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VOLUME 2

MAHOPAC CENTRAL SCHOOL DISTRICT

MAHOPAC, NEW YORK

PROJECT NO. 121111-19002

RECONSTRUCTION AT
MAHOPAC HIGH SCHOOL
MAHOPAC MIDDLE SCHOOL
MAHOPAC FALLS SCHOOL
BUS GARAGE
NEW PUMP HOUSE

AUGUST 21, 2020

The engineer that has signed this document certifies that to the best of their knowledge, information and belief, the asbestos plans and specifications are in accordance with applicable requirements of the New York State Uniform Fire Prevention and Building Code, Construction Standards of the Commissioner of Education, New York State Department of Labor Part 56 of Title 12, and the United States Environmental Protection Agency Hazard Emergency Response ACT Regulations. Kevin C. Terry is accredited to the EPA and New York State under AHERA Regulations as an Asbestos Project Designer (Asbestos Handling Certificate Number 14-20336).

To the best of the Architect's knowledge, information and belief, the design of this project conforms to all applicable provisions of the New York State Uniform Fire Prevention and Building Code, the New York State Energy Conservation Code, and the building standards of the New York State Education Department.

SET NO. _____

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PROJECT MANUAL

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BIDDING REQUIREMENTS AND CONDITIONS OF THE CONTRACT

PLEASE NOTE

All sections of the following **SPECIFICATIONS** are sequentially numbered, beginning with Page 1 and concluding with the last numbered page bearing the marking "END OF SECTION -- -- --".

Sections may include additional attachments as noted in following list of Specification sections.

SPECIFICATIONS

DIVISION 33 – UTILITIES

SECTION 22 05 00 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Definitions, references, and abbreviations.
2. General regulatory requirements.
3. General requirements regarding site/field conditions including existing conditions and field measurements.
4. Sequencing and scheduling including coordination.
5. Definition of design equipment and procedures for consideration of specified equivalents, proposed equivalents, or substitutions.
6. Plumbing requirements for foodservice equipment.
7. Plumbing requirements for laboratory equipment.
8. Grout.
9. Plumbing demolition.
10. Equipment installation requirements common to equipment sections.
11. Painting and finishing.
12. Concrete bases.
13. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 SYSTEM DESCRIPTION

A. Provide complete systems, properly connected, tested, balanced, adjusted, and ready for operation, including all necessary and required controls, safeties, details and accessories, including (but not limited to):

1. Site water and sanitary sewer utilities.
2. Sanitary drainage and vent systems.
3. Water distribution systems.
4. Plumbing fixtures.
5. Compressed air system.
6. Domestic water wells.
7. Natural gas piping systems.
8. Electrical control wiring to equipment furnished in this Contract.
9. Electrical power wiring to equipment furnished in this Contract.
10. Miscellaneous items.

1.5 COORDINATION PROCEDURES

A. Coordinate construction operations and construction schedule of plumbing work with other contractors in accordance with Section 01 31 00 “Project Management and Coordination” and as modified below.

1. Pre-Installation Conference:

    a. Attend pre-installation conference. Arrange for all subcontractors to be in attendance.

2. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.

3. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Section 08 31 13 "Access Doors and Frames."

4. Coordinate Plumbing Work with HVAC systems, lighting fixtures, ceiling mounted devices, ceiling heights, materials, structural work, maintenance clearances, and electric code clearance and building systems.

5. Notify Owner's Project Representative and Architect in case of unresolved interferences prior to installation of Plumbing Work.

6. Adjust exact size, location and offsets of pipes to achieve reasonable appearance objectives in open areas without ceilings without increase in Contract Sum.

1.6 COORDINATION DRAWINGS

A. Comply with requirements of Section 01 31 00 “Project Management and Coordination” and as modified below.

1. Prepare drawings coordinating Plumbing Work with HVAC systems, lighting fixtures, ceiling mounted devices, ceiling heights, materials, structural work, maintenance clearances, electric code clearance, building systems, existing construction, etc. Provide additional details and sections, as required for clarity, at all places of potential conflict.

