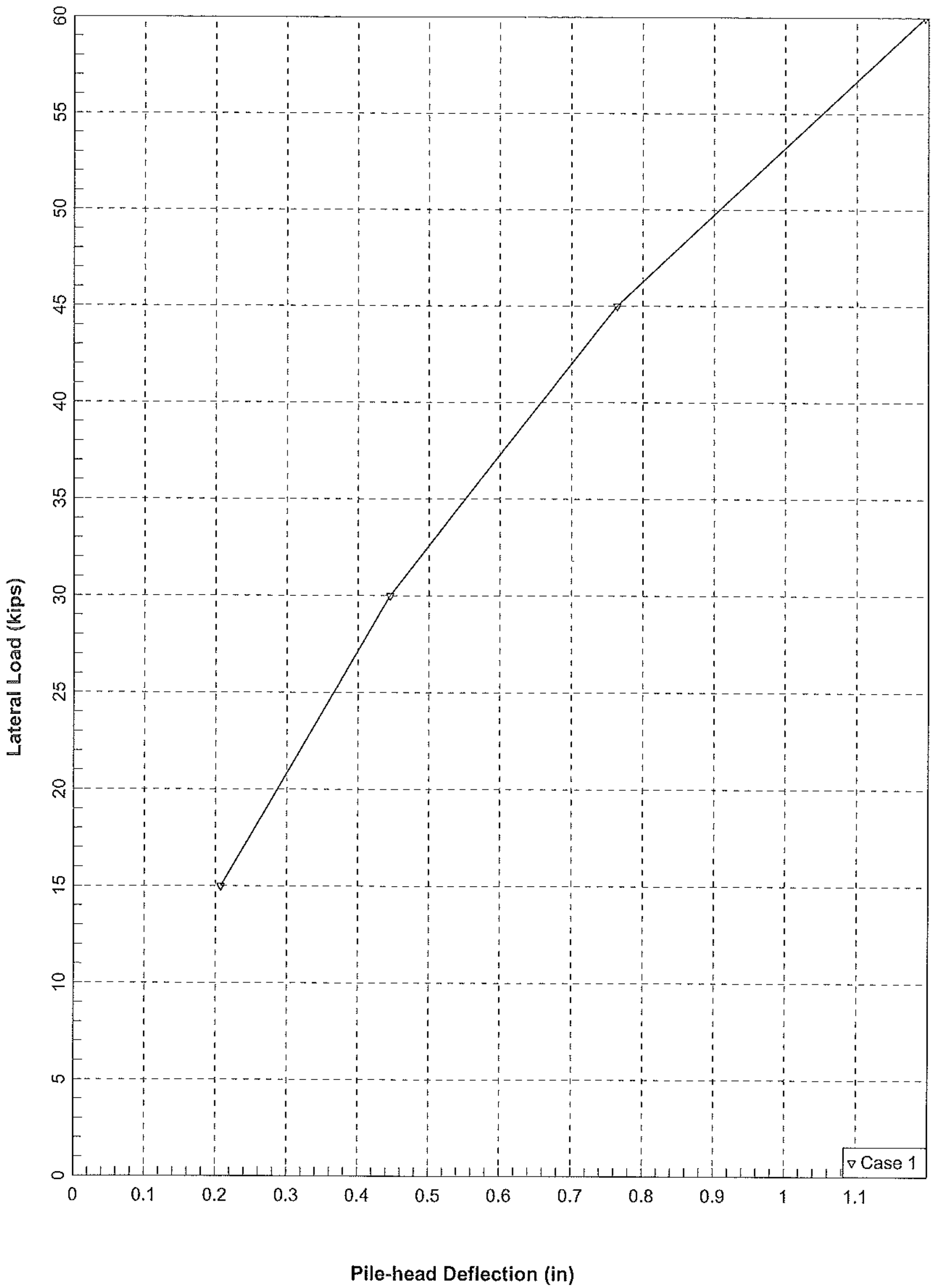


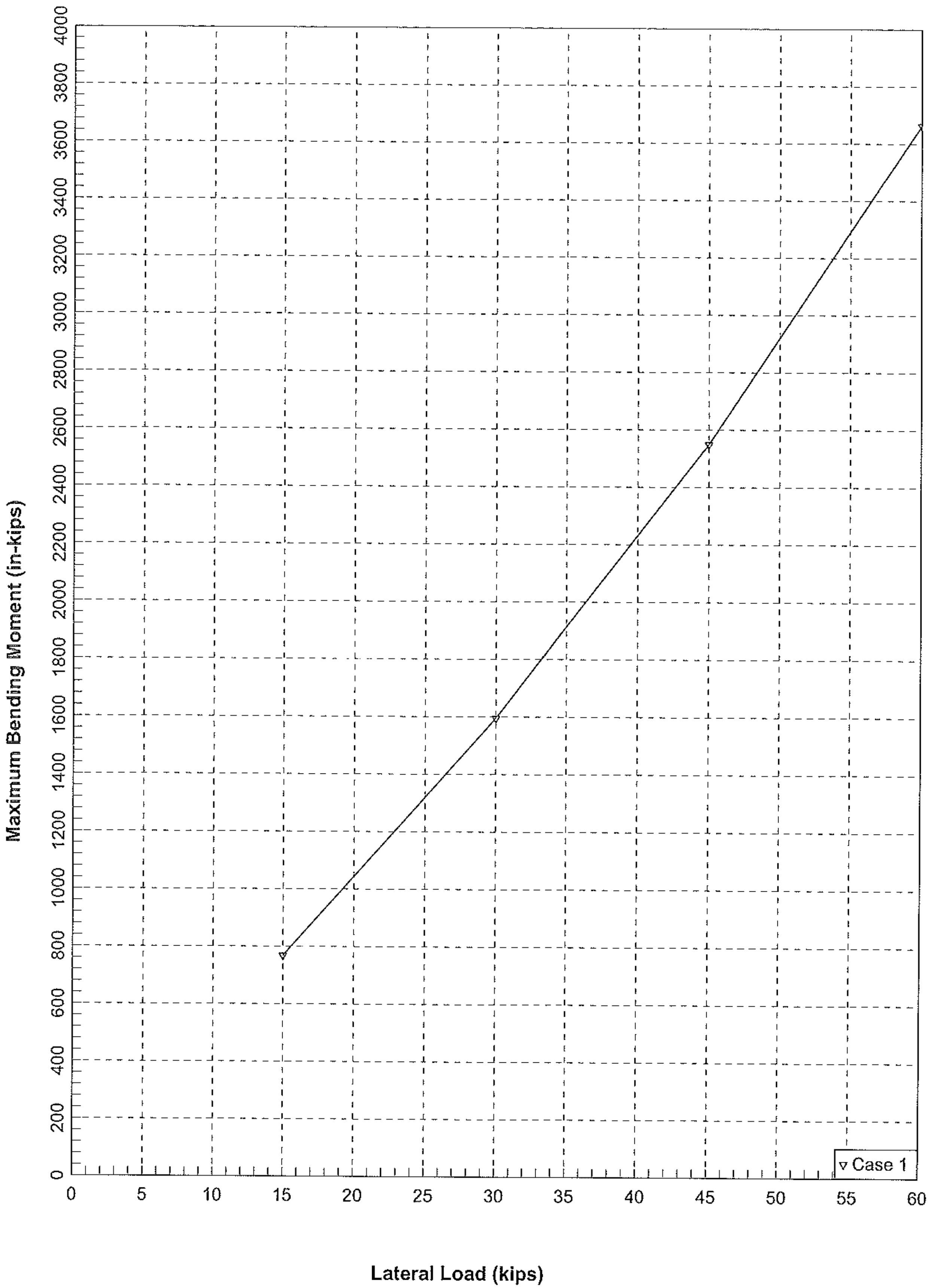
16-inch Diameter ACP - 50 ton, 42' Embedment - Fixed Head, Static



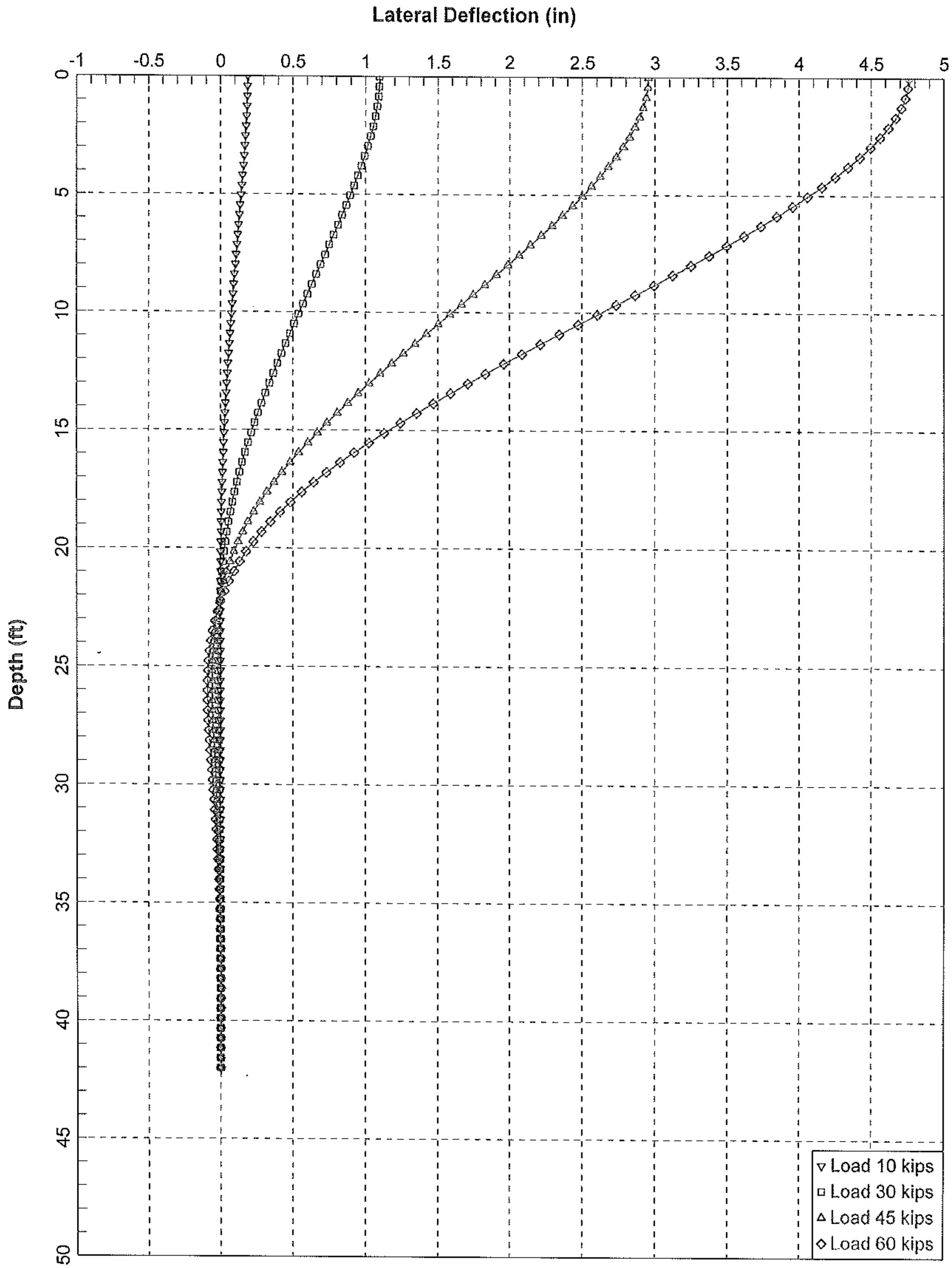
16-inch Diameter ACP - 50 ton, 42' Embedment - Fixed Head, Static