2. Reposition proposed locations of Plumbing systems as required to work within project constraints. Adjust exact size, aspect ratio, location and offsets of piping systems as required. Achieve as specified and other reasonable appearance objectives in open areas without ceilings without increase in Contract Sum.

3. Review Coordination Drawings and compare them with all other drawings to verify that all Work can be installed without interference. Notify Owner's Project Representative in case of unresolved interferences prior to installation of any work. Revise Coordination Drawings as required to eliminate installation interferences upon direction of Architect.

4. Indicate areas of unresolved conflicts between Plumbing systems and other building components by highlighting locations on Coordination Drawings and separately listing.

5. Do not proceed with installation of systems in each area until agreement is reached with all concerned on exact arrangements for each room or area, unless otherwise directed by Architect. If Contractor proceeds with installations prior to resolving conflicts, Contractor shall modify installed Work as required to permit other systems to proceed with a coordinated installation without an increase in Contract Sum.

6. Coordination Drawings do not relieve Contractor of responsibility for coordinating Plumbing system installations with Project work, nor does it authorize extra cost, omission or deviation from Contract Document requirements. Costs arising from errors or omissions in Coordination Drawings shall be borne by Contractor.

1.7 SUBMITTALS, GENERAL

A. Comply with requirements of SECTION 01 33 00 “Submittal Procedures” for each individual Section and as modified below.

B. Submit all action submittals required by individual Section concurrently.

1. Do not use “**As Specified Verification Form**” unless specifically indicated in detailed product specification.

2. Equivalent Products or Substitutions: If product to be incorporated into Project is not specified by name and product designation in Part 2 below, comply with all Product Data requirements specified.

1.8 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sleeves and sleeve seals. Include rated capacities, and furnished specialties and accessories.

1. Penetration firestopping materials.
2. Penetration firestopping assembly drawings.
3. Access doors.

B. As-Specified Data: The product to be incorporated in the Work is as specified by manufacturer name and product designation in this Specification Section, submit the "**As-Specified Verification Form**" (attached to Section 01 33 00 "Submittal Procedures") for each item listed below; otherwise submit full Product Data for the following:

1. Concrete mix for bases and supports.
2. Grout.
3. Sealants.
4. Paint.
5. Foodservice equipment rough-in fittings and piping.
6. Laboratory equipment rough-in fittings and piping.
7. Dielectric fittings.

C. Shop Drawings: Include dimensioned plans, sections, and attachments to other work for concrete bases.

1.9 INFORMATIONAL SUBMITTALS

A. Coordination Drawings.
B. Contract Closeout Submittals: Comply with requirements of Section 01 77 00 "Closeout Procedures".

1.10 QUALITY ASSURANCE.

A. Provide installation, testing and materials in accordance with Federal, State and Local Building, Health, Plumbing and Electrical Codes, Laws, Ordinances, and Regulations that apply to Plumbing Work.

1. Comply with applicable requirements of following documents:

a. New York State Uniform Fire Prevention and Building Code.
b. Building Code of New York State 2015.
c. Fire Code of New York State 2015.
d. Plumbing Code of New York State 2015.
e. Mechanical Code of New York State 2015.
f. Fuel Gas Code of New York State 2015.
g. Energy Conservation Construction Code of New York State 2015, including 2016 and 2017 Code Supplements.
h. New York State Education Department Manual of Planning Standards.
i. In event of a conflict between the Codes identified above and Contract Documents, comply with more stringent requirement.

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

C. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

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

D. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is submitted to the Architect and approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.11 DELIVERY, STORAGE, AND HANDLING

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

B. Packing and Shipping: Ship materials in manufacturer's containers, fully identified with manufacture's name, trade name, type, class, style, model, grade, size and color.

C. Storage and Protection:

1. Store materials, equipment, fixtures, pipe, fittings, and attachments, under cover, off ground in original containers as applicable, and protect from physical and weather damage while in storage and during construction.

2. Furnish extra materials identified in technical sections, in original manufacturers' containers and packaging, to Owner at location identified during prebid conference. Obtain receipt from Owner upon delivery of extra materials and send copy of receipt to Architect.

3. Replace or repair damaged, rusted, corroded or otherwise unusable materials physically damaged or weather damaged equipment as determined by Architect, at no change in Contract Sum.

4. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.12 PROJECT/SITE CONDITIONs

A. Existing Conditions:

1. Reuse equipment only as indicated on Drawings.

2. All usable material and equipment not being reused is to be offered to the Owner. If accepted by Owner the Contractor shall deliver to a location on District grounds designated by the Owner.

3. All other material and equipment to be removed, shall be removed from the site and legally disposed of by the Contractor

B. Rodent Proofing:

1. Strainer Plates: All strainer plates on drain inlets shall be designed and installed so that all openings are not greater than a 1/2 inch in least dimension. Refer to Section 22 13 19 “Sanitary Waste Piping Specialties” for additional requirements.

2. Openings for Pipes: In or on structures where openings have been made in walls, floors or ceilings for the passage of pipes, such openings shall be closed and protected by the installation of approved metal collars that are securely fastened to the adjoining structure. Refer to Section 22 05 17 “Sleeves and Sleeve Seals for Plumbing piping” and 22 05 18 “Escutcheons for Plumbing Piping” for additional requirements.

C. Protection of Plumbing Systems:

1. Corrosion: Provide corrosion protection for pipes passing through concrete or cinder walls and floors or buried in corrosive soil conditions.

a. Provide oversized sleeves or core drilled holes to eliminate rubbing on above grade piping installations. Refer to Section 22 05 17 “Sleeves and Sleeve Seals for Plumbing Piping” for pipe sleeve and core drilling requirements.

b. Refer to individual Division 22 piping Sections for corrosion protection on buried piping installations in corrosive soil conditions.

2. Stress and Strain: Install plumbing systems in a manner that prevents stresses and strains that exceed the structural strength of the pipe. Install piping systems to accommodate expansion, contraction and structural settlement.

3. Freezing: Do not install water, soil, waste or storm piping outside of a building, in attics or crawlspaces, conceal in outside walls or in any other place subjected to freezing temperatures without providing measures to keep the contents of the piping system from freezing.

D. Field Measurements:

1. Layout of equipment, piping, and similar components in Drawings is diagrammatic. Review Drawings to identify interference with other construction and verify dimensions at Site prior to beginning installation.

a. Obtain exact location of all items and openings and confirm all existing conditions in field.

b. Obtain exact location and roughing requirements for all equipment furnished by others, but installed by this Contractor before roughing. Owner reserves right to make reasonable changes prior to "roughing-in" without increase in Contract Sum.

2. Report any conflicts to Architect in writing before beginning installation.

3. Provide fittings, horizontal and vertical offsets, elevation changes, etc. required to install Plumbing Work. Do not infer that Drawings show level of detail indicating every offset, elbow, union, fitting, elevation changes, or other aspect required for complete installation.

4. Install Plumbing Work with proper provisions for removal and/or access to valves, traps, cleanouts, etc.

1.13 SEQUENCING AND SCHEDULING

A. Perform Plumbing Work in cooperation with Owner, Architect, Construction Manager, and all Contractors on this Project, and other separate Contractors at the Site.

1. Coordinate Plumbing Work with construction schedule requirements in Division 01
2. Coordinate all submittals with the construction schedule and with requirements and schedules contained in Section 01 33 00 “Submittals Procedures.”
3. Immediately report any delays in receipt of materials required for Plumbing Work including circumstances causing delays.

B. Refer to Division 01 for cooperation between Contractors. Prior to start of construction:

1. Obtain from Contract Drawings or Architect, exact location of items and openings in construction. Conform to existing conditions in field.

2. Review applicable Shop Drawings of all Contracts.

3. If conflict occurs between Contract Drawings, advise Architect in writing before beginning installation and comply with Architect's directions.