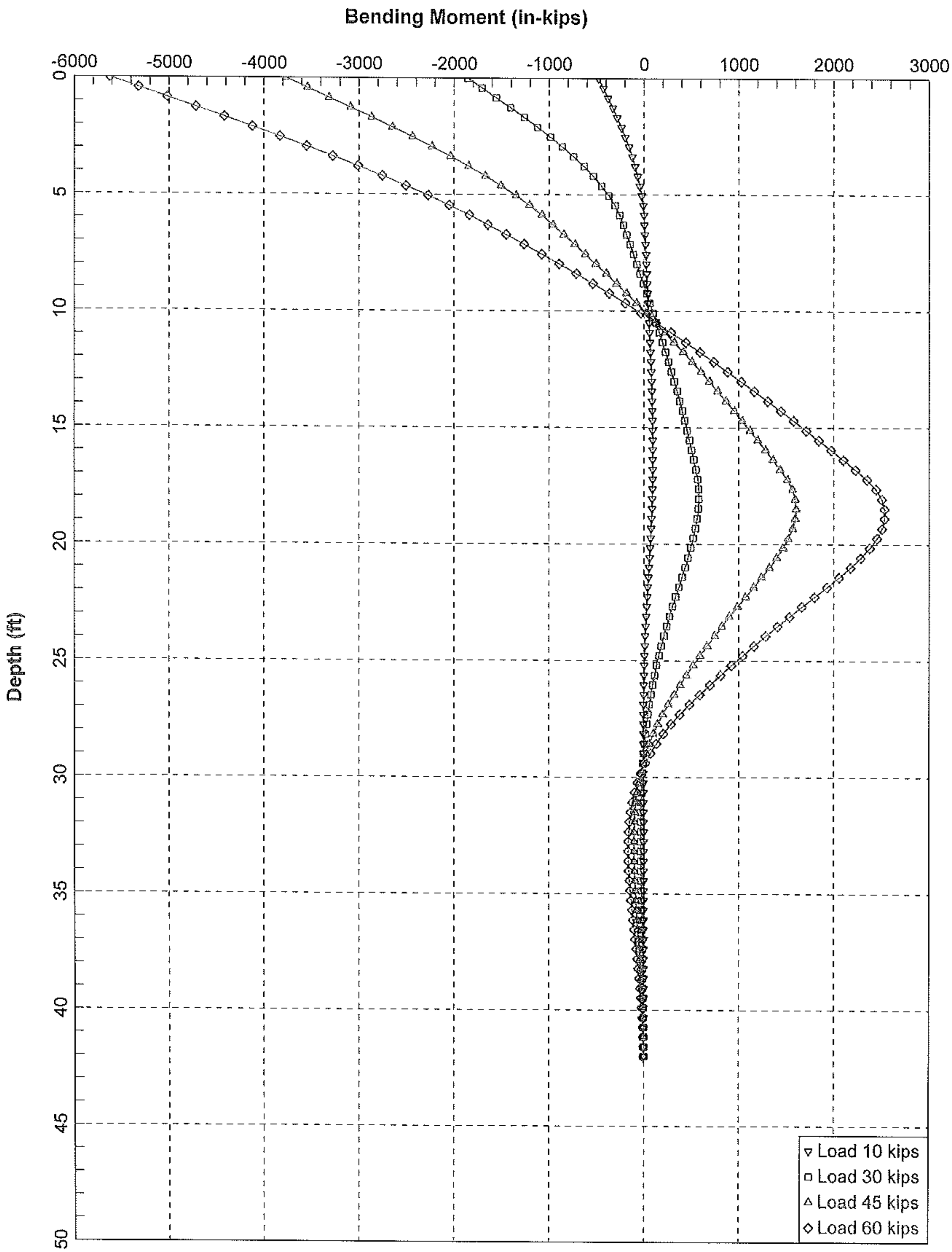
16-inch Diameter ACP - 50 ton, 42' Embedment - Fixed Head, Static



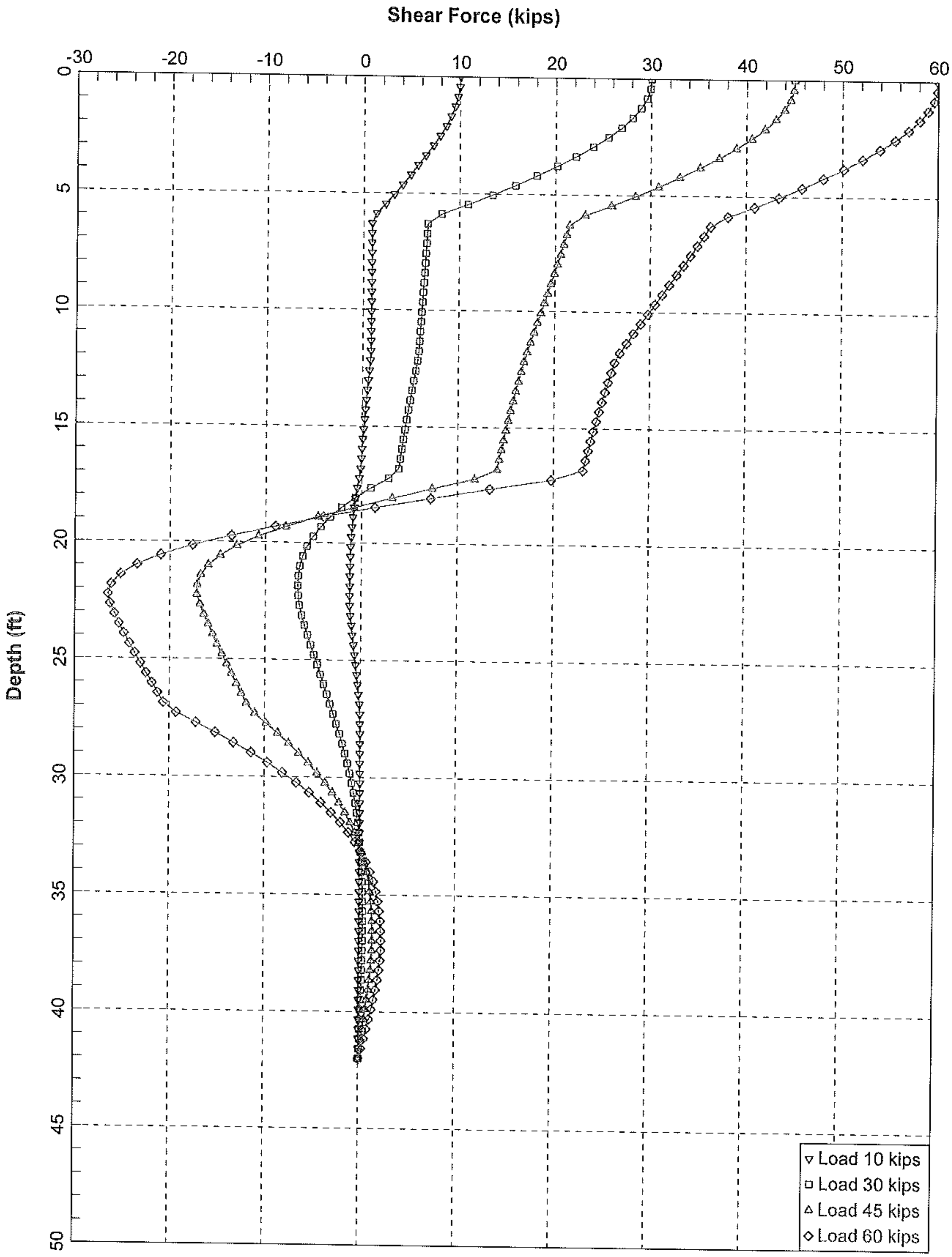
16-inch Diameter ACP - 50 ton, 42' Embedment - Fixed Head, Static



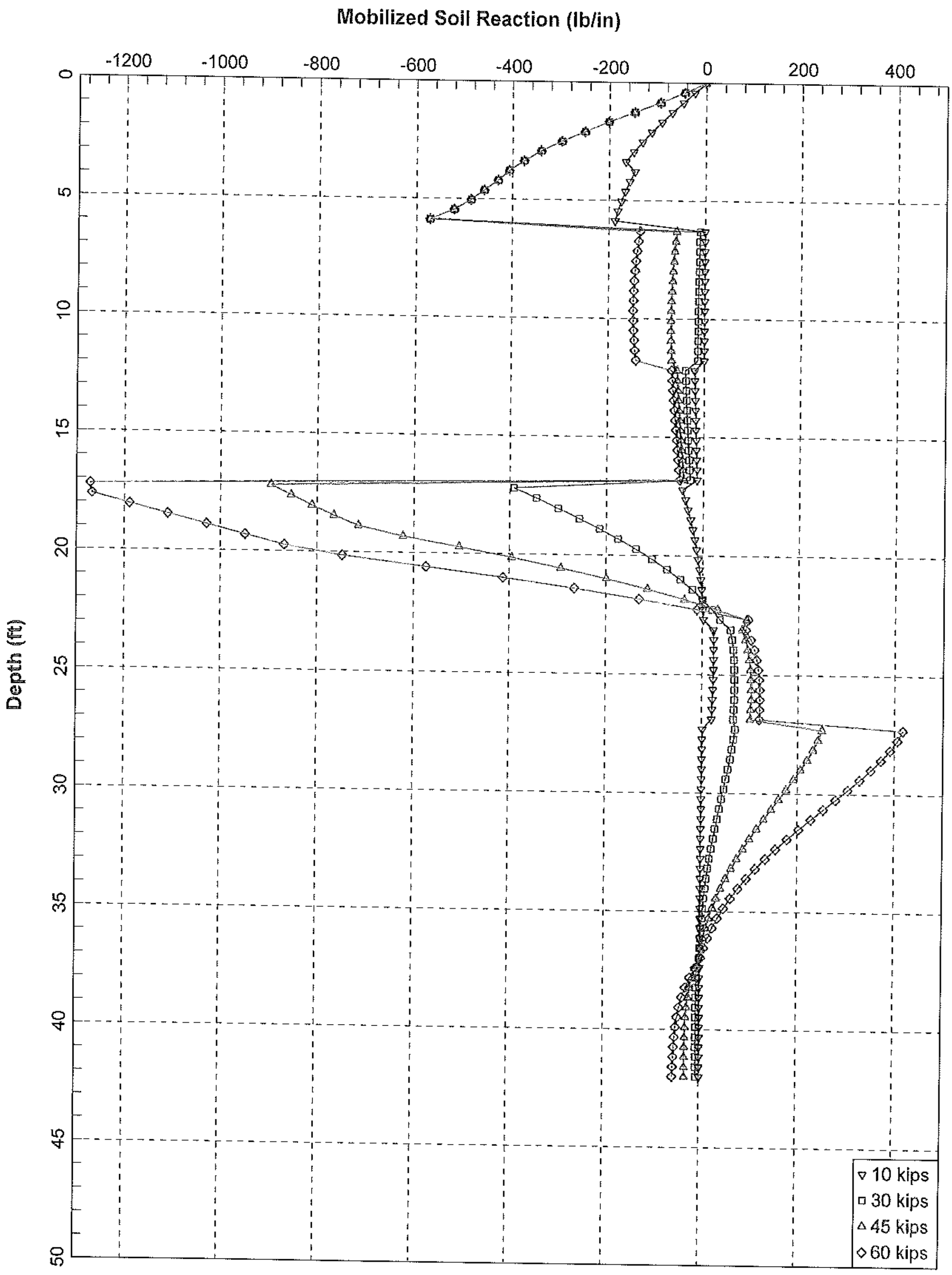
16-inch Diameter ACP - 50 ton, 42' Embedment - Fixed Head, Dynamic



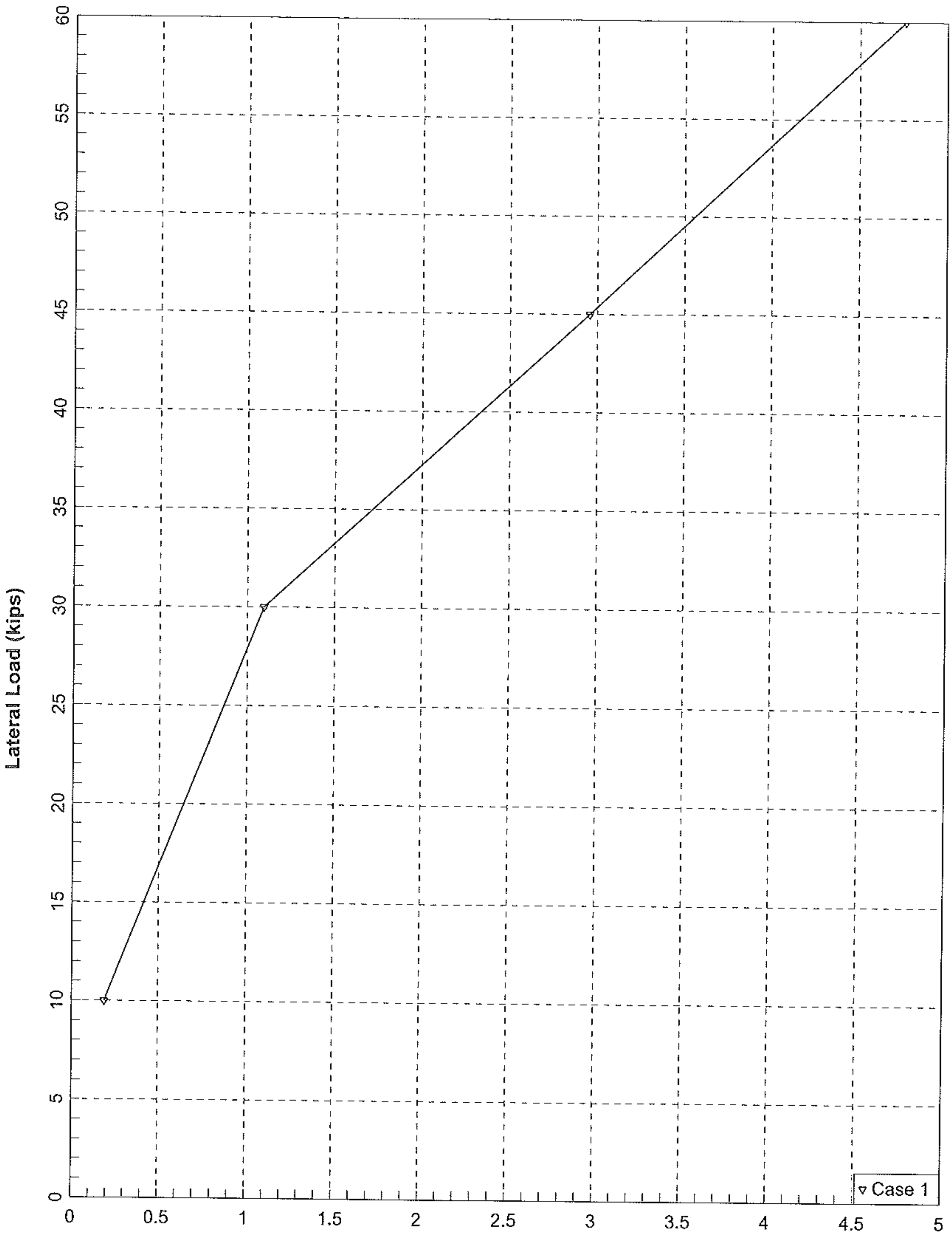
16-inch Diameter ACP - 50 ton, 42' Embedment - Fixed Head, Dynamic



16-inch Diameter ACP - 50 ton, 42' Embedment - Fixed Head, Dynamic

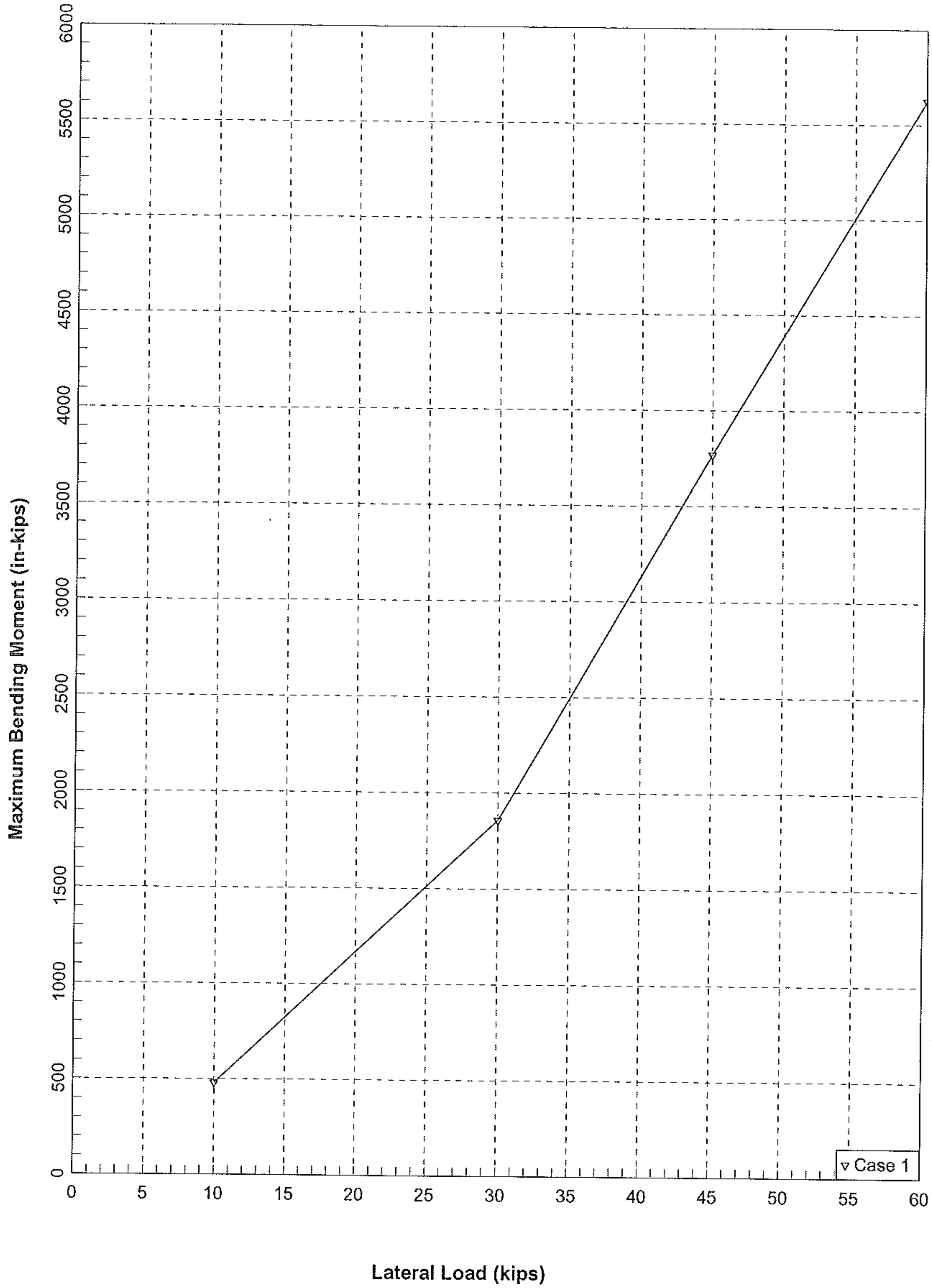


16-inch Diameter ACP - 50 ton, 42' Embedment - Fixed Head, Dynamic



Pile-head Deflection (in)

16-inch Diameter ACP - 50 ton, 42' Embedment - Fixed Head, Dynamic



16-inch Diameter ACP - 50 ton, 42' Embedment - Fixed Head, Dynamic

November 22, 2022

Coastal Carolina University
PO Box 261954
Conway, South Carolina 29526

Attention: Mr. Mark Avant

Reference: **Report of Supplemental Geotechnical Exploration**
Kimbel Library Elevator
Conway, South Carolina
S&ME Project No. 22630166

Dear Mr. Avant:

S&ME, Inc. has completed the supplemental subsurface exploration for the referenced project after receiving signed authorization to proceed from you on September 9, 2022. Our exploration was conducted in general accordance with the Indefinite Delivery Contract (IDC) No. H17-D128-ID, between Coastal Carolina University (CCU) and S&ME, dated January 2019, which is incorporated as part S&ME Proposal No. 22630166 dated September 8, 2022.

The purpose of this study was to further evaluate the surface and subsurface soils in the area of interest, and to provide general recommendations for foundation design and other related construction issues. Structural engineering was excluded.

This report describes our understanding of the project, presents the results of the field exploration, laboratory testing, and engineering analysis and discusses our conclusions and recommendations based on these considerations. S&ME, Inc. appreciates this opportunity to be of service to you. Please call if you have questions concerning this report or any of our services.

♦ Project Information

Project information was initially provided in email correspondence to Ron Forest, Jr. (S&ME) from Mr. Bill Ussery (E+M Structural) on August 31, 2022, regarding the new elevator to be installed at the Kimbel Library. Mr. Ussery provided a drawing depicting the location of the new elevator. Mr. Ussery also stated that micro piles are the preferred approach to support the new elevator foundation with an estimated axial working capacity demand per pile of about 20 tons. The site is located at the Kimbel Library on the CCU campus in Conway, South Carolina. A Site Vicinity Map is included in Appendix I as Figure 1.

On October 24, 2022, Mr. Ussery followed up with some additional information. He indicated that there is a 10 ft by 8 ft exterior addition for a vestibule on one side of the building, and that it will be lightly loaded, but will have a slab and some framing for the walls and roof. He also indicated that there is a new canopy at the north side of the building. One edge of the canopy will be supported from the existing second floor beams. The other side is to be supported by isolated columns. There will be four columns. The approximate column load will be 3 to 5 kips. Mr. Ussery asked us to confirm that piles will be required at these two locations as well.

♦ Exploration Procedures

Field Exploration

Between the dates of September 12th through the October 3rd, 2022, representatives of S&ME, Inc. visited the site. Using the information provided, we performed the following tasks:

- We established one (1) cone penetration test (CPT) sounding location within the green space southwest of the building, as close to the proposed new elevator as possible. The sounding was advanced to a depth of about 35.7 feet at which depth the tooling encountered refusal to advance any further on assumed cemented sands. A Test Location Sketch showing the approximate sounding location is attached in Appendix I as Figure 2.
- In conjunction with the CPT sounding, a hand auger boring was performed at the test location. The hand auger boring was advanced to a target depth of 4 feet. Grab samples of subsurface soil materials were collected from representative subsurface strata within the hand auger borings. Within the borings, our engineer observed and documented the subgrade soil types observed and subsurface water levels, where encountered.
- The hand auger boring was backfilled to the original ground surface with soil cuttings at the time of completion.
- Groundwater level was not directly measured in the CPT sounding; the groundwater level at this location were interpreted based on pore pressure measurements. Groundwater was not encountered within the hand auger boring.

A more detailed description of the field tests performed during the exploration as well as the CPT sounding log and hand auger boring log are attached in Appendix II. We have also included relevant boring logs from a previous report titled "Report of Geotechnical Exploration - Kimbel Information Commons" S&ME Project No. 1633-09-251 dated November 5, 2009 in Appendix II.

♦ Surface Conditions

The site surface at the test location consisted of landscaped areas with some concrete walkways surrounding those areas. Topsoil was encountered at the test location and was measured to be approximately 4 inches in thickness.

Subsurface Conditions

Description of Subsurface Soils

This section describes subsurface soil conditions observed at the site. Soils encountered by the test borings were grouped into strata based on estimated physical properties derived from subsurface data and the recovered soil samples. The site subsurface soils were separated into three strata, labeled I through III.

Stratum I: Upper Coastal Plain Sands

Beneath the topsoil at the test location, an upper stratum of Coastal Plain sands was encountered to the maximum exploration depth of 4 feet in the hand auger boring and to a depth of 12 feet below the ground surface in sounding C-1. Based on soils recovered from the hand auger boring these soils consisted of silty sand (USCS Classification "SM") and clayey sand (SC). These soils were observed to be moist, with tan, brown, and orange coloration. CPT tip resistance values at the test sounding location ranged widely from approximately 10 tons per square foot (tsf) to 240 tsf and averaged about 40 tsf to 80 tsf indicating a generally medium dense relative density with some very loose to very dense layers.

Stratum II: Very Soft to Very Stiff Clays and Silts

Beneath Stratum I in the sounding, very soft to very stiff clays and silts were encountered to a depth of about 27 feet below the ground surface. The silty clays between depths of about 12 and 17 feet were measured to be very soft. A layer of very loose to loose sand mixtures was encountered within this stratum between depths of 18 to 20 feet. CPT tip resistance values within the clays ranged from approximately 5 tsf to 30 tsf and averaged about 15 tsf to 25 tsf indicating a generally stiff consistency with some very soft to very stiff layers. CPT tip resistances within the sand layer in this stratum ranged from approximately 15 tsf to 40 tsf indicating a generally loose relative density.

Stratum III: Lower Sand Mixtures

Beneath Stratum II in the sounding, starting at a depth of about 27 feet, a lower stratum of sand mixtures was encountered to the maximum exploration depth of 35.7 at which depth the tooling encountered refusal to further advancement on assumed cemented sands. CPT tip resistance values in this stratum ranged from approximately 20 tsf to greater than 400 tsf and averaged about 25 tsf to 45 tsf indicating a generally medium dense relative density with some loose to very dense layers. The refusal that was encountered at 35.7 likely occurred on top of the Pee Dee Formation, a cretaceous age marine formation that is known to be present in this area.

Groundwater

Based upon the pore pressure readings measured in the CPT soundings, the groundwater level at the time of our assessment was interpreted to be approximately 5 feet below the ground surface in the sounding. Groundwater was not encountered in the hand auger boring at the time of this assessment. Groundwater levels may fluctuate seasonally at the site, being influenced by rainfall variation and other factors. Site construction activities can also influence groundwater elevations.

Conclusions and Recommendations

The conclusions and recommendations included in this section are based on the project information outlined previously and the data obtained during our exploration. If the construction scope is altered, the locations of the structures changed, or if conditions are encountered during construction that differ from those encountered in the borings, then S&ME, Inc. should be retained to review the following recommendations based upon the new information and make necessary changes.

Based upon the results of our exploration and our experience with similar soils in the site vicinity, the site appears adaptable for the proposed construction. Based on the assumed loading and settlement tolerances, it appears feasible that the structure can be supported on micropile foundations as requested, assuming that the recommended site preparation measures described below are implemented.

Demolition of Existing Structures

The following general recommendations are provided for demolition of previous construction:

- Remove or plug existing underground utilities that are to be permanently abandoned from within the new construction footprint. If not removed or plugged, underground pipes may serve as conduits for subsurface erosion resulting in formation of voids below foundations or grade slabs.
    - Where existing utilities are left in place and plugged in the structural footprint, it may be necessary to undercut poorly compacted backfill to provide adequate support for foundations or slabs.
    - Backfill all excavations created to remove utilities in accordance with the “Controlled Fill” section of this report.
- Reroute existing utilities that will remain in use around the proposed new structural footprints.
- Remove any foundation and fill located in the footprint of the proposed new foundations.

Site Preparation and Excavation

Subsurface water was estimated to be about 5 feet below the existing ground surface at the time of our exploration. If subsurface water is encountered during excavation, the water level should be maintained at least 2 feet below the excavation bottoms to help maintain bottom stability. Water can probably be controlled at the site by pumping from sumps located within and/or beside the excavation. The effects of dewatering on nearby structures should be evaluated and are the responsibility of the designer of any dewatering system.

All excavations should be sloped or shored in accordance with local, state, and federal regulations, including OSHA (29 CFR Part 1926) excavation trench safety standards for Type C soils. The contractor is solely responsible for site safety. This information is provided only as a service, and under no circumstances should S&ME be assumed to be responsible for construction site or excavation safety.

Controlled Fill

Backfill beneath Foundations

Controlled Fill material beneath all footings should consist of an open-graded, manufactured, washed coarse granitic gravel meeting the gradation requirements of SCDOT No. 57 or No. 67 stone. Do not use limestone aggregates. All fill should be placed in uniform lifts of 6 in. (loose measure) and each lift shall be thoroughly compacted with a heavy vibratory tamp. Fill placement should be observed by a qualified Materials Technician working under the direction of the Geotechnical Engineer.