4. Obtain exact location and roughing requirements for equipment furnished by other Contractor or by Owner, but installed by Contractor responsible for Plumbing Work before beginning roughing.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Minimum Material Requirements:

1. Construct potable water systems and equipment according to AWWA standards.

2. Provide electrical equipment and systems meeting UL standards and requirements of NEC.

3. Provide UL label on all equipment and material with listing service.

4. Material Flammability:

    a. Flame spread rating of 25 or less.
    b. Smoke developed rating of 50 or less.

5. Equipment Verification: Carefully check manufacturer's drawings and specifications as they affect their equipment; follow factory instructions for roughing, installation, connection, filling, lubrication, testing, balancing, adjusting, alignment, wiring, and start-up operation.

2.2 CONCRETE BASES AND SUPPORTS

A. Comply with requirements for concrete bases and supports specified in Section 03 30 00 "Cast-in-Place Concrete."

B. Equipment Bases: 3-1/2 inches thick minimum, reinforced with 6x6-W1.4xW1.4 welded wire mesh, minimum 1-1/2 inches cover, doubled over 12 inches on long edges, unless otherwise specified.

2.3 GROUT

A. Description: ASTM C 1107, Grade B, non-shrink, non-metallic, high strength grout, suitable for interior and exterior, above and below grade applications.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.4 SEALANTS

A. Comply with requirements for sealants in non-fire rated penetrations specified in Section 07 92 00 "Joint Sealants."

B. Mildew-Resistant, Single-Component, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.

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. BASF Building Systems; Omniplus.
    b. Dow Corning Corporation; 786 Mildew Resistant.
    c. GE Advanced Materials - Silicones; Sanitary SCS1700.

2.5 PENETRATION FIRESTOPPING

A. Comply with requirements for sealants in fire rated penetrations specified in Section 07 84 13 “Penetration Firestopping”.

B. Submit Manufacturers Product Data Sheets for each type of product selected. Certify that Firestop Material is free of asbestos and lead paint, and complies with local regulations.

1. Certification by firestopping manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs) and are nontoxic to building occupants.

C. Submit system design listings, including illustrations from qualified testing and inspection agency that is applicable to each firestop configuration.

D. Submit a project specific Penetration Firestopping Schedule indicating where each firestop configuration will be used.

2.6 ACCESS DOORS

A. Comply with requirements for access doors specified in Section 08 31 13 “Access Doors and Frames” for product requirements.

B. Access Door Sizes for Plumbing Applications:

1. Single Valve:

a. 1 NPS and Smaller Valve Size: 8 inches by 8 inches.
b. 1-1/2 NPS and 2 NPS Valve Size: 12 inches by 12 inches.
c. 3 NPS and 4 NPS Valve Size: 18 inches by 18 inches.

2. Two Valves:

a. 2 NPS and Smaller Valve Size: 12 inches by 12 inches.
b. 3 NPS and 4 NPS Valve Size: 18 inches by 18 inches.

3. Condensate Drain Connection: 18 inches by 18 inches.

4. Other Devices: 12 inches by 12 inches.

2.7 PAINT AND FINISHES

A. Refer to Section 09 91 00 "Painting" for interior and Section 09 96 00 “High-Performance Coatings” for exterior painting and finishing of plumbing piping, equipment and systems.

2.8 FOODSERVICE EQUIPMENT AND FIXTURES

A. Refer to Section 11 40 00 "Foodservice Equipment" for foodservice equipment and fixtures requiring plumbing piping rough-ins and connections.

B. Provide plumbing piping rough-ins and connections to food service fixtures and equipment.

C. Provide plumbing piping rough-ins and connections to relocated food service fixtures and equipment.

D. Verification of Locations and Dimensions

1. New Equipment: Verify exact locations and roughing-in dimensions for each connection and installation from equipment shop drawings furnished by Contractor Responsible for Kitchen Equipment before beginning installation and provide required adjustments to locations or dimensions.

2. Relocated Equipment: Verify exact locations and roughing-in dimensions for each connection and installation of relocated equipment and fixtures by inspecting existing installations prior to removal and relocation. Disconnect existing equipment to be relocated or removed.