Backfill beside Foundations, if necessary

Controlled fill material placed beside footings (such as in benched areas after form removal) should be cohesionless, low plasticity or non-plastic sandy soil containing no more than 25 percent fines (material passing the No. 200 sieve) by weight and having a maximum dry density of at least 105 pounds per cubic foot (pcf) as determined by a laboratory modified Proctor moisture density relationship test (ASTM D1557). The soil should be relatively free of organics or other deleterious matter. Fill should be placed in uniform lifts of 12 in. or less (loose measure), reduced to a maximum of 6 inches if using small, portable compaction equipment, and each lift shall be compacted to at least 95 percent of the modified Proctor maximum dry density (ASTM D 1557).

Fill placement should be observed by a qualified Materials Technician working under the direction of the Geotechnical Engineer. In addition to this visual evaluation, the Technician should perform a sufficient number of in-place field density tests to confirm that the required degree of compaction is being attained. At least two density tests per lift of fill should be performed.

Foundation Support for the Elevator

Based on conversations with Mr. Bill Ussery, we understand that the piles are anticipated to support the elevator foundation with an estimated axial working capacity demand per pile of about 20 tons. Based on its proximity to other structures, driven piles are not recommended, so the micro piles should be drilled into place.

Micro Piles

Micro piles are typically constructed with a hollow-stem, continuous flight auger. The auger is screwed into the soil to facilitate the removal of the soils in the column. When the auger reaches the desired depth, grout is pumped through the center of the auger while the auger is extracted from the hole. A reinforcing cage or central bar are inserted into the grout immediately following auger removal, to add tensile and/or lateral load carrying capacity. This pile type appears to be feasible to install at this site. The appropriate pile diameter will depend upon the final loading requirements, but based on our past experience, we anticipate that either a 10-inch or 12-inch diameter micro pile may be needed to carry the required load.

We initially considered terminating the micro piles at a depth of about 10 feet, where sounding C-1 indicated a thin seam of dense sand; however, the estimated available capacity per pile was too low (only about 5 tons). This may be sufficient for support of the very lightly loaded exterior vestibule and/or canopy structure, but is unlikely to be sufficient for support of the elevator. Once Stratum II is penetrated below this sand lens, there is very little end bearing resistance available until reaching the refusal layer. Therefore, in order to obtain working load capacities in the general range requested for the elevator, the micro piles will likely need to be installed to the bottom of Stratum III (the refusal layer) which is anticipated to be encountered at depths of approximately 35 to 37 feet based upon sounding C-1 and previous borings B-1 through B-3 which were performed for the Kimbel Information Commons project in 2009.

Single Micro Pile Axial and Uplift Capacities

Axial capacities versus depth were estimated for individual 8-inch, 10-inch, and 12-inch diameter micro piles based upon the subsurface conditions encountered in the borings and sounding C-1, and considering static loading. The estimated axial capacities are summarized in Table 1 below.

Table 1: Single Micro Pile Vertical Capacities

Modeled Pile Diameter (inches)	Pile Embedment Depth (feet)	Allowable Axial Download Capacity per pile (tons)	Allowable Uplift Capacity per pile (tons)
8-inch	35 – 37*	14	5
10-inch	35 – 37*	20	7
12-inch	10**	5	1
	35 – 37*	30	10

*installed to the top of the very hard layer that was encountered within this depth range.
**not suitable for support of the elevator; could be considered for the canopy/vestibule area, if appropriate.

The soil coefficients used in our axial capacity analyses were developed using published correlations relating soil skin friction and end bearing unit capacities to CPT tip resistance values. Soils in the upper five feet of the soil profile are assumed to be in contact with the pile cap, not the individual piles, and were considered not to contribute to individual pile resistance. Also, soils within one pile diameter above the pile tip are generally considered not to contribute to side friction capacity, and were ignored in computation of ultimate pile capacity.

Difficult Drilling Conditions and Auger Refusal

Based on the soils encountered in sounding C-1 and previous borings B-1 through B-3, soils above the desired termination depth are typically loose to medium dense with some soft to stiff clay layers. However, there may be a thin layer of dense to very dense sands encountered during drilling between depths of about 9 and 12 feet. This dense sand layer was not encountered in borings B-1 through B-3 but was observed in sounding C-1. It is important that the micro piles supporting the elevator penetrate through this thin layer of dense sand, so early refusal within this depth range is not acceptable. There is also a possibility that one or more cemented lenses may be encountered in the lower sands of Stratum III between depths of 27 and 37 feet. Early refusal within this depth zone is acceptable if a refusal criteria of less than 1 foot of advancement per minute for at least 10 continuous minutes of drilling is met.

If early refusal is not met, it should be obvious when the very hard top of the Pee Dee Formation is encountered between depths of 35 and 37 feet, since advancement of the drilling tools is expected to suddenly halt. This is the target end bearing condition, and drilling may be terminated once this very hard layer is encountered.

Capacity Reductions and Group Effects

Micro piles are essentially small-diameter drilled shafts. Therefore, for "large groups" of shafts or micro piles where each pile in the group is completely surrounded by other piles at a spacing of no less than 3 pile diameters center-to-center, a reduction factor would typically be applied to the estimated single pile capacities given above. The reduction factor may range from 0.7 to 1.0, and depends upon the pile spacing and soil conditions.

If the piles are spaced at least 6 diameters apart center-to-center (5 feet for a 10-inch diameter micro pile) then no reduction factor for group effects is needed. Intermediate reduction factors may be used for small groups of piles, if applicable. Once the pile configuration of the typical pile caps has been determined, S&ME should be contacted to evaluate potential capacity reductions due to group effects and to check block failure of the pile groups.

Lateral Pile Reactions for Assumed Loads

Our lateral pile analyses were performed using the computer program LPILE 2019©. This program performs a beam-column analysis of single piles, which are subjected to given lateral and axial loading, and assumes a non-linear soil response. Individual 10-inch diameter micro piles, reinforced with one, #8 reinforcing bar were analyzed. A vertical load equivalent to the allowable axial compressive capacity was applied to each modeled auger cast pile based upon the axial load values shown in Table 1 above.

Lateral loads ranging from approximately 4.8 to 13.0 kips, varying by pile size, were applied at the pile head to evaluate the resulting lateral deflection and bending moment at the pile head along the pile. The single pile analysis modeled both fixed head and free head restraint conditions with a constant elastic modulus (i.e., no reduced stiffness to account for non-linear bending stiffness) and static loading. No adjustment was made to the p-y curves to reflect group action. The lateral deflection versus depth curves, moment versus depth curves, shear force versus depth curves, pile-head deflection versus lateral load curves, and lateral load versus maximum bending moment curves output from the program are attached to this report in Appendix III.

The lateral load that can be withstood by a typical pile will be limited by the maximum allowable shear stress for the pile material and the radius of curvature introduced by bending. For purpose of preliminary assessment of the micro pile sections described herein, lateral deflections at the pile heads were computed for applied lateral loading and applied moments and are provided in Tables 2 and 3 below. The 8-inch and 12-inch diameter pile alternatives were not analyzed for lateral response, since their axial capacities were significantly below (8 inch) or above (12 inch) the design engineer's stated working load target range of about 20 tons per pile; however, if one of these other pile diameters is ultimately selected for use and you need us to model the lateral deflection response for it, please notify us and we would be happy to do so.

Table 2: Lateral Response for Fixed Head Conditions under Static Loading, 10 inch dia. Micro Piles advanced to refusal at 35 to 37 ft.

Pile Diameter (inches)	Applied Axial Load (tons)	Embedment Depth* (feet)	Deflection (inches)	Lateral Load (kips)	Minimum/Maximum Bending Moments (in-kips)
10	20	35 – 37	¼	9.4	110 / -205
10	20	35 – 37	½	11.7	150 / -240
10	20	35 – 37	¾	12.5	180 / -240
10	20	35 – 37	1	13.0	200 / -240

*installed to the top of the very hard layer that was encountered within this depth range.

Table 3: Lateral Response for Free Head Conditions under Static Loading, 10 inch dia. Micro Piles advanced to refusal at 35 to 37 ft.

Pile Diameter (inches)	Applied Axial Load (tons)	Embedment Depth* (feet)	Deflection (inches)	Lateral Load (kips)	Minimum/Maximum Bending Moments (in-kips)
10	20	35 – 37	¼	4.8	120 / -7
10	20	35 – 37	½	6.1	160 / -9
10	20	35 – 37	¾	6.9	190 / -11
10	20	35 – 37	1	7.4	210 / -13

*installed to the top of the very hard layer that was encountered within this depth range.

Helical Piers

Helical piers, often called "screw anchors", could also be considered as an alternative to micro piles. Helical piers have been used for remedial underpinning and building foundations for many years. The anchor consists of a plate or plates formed into the shape of a helix. The plate or plates are attached to a central shaft. The anchors are installed by applying a specified torque to the anchor and screwing it into the soil to the proper bearing elevation. There are varying sizes (typically 6 to 14 inch diameter) and number of helices which have been used depending on the soil parameters, loads, depth of embedment, etc. Torque capacities of the installation equipment can range from 12,000 to 50,000 ft-lb.

1. The use of helical piers as a foundation support system has several advantages, as follows:
   - A. The ease and speed of the installation.
   - B. No removal of soil since the installation causes displacement of the soil which produces little to no spoils.
   - C. Installation equipment comes in various sizes and types and may be mounted to a Bobcat® or small hoe, or even installed by hand for low-torque applications.

D. The installation of the piers is practically vibration free which is advantageous to nearby vibration sensitive buildings or equipment.
E. The installation of piers in the vicinity of existing foundations typically do not cause problems related to the performance of the existing foundations.

2. The design of the helical piers is based on bearing capacity and assumes that the capacity of the pier is equal to the sum of the capacities of the individual helices. The capacity of the helix is based on the unit bearing capacity at the depth of the helix applied to the helix area. Friction along the shaft is not accounted for in determining the pier capacity. The capacity of the pier is also based on the soil parameters above or below the helices. The helices are required to be spaced so that the stress zones for each helix do not overlap.
3. Based on the soil profile encountered at the site, we anticipate that the helical piers would need to be embedded to a target depth of at least 35 feet below the existing ground surface to provide suitable bearing support and mitigate settlement.

   A. It should be possible to design piers bearing at or near the target depth to support between 20 tons of load per pier, depending upon the number of helices, the limitations of the installation equipment, and the depth of advancement of the piers.
   B. Based on the sounding C-1, it is possible that the piers may encounter refusal to further advancement above a depth of 35 feet. Based on the sounding log, piers should not be allowed to terminate above a depth of 19 feet below the existing ground surface. If this occurs, consult the Geotechnical Engineer for further guidance.

4. The piers may be installed with the use of a hydraulic motor attached to a machine, or by other means depending upon the system being used. Once the helical piers are installed, they are typically terminated with a heavy duty bracket that is cast into new foundation concrete.
5. We have not provided structural design specifications for the helical piers in this report, because it was beyond the scope of this exploration. The design of helical piers is often vendor-specific, due to the variability between manufacturers. Typically, each vendor can provide design guidance on their own specific product. We can also assist in provision of design recommendations, pier capacities, and specifications for the helical pier foundation systems, but this would need to be performed in conjunction with the pier vendor selected, because many of the capacity-related design characteristics of these systems are proprietary to specific products and equipment.
6. Due to the proprietary nature of helical piers, the pier lateral capacity calculations cannot be performed until a specific helical pier design is selected. Lateral pier capacity and lateral deflection estimation was beyond the scope of this report, and may be provided by the selected pier vendor at a later date.
7. Static settlements of properly designed piers are anticipated to be about ½ inch or less under static loading due to elastic shortening of the piers. Settlements contributed by consolidation of the bearing layer under the axial loads applied are anticipated to be insignificant for a single pier. Total post-construction static settlements of the combined footing and pier support system should be ½ inch or less.

Fuller Piles

Fuller piles™ are a hybrid between a grouted micro pile and a helical steel pier. It uses a displacement installation method which pushes the soils down and to the sides, rather than excavating the soils to the ground surface as a typical micro pile installation would do. This allows for increased soil coefficients to be used in the capacity calculations, which increases the capacity of the piles on a per foot basis. Also, instead of typical steel rebar as would be used in a micro pile, the Fuller pile contains a strong central shaft similar to that of a helical pier, providing additional strength and stiffness.

This is a proprietary system that is designed and installed by Claycor out of Walterboro, South Carolina. We are currently involved in a project right now at Myrtle Beach International Airport, where Fuller piles are being installed by Claycor to support some new canopies over the rental car parking lot. In that case, the 12-inch diameter piles are being installed to a target depth of 17 feet to carry a working axial load of 50 kips (25 tons), an uplift load of 30 kips (15 tons), and a lateral shear of 3 kips per pile. If this approach is chosen, it would need to be done as a delegated design to Claycor. You can read more about this proprietary system at www.fullerpile.com. Note: S&ME is not affiliated with Claycor in any way, nor do we receive any consideration or compensation for introducing or discussing this proprietary pile system.

Lateral Earth Pressures

The lateral earth pressure coefficients given below may be used to design of structural components by others located near the ground surface. The values given in the following table assume placement and compaction of backfill around and behind these structures in accordance with the compaction recommendations given in the Controlled Fill section of this report. These values assume backfill generally classified as SP, SM or SC soils according to the Unified Soil Classification system.

- **Important:** In order for the parameters presented in Table 4 to apply, do not backfill behind earth retaining structures or pile caps with peats, clays (CL/CH) or silts (ML/MH), or with sand mixtures containing more than 25 percent by weight of material passing the No. 200 sieve (ASTM D1140), or with soils having a plasticity index of greater than 15 percent (ASTM D4318).

Table 4: Lateral Earth Pressures for Sandy Fills above W.T.

Support Condition	Angle of Internal Friction (φ’)	Moist/ Buoyant Unit Weight (pcf)	Drained Static Condition		Drained Seismic Condition PGA=0.245g	
			Coeff. (K)	Equiv. Unit Weight (pcf)	Coeff. (K)	Equiv. Unit Weight (pcf)
Active (K_a)	30	120 / 58	0.33	40	0.40	48
At-Rest (K_o)	30	120 / 58	0.50	60	0.60	72
Passive (K_p)	30	120 / 58	3.0	360	2.8	337

A. The above values represent a fully-drained soil conditions above the water table (W.T.) at or near the optimum moisture content. Where backfill soils are not fully drained, the lateral soil pressure must consider hydrostatic forces below the water level, and submerged soil unit weight.
B. A coefficient of sliding friction (tan δ) of 0.36 may be used in computation of the lateral sliding resistance.

Earth pressures should be calculated by the designer assuming the moist soil unit weight above the water table. Buoyant unit weights should be used in computations for soils below the water level. The designer shall consider all unbalanced water forces along with any surcharge or building loads. Note that the water levels can fluctuate and may vary at the time of construction.

♦ Limitations

This letter has been prepared in accordance with generally accepted geotechnical engineering practice for specific application to this project. The conclusions and recommendations contained in this letter are based upon applicable standards of our practice in this geographic area at the time this letter was prepared. No other representation or warranty either express or implied, is made.

We relied on project information given to us to develop our conclusions and recommendations. If project information described in this letter is not accurate, or if it changes during project development, we should be notified of the changes so that we can modify our recommendations based on this additional information if necessary.

Our conclusions and recommendations are based on limited data from a field and laboratory testing program. Subsurface conditions can vary widely between explored areas, which may affect the behavior of the structure and could cause variations. Some variations may not become evident until construction. If conditions are encountered which appear different than those described in our letter, we should be notified. This letter should not be construed to represent subsurface conditions for the entire site.

Unless specifically noted otherwise, our field testing program did not include an assessment of regulatory compliance, environmental conditions or pollutants or presence of any biological materials (mold, fungi, bacteria). If there is a concern about these items, other studies should be performed. S&ME can provide a proposal and perform these services if requested.

Closing

S&ME appreciates this opportunity to work with you as your geotechnical engineering consultant on this project. Please contact us at (843) 317-6888 if you have questions or need additional information regarding this letter.

Sincerely,

S&ME, Inc.

Jonathan M. Prevatte
Geotechnical Staff Professional

SOUTH CAROLINA CERTIFICATE OF AUTHORIZATION S&ME, INC. No. C00473

Ronald P. Forest, Jr., P.E.
Principal Engineer
SC Registration No. 21248

SOUTH CAROLINA REGISTERED PROFESSIONAL ENGINEER No. 21248 RON FOREST JR. 11/22/22

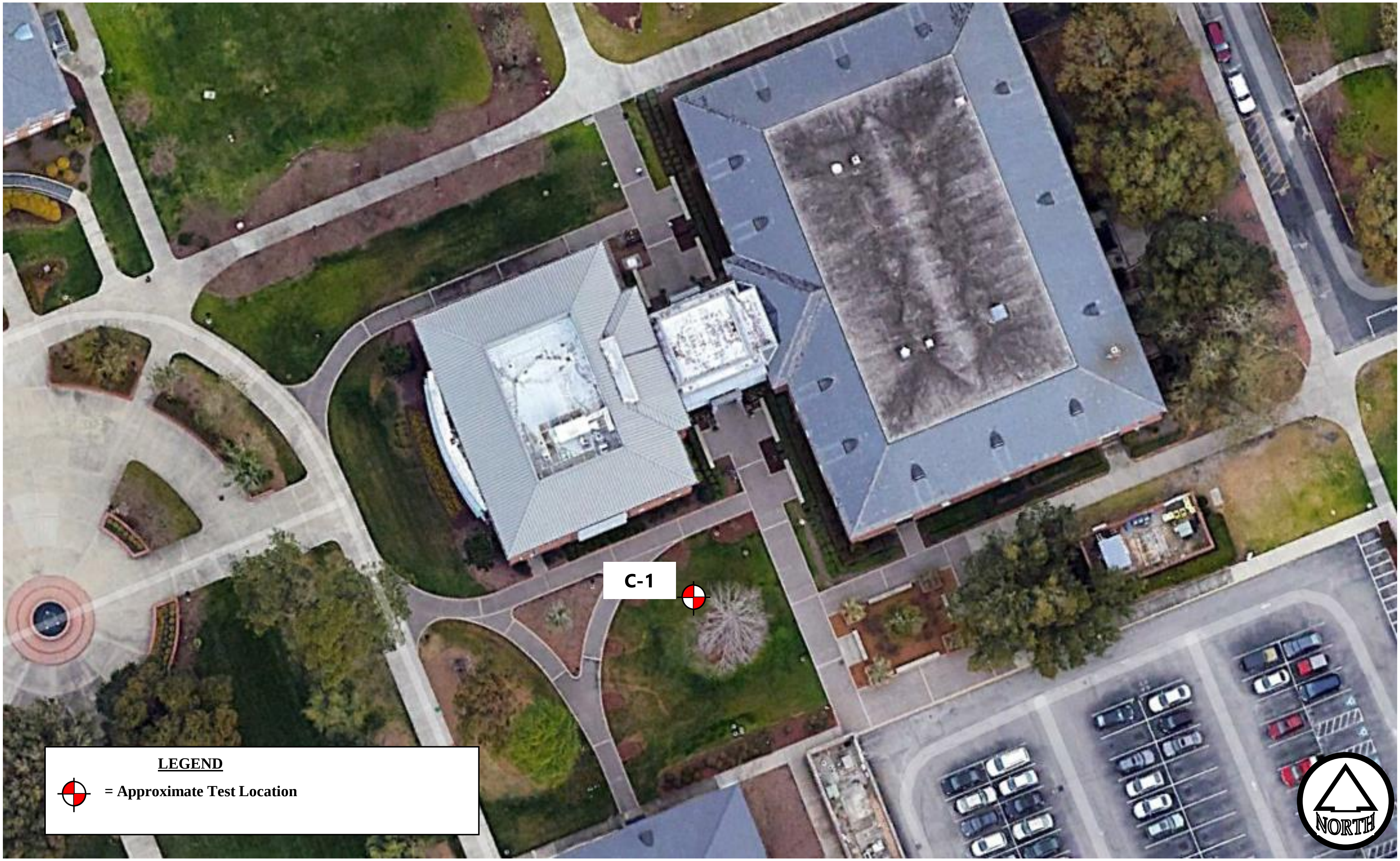
Attachments: Appendices I, II, and III

Appendix I

REFERENCE:
Image Courtesy of Google Earth

NORTH

S&ME	Site Vicinity Map	SCALE: Not to Scale	FIGURE NO.
		DATE: 10/3/2022	1
	Kimbel Library Elevator Conway, South Carolina	PROJECT NUMBER 22630166	



Test Location Sketch

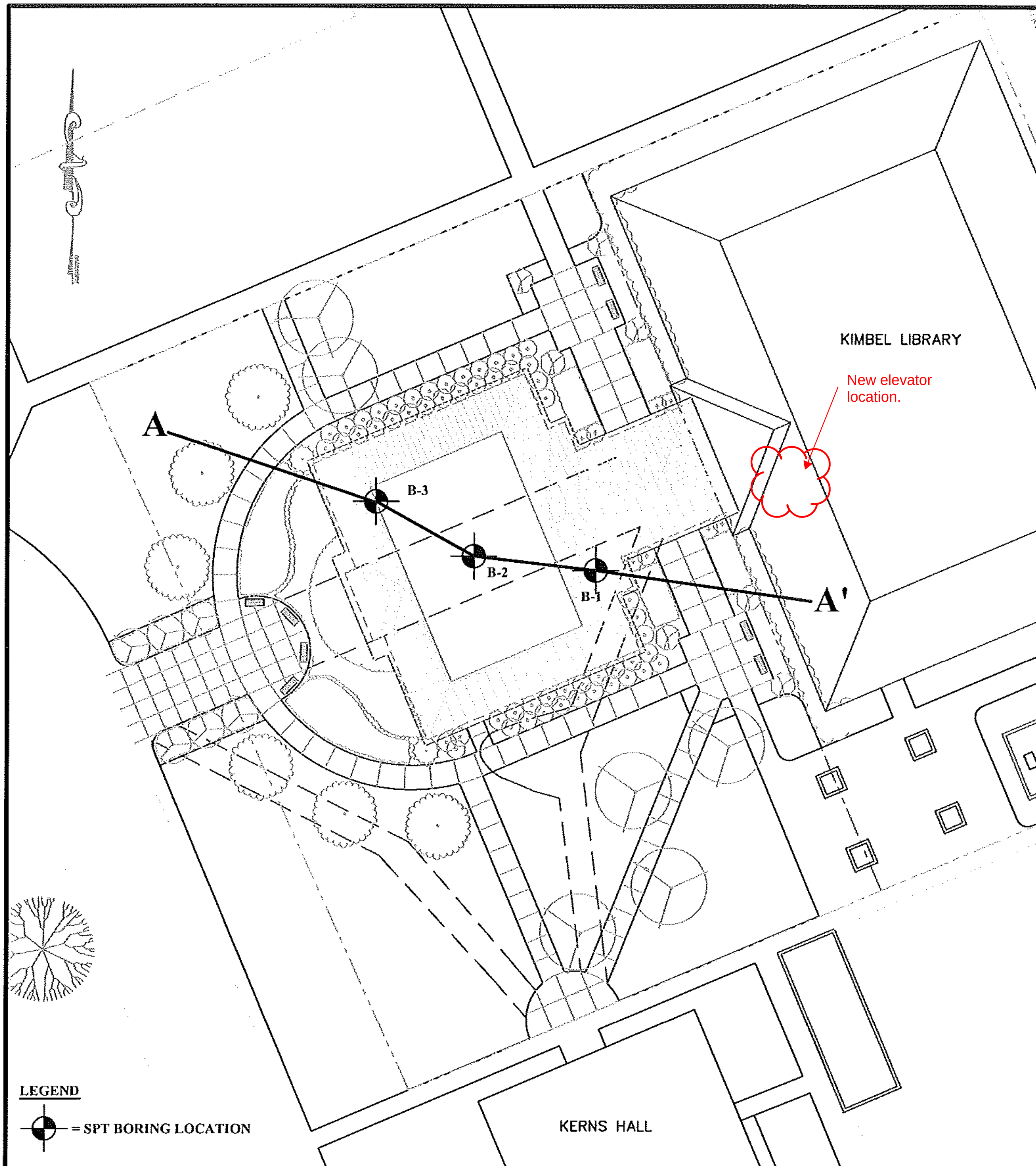
Kimbel Library Elevator
Conway, South Carolina

SCALE: NOT TO SCLAE

DATE: 9/20/2022

PROPOSAL NUMBER 22630166

FIGURE NO. 2



Scale: NTS	S&ME	Test Location Sketch CCU - Kimbel Information Commons Conway, South Carolina	FIGURE NO
Checked By: RPF			2
Drawn By: JDL		Project No: 1633-09-251	
Date: October, 2009			

Appendix II

Summary of Exploration Procedures

The American Society for Testing and Materials (ASTM) publishes standard methods to explore soil, rock and ground water conditions in Practice D-420-18, "*Standard Guide for Site Characterization for Engineering Design and Construction Purposes*." The boring and sampling plan must consider the geologic or topographic setting. It must consider the proposed construction. It must also allow for the background, training, and experience of the geotechnical engineer. While the scope and extent of the exploration may vary with the objectives of the client, each exploration includes the following key tasks:

- Reconnaissance of the Project Area
- Preparation of Exploration Plan
- Layout and Access to Field Sampling Locations
- Field Sampling and Testing of Earth Materials
- Laboratory Evaluation of Recovered Field Samples
- Evaluation of Subsurface Conditions

The standard methods do not apply to all conditions or to every site. Nor do they replace education and experience, which together make up engineering judgment. Finally, ASTM D 420 does not apply to environmental investigations.

Boring and Sampling

Electronic Cone Penetrometer (CPT) Soundings

CPT soundings consist of a conical pointed penetrometer which is hydraulically pushed into the soil at a slow, measured rate. Procedures for measurement of the tip resistance and side friction resistance to push generally follow those described by ASTM D-5778, "*Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils*."

A penetrometer with a conical tip having a 60 degree apex angle and a cone base area of 10 cm^2 was advanced into the soil at a constant rate of 20 mm/s. The force on the conical point required to penetrate the soil was measured electronically every 50 mm penetration to obtain the *cone resistance* q_c. A friction sleeve is present on the penetrometer immediately behind the cone tip. The force exerted on the sleeve was measured electronically at a minimum of every 50 mm penetration and divided by the surface area of the sleeve to obtain the *friction sleeve resistance value* f_s A pore pressure element mounted immediately behind the cone tip was used to measure the pore pressure induced during advancement of the cone into the soil.