E. Provide final plumbing connections to kitchen equipment including interconnecting and final hook-up of plumbing fixtures and piping, valves, traps, fittings, shutoff valves etc. required for complete and operating system.

F. Install loose plumbing devices, i.e. faucets, pressure regulators relief valves, vacuum breakers, strainers, drains, etc. furnished with kitchen equipment and fixtures at locations indicated on approved equipment shop drawings and equipment product data sheets submitted by Contractor Responsible for Kitchen Equipment. Obtain receipt of delivery for materials supplied by Prime Contractor(s).

G. Provide indirect waste from kitchen equipment and fixtures at locations indicated on equipment shop drawings and equipment product data sheets submitted by Contractor Responsible for Kitchen Equipment. Obtain receipt of delivery for materials supplied by Prime Contractor(s). Route indirect waste to floor drains or floor sinks with air gap at terminus.

H. Verify exact locations and roughing-in dimensions for each connection and installation from Roughing Drawings and Assembly Drawings of kitchen equipment accepted by Architect before beginning installation. Obtain Roughing Drawings and Assembly Drawings from Contractor Responsible for Kitchen Equipment Installation.

I. Install plumbing rough-ins as required for complete and operable installation meeting installation guidelines established by equipment manufacturer.

J. Install accessible plumbing systems and components in locations and arrangement to allow for regular cleaning of surfaces. Do not support piping from floor where regular cleaning is required.

K. Maintain 6-inch clear space between floor and plumbing piping, valves, fitting, devices to aid in cleaning floors. Provide supports to bracing piping from walls or equipment.

2.9 LABORATORY EQUIPMENT AND FIXTURES

A. Refer to Section 12 32 13 "Manufactured Wood-Veneer-Faced Casework" for laboratory equipment and fixtures requiring plumbing piping rough-ins and connections.

B. Provide plumbing piping rough-ins, traps, drains, supplies with stops and escutcheon plates for connections to fixtures and equipment provided in Section 12 32 13 "Manufactured Wood-Veneer-Faced Casework".

C. Provide chrome plating on exposed metallic water and gas piping, valves, etc.

D. Install fume hood equipment fittings and fixtures, i.e. faucet, sink drains, tailpieces, gas and air turrets and cocks, etc. Obtain receipt of delivery for materials supplied by other Prime Contractors.

E. Install sink drains and tailpieces furnished by Section 12 32 13 "Manufactured Wood-Veneer-Faced Casework". Obtain receipt of delivery for materials supplied by other Prime Contractors.

F. Install emergency eye wash equipment fittings and fixtures, i.e. eye wash, sink drains, tailpieces, etc. Obtain receipt of delivery for materials supplied by other Prime Contractors.

G. Install emergency eyewash and shower equipment fittings and fixtures, i.e. sink drains, eyewash shower head, tailpieces, etc. Obtain receipt of delivery for materials supplied by other Prime Contractors.

H. Coordinate size, location and number of hole punches required for installation of plumbing faucets and counter mounted turrets with Laboratory Equipment Installer in ample time for holes to be indicated on Roughing Drawings and Assembly Drawing from Laboratory Equipment Installer and Casework Installer.

I. Verify exact locations and roughing-in dimensions for each connection and installation from Roughing Drawings and Assembly Drawings of laboratory casework and equipment accepted by Architect before beginning installation. Obtain Roughing Drawings and Assembly Drawings from Laboratory Equipment Installer and Casework Installer.

J. Adjust rough in as required for complete and operable installation meeting installation guidelines established by equipment manufacturer.

2.10 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. Insulating Material: Suitable for system fluid, pressure, and temperature.

1. 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: 125 psig minimum at 180 deg F.
3) End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

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

a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. Matco-Norca, Inc.
d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
e. Wilkins; a Zurn company.

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

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Central Plastics Company.
d. Pipeline Seal and Insulator, Inc.

2. 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.