Refusal to CPT Push

Refusal to the cone penetrometer equipment occurred when the reaction weight of the CPT rig was exceeded by the thrust required to push the conical tip further into the ground. At that point the rig tended to lift off the ground. Refusal may have resulted from encountering hard cemented or indurated soils, soft weathered rock, coarse gravel, cobbles or boulders, thin rock seams, or the upper surface of sound continuous rock. Where fills are present, refusal to the CPT rig may also have resulted from encountering buried debris, building materials, or objects.

CPT Soil Stratification

Using ASTM D-5778 soil samples are not obtained. Soil classification was made on the basis of comparison of the tip resistance, sleeve resistance and pore pressure values to values measured at other locations in known soil types, using experience with similar soils and exercising engineering judgment.

Plots of normalized tip resistance versus friction ratio and normalized tip resistance versus penetration pore pressure were used to determine soil classification (Soil Behavior Type, SBT) as a function of depth using empirical charts developed by P.K. Robertson (1990). The friction ratio soil classification is determined from the chart in the appendix using the normalized corrected tip stress and the normalized corrected tip stress and the normalized friction ratio.

At some depths, the CPT data fell outside of the range of the classification chart. When this occurred, no data was plotted and a break was shown in the classification profile. This occasionally occurred at the top of a penetration as the effective vertical stress is very small and commonly produced normalized tip resistances greater than 1000.

To provide a simplified soil stratigraphy for general interpretation and for comparison to standard boring logs, a statistical layering and classification system was applied the field classification values. Layer thicknesses were determined based on the variability of the soil classification profile, based upon changes in the standard deviation of the SBT classification number with depth. The average SBT number was determined for each successive 6-inch layer, beginning at the surface. Whenever an additional 6-inch increment deviated from the previous increment, a new layer was started, otherwise, this material was added to the layer above and the next 6-inch section evaluated. The soil behavior type for the layer was determined by the mean value for the complete layer.

Hand Auger Borings

Auger borings were advanced using hand-operated augers. The soils encountered were identified in the field by cuttings brought to the surface. Representative samples of the cuttings were placed in plastic bags and transported to the laboratory. Soil consistency was qualitatively estimated by the relative difficulty of advancing the augers.

Water Level Determination

Subsurface water levels in the soundings were interpreted from pore pressure readings obtained during the performance of the CPT soundings. Water levels were not directly measured.

The subsurface water level in the hand auger boring was measured during the onsite exploration by measuring depths from the existing grade to the current water level using a measuring tape.

Backfilling of Borings

Boring spoils were backfilled into the open hand auger bore hole to the top of the existing ground surface.

CPT Soil Classification Legend

Zone	Q_t/N	Description
1	2	Sensitive, Fine Grained
2	1	Organic Soils-Peats
3	1.5	Clays-Clay to Silty Clay
4	2	Silt Mixtures-Clayey Silt to Silty Clay
5	3	Sand Mixtures-Silty Sand to Sandy Silt
6	4.5	Sands-Clean Sand to Silty Sand
7	6	Gravelly Sand to Sand
8	1	Very Stiff Clay to Clayey Sand*
9	2	Very Stiff, Fine Grained*

(*) Heavily Overconsolidated or Cemented

Robertson's Soil Behavior Type (SBT), 1990			
Group #	**Description**	**Ic**	
		Min	**Max**
1	Sensitive, fine grained	N/A	
2	Organic soils - peats	3.60	N/A
3	Clays - silty clay to clay	2.95	3.60
4	Silt mixtures - clayey silt to silty clay	2.60	2.95
5	Sand mixtures - silty sand to sandy silt	2.05	2.60
6	Sands - clean sand to silty sand	1.31	2.05
7	Gravelly sand to dense sand	N/A	1.31
8	Very stiff sand to clayey sand (High OCR or cemented)	N/A	
9	Very stiff, fine grained (High OCR or cemented)	N/A	

Soil behavior type is based on empirical data and may not be representative of soil classification based on plasticity and grain size distribution.

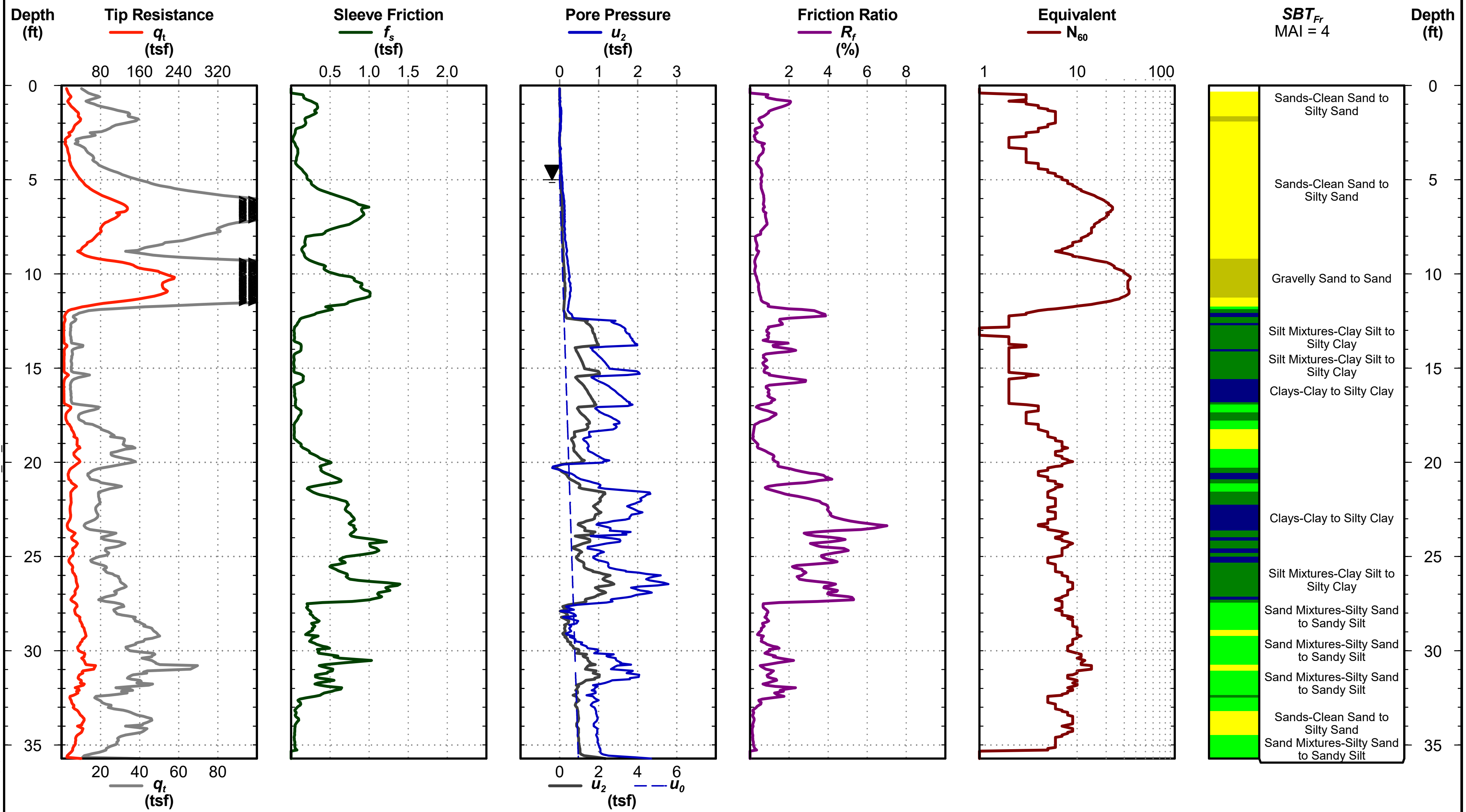
Relative Density and Consistency Table			
SANDS		SILTS and CLAYS	
Cone Tip Stress, qt (tsf)	Relative Density	Cone Tip Stress, qt (tsf)	Consistency
Less than 20	Very Loose	Less than 5	Very Soft
20 - 40	Loose	5 - 15	Soft to Firm
40 - 120	Medium Dense	15 - 30	Stiff
120 - 200	Dense	30 - 60	Very Stiff
Greater than 200	Very Dense	Greater than 60	Hard

Sounding ID: C-01

Kimbel Library Elevator
Conway, South Carolina
S&ME Project No: 22630166

Date: Oct. 3, 2022
Estimated Water Depth: 5 ft
Rig/Operator: LGreene | MNissen

Total Depth: 35.7 ft
Termination Criteria: Maximum Reaction Force
Cone Size: 1.75



Cone Penetration Test

Electronic Filename: C-01.DAT

LEGEND TO SOIL CLASSIFICATION AND SYMBOLS

SOIL TYPES

(Shown in Graphic Log)

- Fill
- Asphalt
- Concrete
- Topsoil
- Gravel
- Sand
- Silt
- Clay
- Organic
- Silty Sand
- Clayey Sand
- Sandy Silt
- Clayey Silt
- Sandy Clay
- Silty Clay
- Partially Weathered Rock
- Cored Rock

WATER LEVELS

(Shown in Water Level Column)

- ▽ = Water Level At Termination of Boring
- ▼ = Water Level Taken After 24 Hours
- ◄ = Loss of Drilling Water
- HC = Hole Cave

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Soft	0 to 2
Soft	3 to 4
Firm	5 to 8
Stiff	9 to 15
Very Stiff	16 to 30
Hard	31 to 50
Very Hard	Over 50

RELATIVE DENSITY OF COHESIONLESS SOILS

RELATIVE DENSITY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Loose	0 to 4
Loose	5 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	Over 50

SAMPLER TYPES

(Shown in Samples Column)

- Shelby Tube
- Split Spoon
- Rock Core
- No Recovery

TERMS

Standard Penetration Resistance - The Number of Blows of 140 lb. Hammer Falling 30 in. Required to Drive 1.4 in. I.D. Split Spoon Sampler 1 Foot. As Specified in ASTM D-1586.

REC - Total Length of Rock Recovered in the Core Barrel Divided by the Total Length of the Core Run Times 100%.

RQD - Total Length of Sound Rock Segments Recovered that are Longer Than or Equal to 4" (mechanical breaks excluded) Divided by the Total Length of the Core Run Times 100%.

PROJECT: Kimbel Library Elevator Conway, South Carolina 22630166	HAND AUGER BORING LOG: C-1
DATE STARTED: 10/3/22 DATE FINISHED: 10/3/22	NOTES: Elevation Unknown
SAMPLING METHOD: Hand Auger PERFORMED BY: S&ME/J. Prevatte	
WATER LEVEL: **Not Encountered**	

Depth (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION (feet)	WATER LEVEL
		TOPSOIL - 4 inches.		
1 2		**SILTY SAND (SM)** - Tan and brown, mostly fine to medium sand, some low plasticity to non-plastic fines, moist.		
3 4		**CLAYEY SAND (SC)** - Tan and orange, mostly fine to medium sand, some low to medium plasticity fines, moist.		

Boring terminated at 4 ft
Target Depth

DCP INDEX IS THE DEPTH (IN.) OF PENETRATION PER BLOW OF A 10.1 LB HAMMER FALLING 22.6 IN., DRIVING A 0.79 IN. O.D. 60 DEGREE CONE.

SOIL CLASSIFICATION CHART

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		(LITTLE OR NO FINES)		GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SANDS		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		(LITTLE OR NO FINES)		SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES		SM	SILTY SANDS, SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

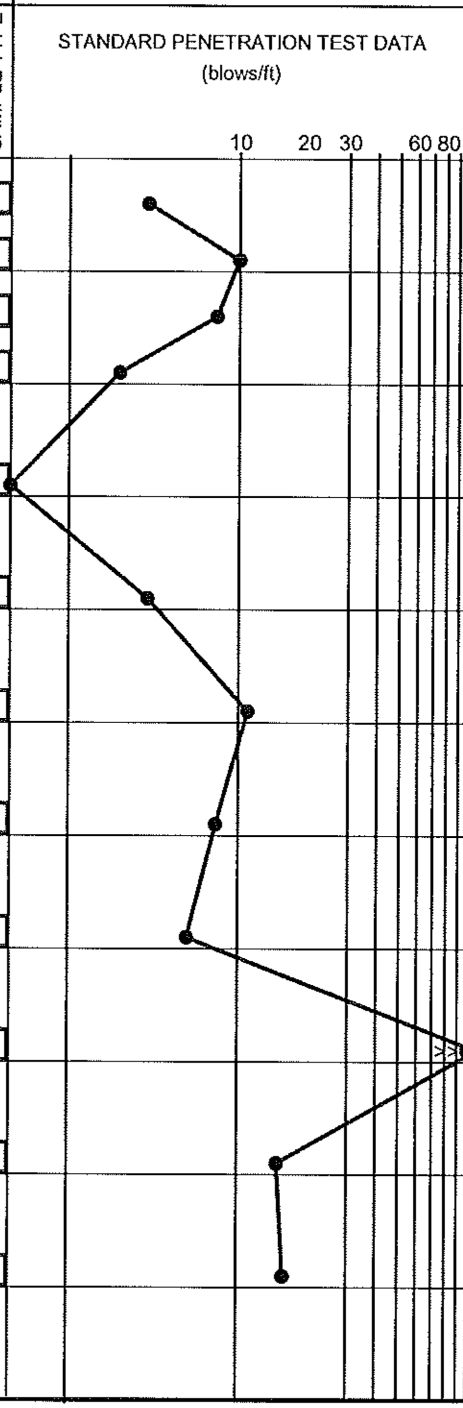
S&ME

PROJECT:	CCU - Kimbel Information Commons Conway, South Carolina 1633-09-251	BORING LOG B-1

DATE DRILLED:	10/13/2009	ELEVATION:	unknown
DRILLING METHOD:	Mud Rotary	BORING DEPTH:	50 feet
LOGGED BY:	JDL	WATER LEVEL:	5 feet at TOB; 4.3 feet after 24 hrs.
DRILLER:	George Bridger	DRILL RIG:	CME 45-B

NOTES:

DEPTH (feet)	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	N VALUE
0	TOPSOIL (Approximately 4")			1	4
	CLAYEY SAND (SC) - FILL - Mostly fine to medium sand, some low to medium plasticity fines, tan, moist, very loose.	▽		2	10
5	POORLY GRADED SAND WITH SILT (SP-SM) - Mostly fine to medium sand, few low to medium plasticity fines, brown, moist to saturated, loose to very loose.			3	8
10				4	3
15	LEAN CLAY WITH SAND (CL) - Mostly medium plasticity fines, some fine sand, gray, saturated, very soft.			5	WOH
20	CLAYEY SAND (SC) - SHELL HASH - Mostly fine to medium sand and sand-sized shell particles, some low to medium plasticity fines, gray, saturated, very loose.			6	4
25	CLAYEY SAND (SC) - Mostly fine to medium sand, some low to medium plasticity fines, green to gray, wet, medium dense.			7	11
30	CLAYEY SAND (SC) - Mostly fine to medium sand, some low to medium plasticity fines, some shell and cemented particles, light gray, saturated, loose.			8	8
35				9	6
	- Cemented Limestone Lens (Approxmiately 18 inches thick).				
40	SANDY LEAN CLAY (CL) - PEE DEE FORMATION - Mostly low to medium plasticity fines, some fine to medium sand, gray, moist to wet, stiff to very stiff.			10	50/ 1"
45				11	15
50	- Boring terminated at 50 feet.			12	16



BORING LOG 1633-09-251.GPJ WITH CPT.GDT 11/3/09

NOTES:

1. *THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.*
2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

S&ME

PROJECT:	CCU - Kimbel Information Commons Conway, South Carolina 1633-09-251	**BORING LOG**	**B-2**
DATE DRILLED:	10/13/2009	ELEVATION:	unknown
DRILLING METHOD:	Mud Rotary	BORING DEPTH:	50 feet
LOGGED BY:	JDL	WATER LEVEL:	3.5 feet at TOB; 4.4 feet after 24 hrs.
DRILLER:	George Bridger	DRILL RIG:	CME 45-B

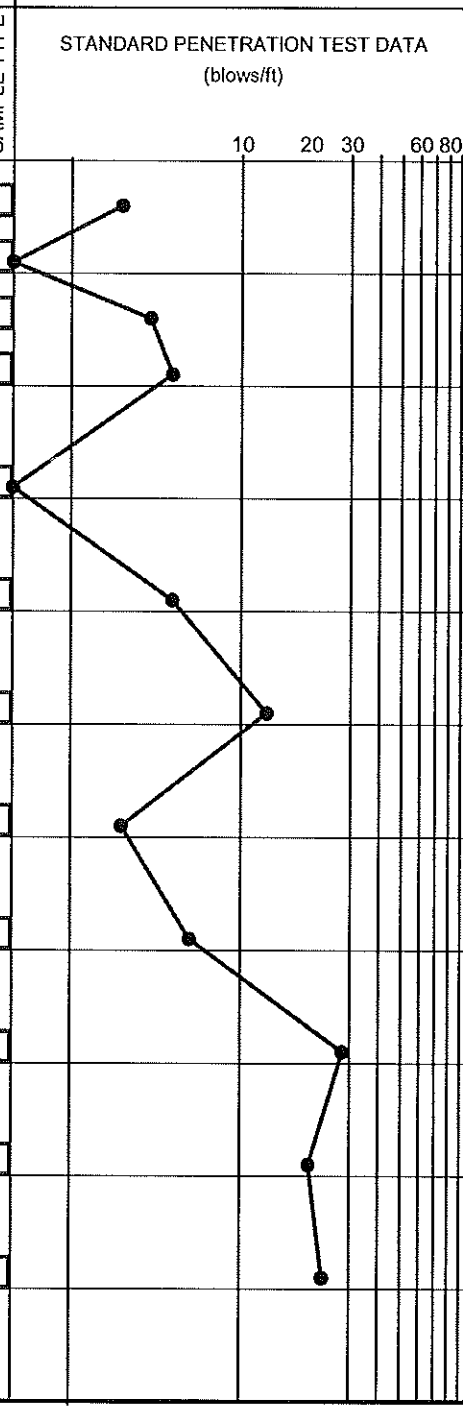
NOTES:

MATERIAL DESCRIPTION

- CONCRETE (Approximately 5.5 inches thick)
- SILTY SAND (SM) - FILL - Mostly fine to medium sand, some low to medium plasticity fines, brown, moist to wet, medium dense.
- CLAYEY SAND (SC) - Mostly fine to medium sand, some medium to high plastic fines, tan, wet to saturated, loose.
- POORLY GRADED SAND (SP) - Mostly fine to medium sand, trace fines, brown, moist to saturated, loose to very loose.
- LEAN CLAY WITH SAND (CL) - Mostly medium plasticity fines, some fine sand, gray, saturated, very soft.
- CLAYEY SAND (SC) - SHELL HASH - Mostly fine to medium sand and sand-sized shell particles, some low to medium plasticity fines, gray, saturated, loose.
- SANDY LEAN CLAY (CL) - Mostly medium plastic fines, some fine sand, gray, saturated, stiff.
- CLAYEY SAND (SC) - Mostly fine to medium sand, some low to medium plasticity fines, gray, saturated, very loose.
- CLAYEY SAND (SC) - Mostly fine to medium sand, some low to medium plasticity fines, some shell and cemented particles, light gray, saturated, loose.
- Cemented Limestone Lens (Approxmiately 6 inches thick).
- SANDY LEAN CLAY (CL) - PEE DEE FORMATION - Mostly low to medium plasticity fines, some fine to medium sand, gray, moist to wet, very stiff.
- Boring terminated at 50 feet.

SAMPLE NO.	N VALUE
1	3
2	WOH
3	4
4	5
5	WOH
6	5
7	13
8	3
9	6
10	28
11	20
12	23

STANDARD PENETRATION TEST DATA (blows/ft)



BORING LOG 1633-09-251.GPJ WITH CPT.GDT 11/3/09

NOTES:

1. *THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.*
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3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

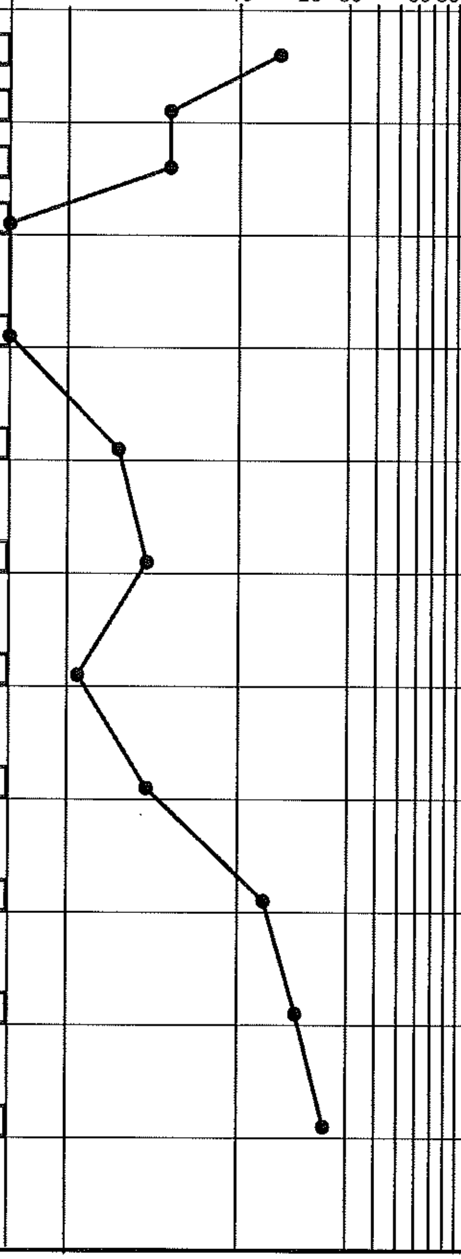
S&ME

PROJECT:	CCU - Kimbel Information Commons Conway, South Carolina 1633-09-251	BORING LOG B-3

DATE DRILLED: 10/13/2009	ELEVATION: unknown	NOTES:
DRILLING METHOD: Mud Rotary	BORING DEPTH: 50 feet	
LOGGED BY: JDL	WATER LEVEL: 3.5 feet at TOB; 3.6 feet after 24 hrs.	
DRILLER: George Bridger	DRILL RIG: CME 45-B	

DEPTH (feet)	MATERIAL DESCRIPTION	SAMPLE NO.	N VALUE
	TOPSOIL (Approximately 6")		
	SILTY SAND (SM) - FILL - Mostly fine to medium sand, some low to medium plasticity fines, brown, moist to wet, medium dense.	1	15
5	CLAYEY SAND (SC) - Mostly fine to medium sand, some low to medium plasticity fines, tan, moist, loose.	2	5
		3	5
10	POORLY GRADED SAND (SP) - Mostly fine to medium sand, trace fines, brown, moist to saturated, loose to very loose.	4	1/18"
15	LEAN CLAY WITH SAND (CL) - Mostly medium plasticity fines, some fine sand, gray, saturated, very soft.	5	WOH
20	CLAYEY SAND (SC) - SHELL HASH - Mostly fine to medium sand and sand-sized shell particles, some low to medium plasticity fines, gray, saturated, very loose.	6	3
25	SANDY LEAN CLAY (CL) - Mostly medium plasticity fines, some fine sand, gray, saturated, soft.	7	4
30	CLAYEY SAND (SC) - Mostly fine to medium sand, some low to medium plasticity fines, gray, wet, very loose.	8	2
35	CLAYEY SAND (SC) - Mostly fine to medium sand, some low to medium plasticity fines, some shell and cemented particles, light gray, saturated, very loose.	9	4
	- Cemented Limestone Lens (Approxmiately 6 inches thick).		
40	SANDY LEAN CLAY (CL) - PEE DEE FORMATION - Mostly low to medium plasticity fines, some fine to medium sand, gray, moist to wet, very stiff.	10	13
45		11	18
50		12	24
	- Boring terminated at 50 feet.		

STANDARD PENETRATION TEST DATA (blows/ft)



NOTES:

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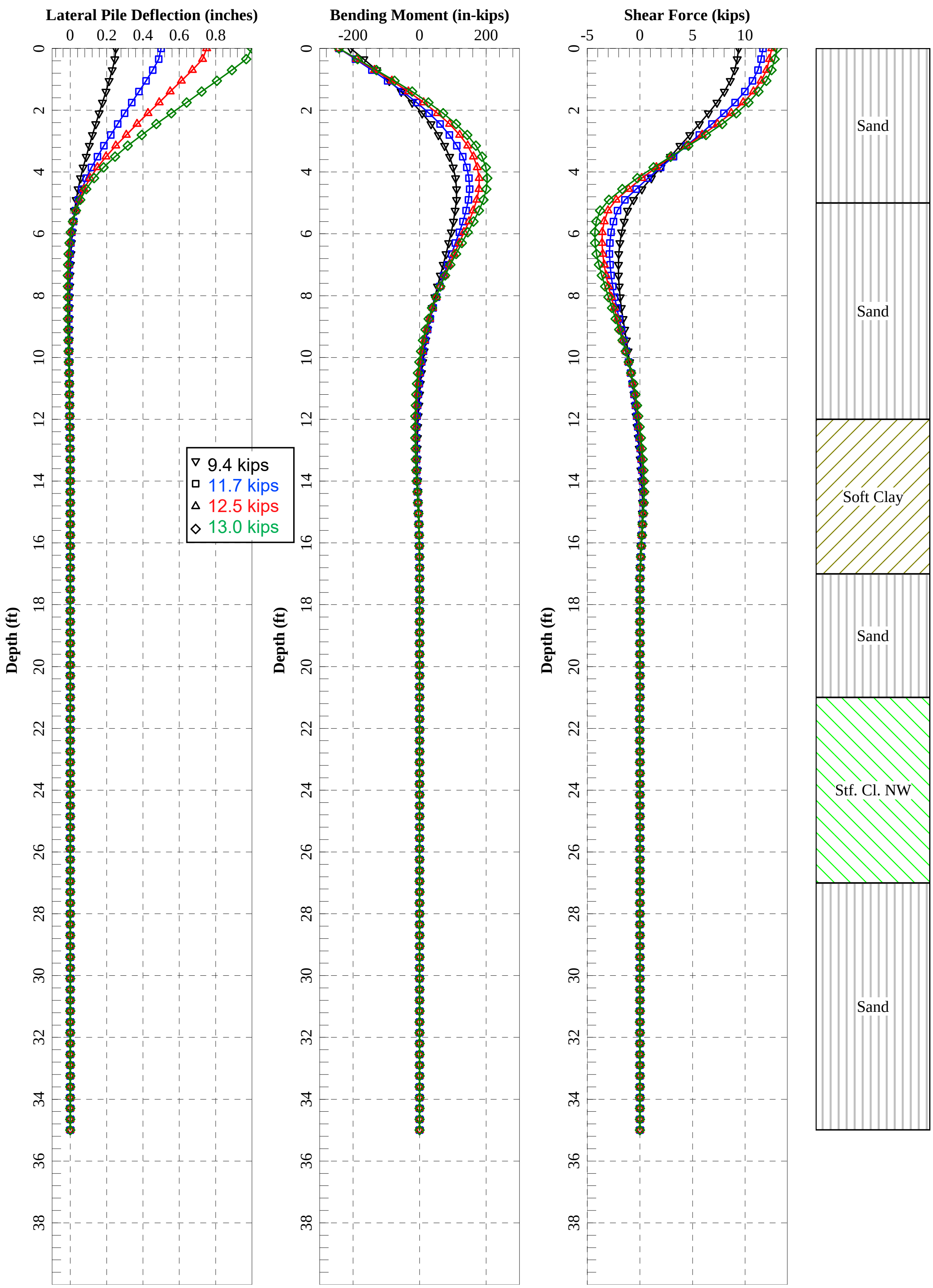
2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

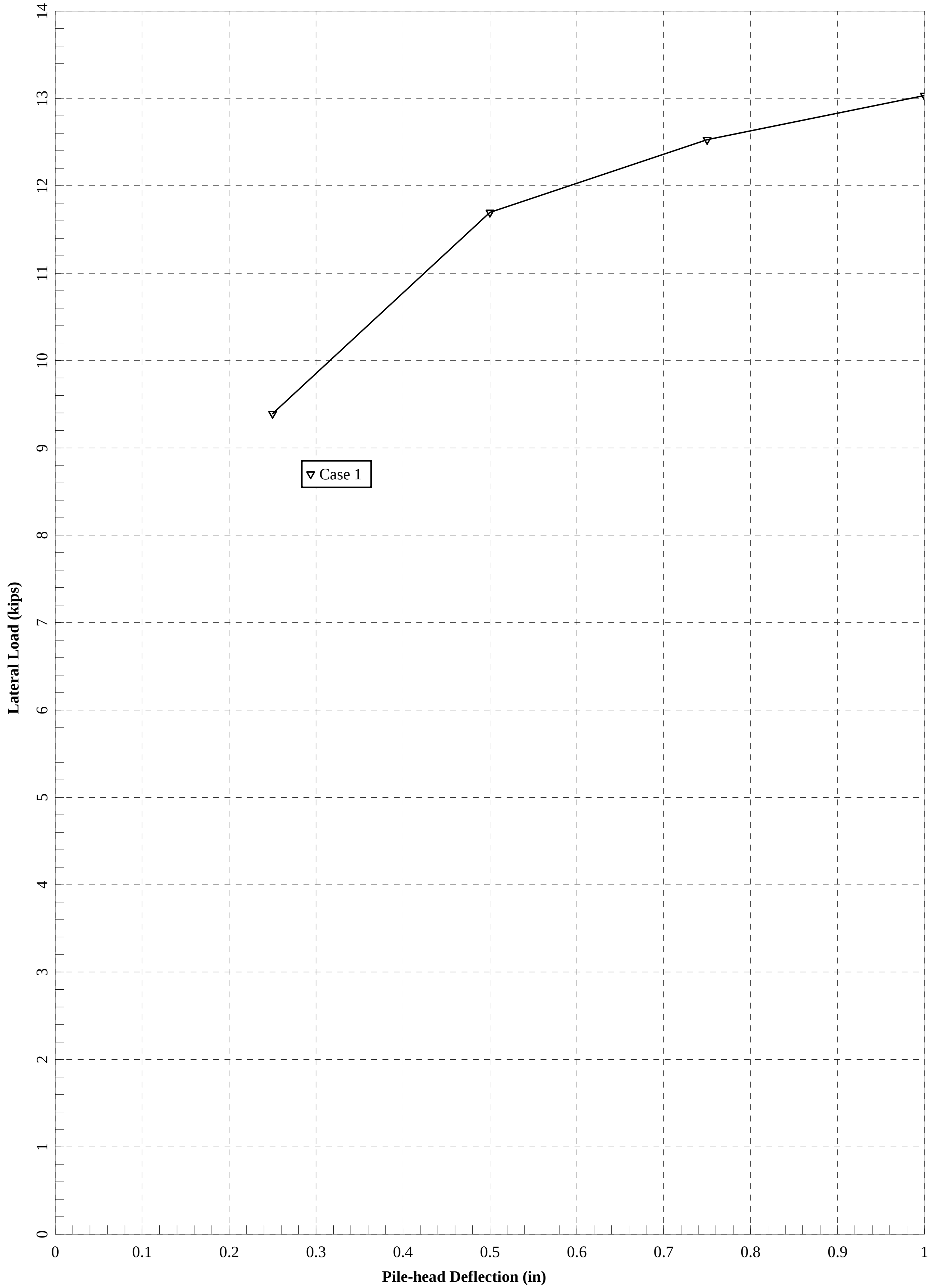
S&ME

Appendix III

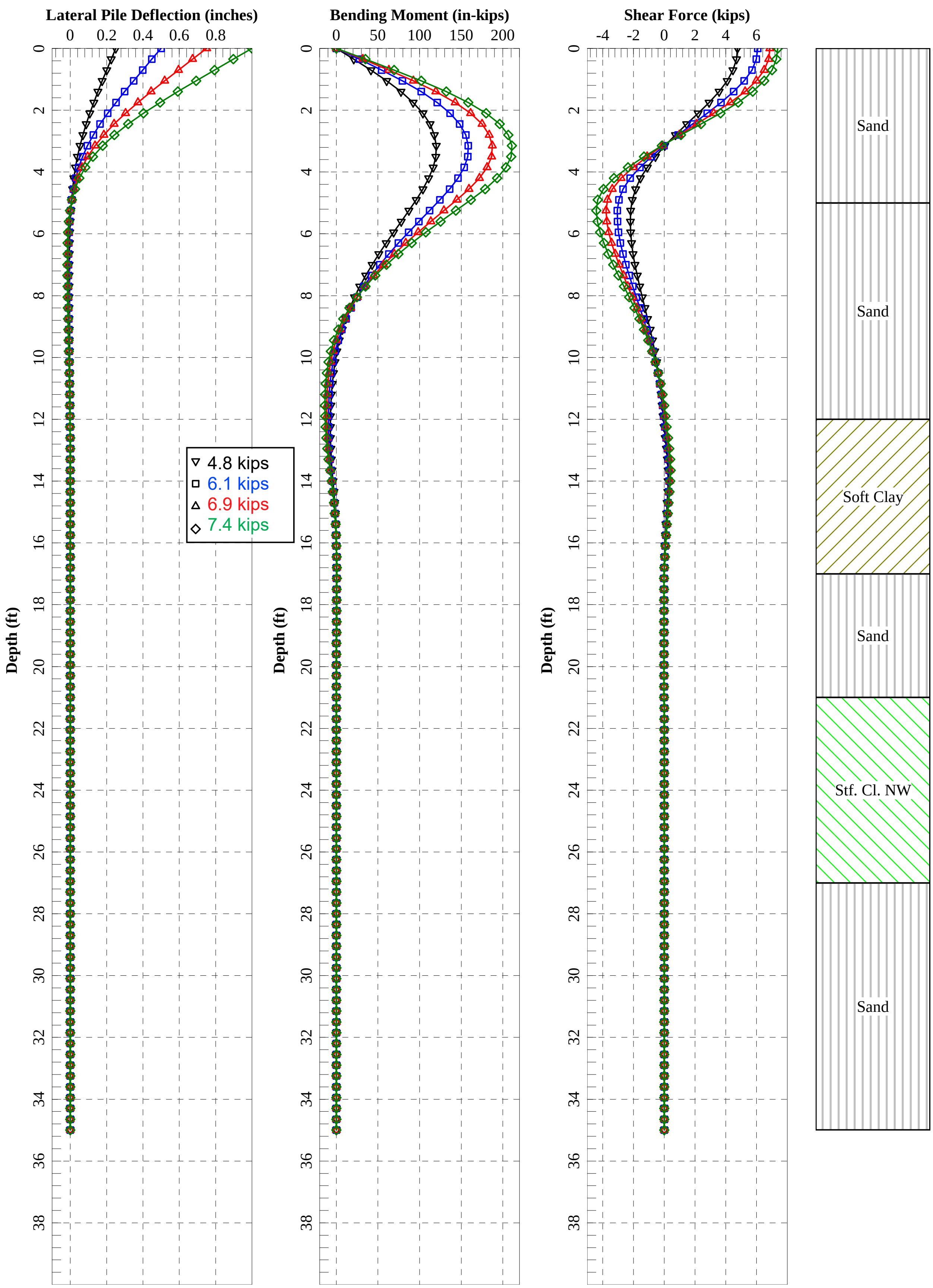
10 inch Diameter Micropile
Fixed Head - Static Conditions - 35 feet long

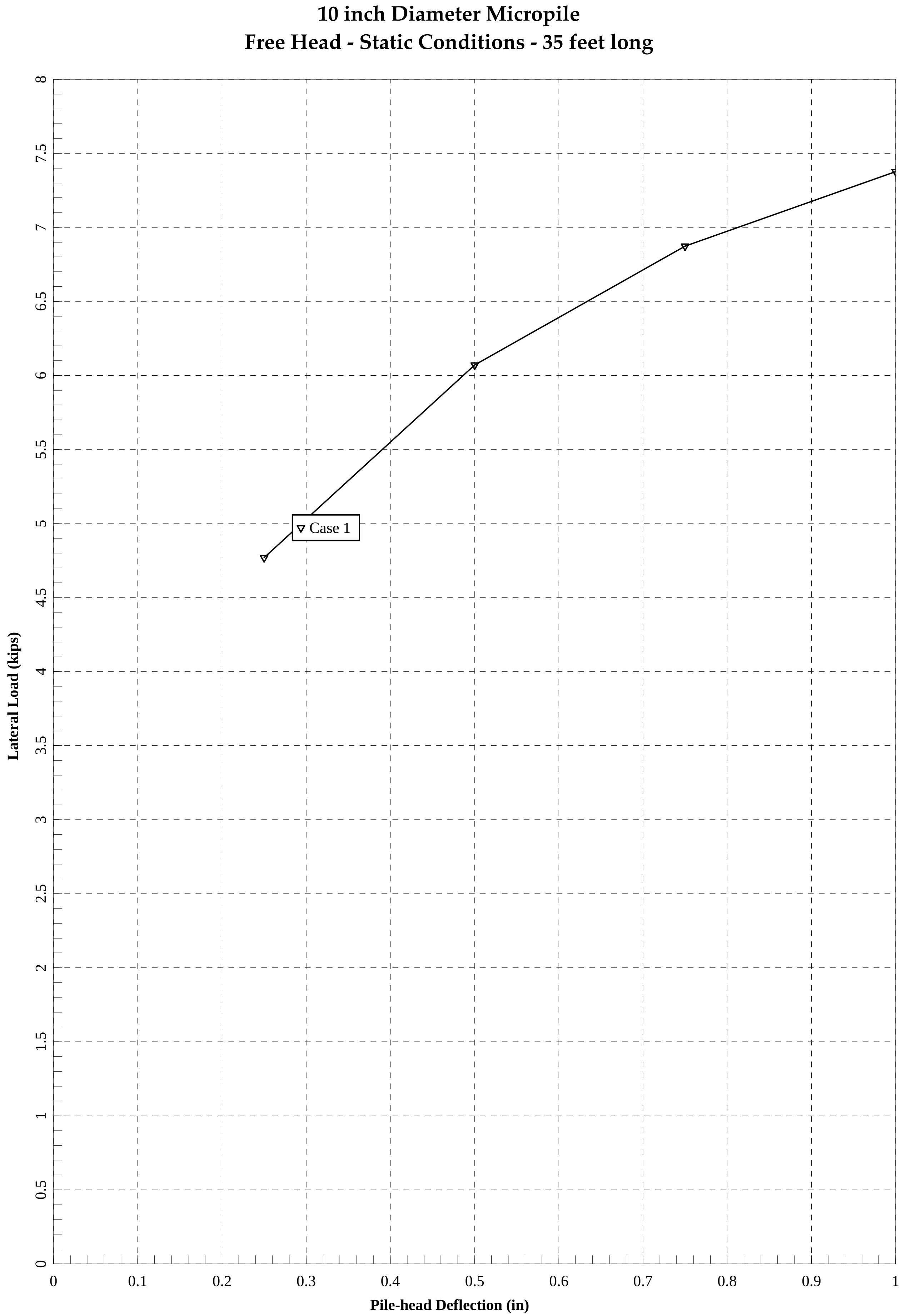


10 inch Diameter Micropile
Fixed Head - Static Conditions - 35 feet long



10 inch Diameter Micropile
Free Head - Static Conditions - 35 feet long




10 inch Diameter Micropile
Free Head - Static Conditions - 35 feet long
Lateral Load (kips)
Pile-head Deflection (in)
Case 1
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1