PART 3 - EXECUTION

3.1 PLUMBING DEMOLITION

A. Refer to Section 02 41 19 "Selective Structure Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.

1. Remove Piping: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Abandon Piping in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Remove Equipment: Disconnect and cap services and remove equipment.
4. Remove and Reinstall Equipment: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
5. Remove and Salvage Equipment: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is rendered unserviceable during the process of demolition, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Unless specific mounting heights are indicated, install equipment to allow maximum possible headroom.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.3 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Sections, Section 22 05 29 “Hangers and Supports for Plumbing Piping and Equipment”, and Section 22 05 48.13 “Vibration Controls for Plumbing Piping and Equipment” for detailed additional requirements.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.4 CONCRETE BASES

A. Refer to individual Division 22 piping and equipment Sections for specific concrete base and support requirements.

3.5 GROUTING

A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
B. Clean surfaces that will come into contact with grout.
C. Provide forms as required for placement of grout.
D. Avoid air entrapment during placement of grout.
E. Place grout, completely filling equipment bases.
F. Place grout on concrete bases and provide smooth bearing surface for equipment.
G. Place grout around anchors.
H. Cure placed grout.

3.6 SEALANTS

A. Install sealants according to the requirements specified in Section 07 92 00 "Joint Sealants."
B. Refer to individual Division 22 plumbing fixture and equipment Sections for specific sealant and caulking requirements.

3.7 FIRESTOPPING

A. Install firestopping according to the requirements specified in Section 07 84 13 "Penetration Firestopping."

B. Applied Fireproofing:

1. Coordinate the installation of hangers, supports and accessories from the structural steel with the fireproofing installation. Install all hangers and supports prior to installation of fireproofing.

2. Repair or replace existing fireproofing removed as a part of Plumbing Work installation.

   a. Employ the services of an approved fireproofing contractor to repair or replace the fireproofing by patching any areas that have been removed or damaged due to the installation of work after the completion of the fireproofing.

   b. Repaired or replacement fireproofing shall match the fireproofing adjacent to the repaired area. All warranties shall be maintained.

3.8 ACCESS DOORS

A. Install access doors according to the requirements specified in Section 08 31 13 “Access Doors and Frames.”

B. Install access doors where shown on Drawings or where required for access to plumbing system components requiring service (i.e. valves, equipment, slip joints, unions, gauges, etc.) and are located in concealed installations.

3.9 PAINTING

A. Painting of plumbing systems, equipment, and components is specified in Section 09 91 00 "Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.10 DIELECTRIC FITTINGS

A. Install dielectric fittings according to the specific requirements in the Division 22 Sections specifying piping systems.

END OF SECTION 22 05 00

SECTION 22 05 13 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 and DOE 10 CFR 431 unless otherwise indicated.
B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficiency, tested and rated in accordance with DOE 10 CFR 431.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. Code Letter Designation:

1. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.

2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.

3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.

4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 22 05 13

SECTION 22 05 17 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.

1.3 SUBMITTALS, GENERAL

A. General: Submit all action submittals required by this Section concurrently.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sleeves and sleeve seals. Include rated capacities, and furnished specialties and accessories.

1. Sleeve-seal systems.
2. Firestopping.

B. As-Specified Data: If the product to be incorporated in the Work is as specified by manufacturer name and product designation in this Specification Section, submit the "**As-Specified Verification Form**" (attached to Section 01 33 00 "Submittal Procedures") for each item listed below; otherwise submit full Product Data for the following:

1. Wall pipe sleeves.
2. Grout.

PART 2 - PRODUCTS

2.1 SLEEVES

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. Advance Products & Systems, Inc.

2. CALPICO, Inc.
3. GPT; an EnPro Industries company.

B. 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.

C. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

D. Flanged Galvanized-Steel Sheet: 0.1345-inch minimum thickness; round tube closed with welded longitudinal joint with 2-inch minimum wide anchor flange welded to perimeter of sleeve. Set flange on perimeter of sleeve to obtain minimum of 2-inches concrete embedment.

E. Flanged Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, welded steel pipe with plain ends and a 2-inch minimum wide anchor flange welded to perimeter of sleeve. Set flange on perimeter of sleeve to obtain minimum of 2-inches concrete embedment.

2.2 SLEEVE-SEAL SYSTEMS

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

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

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

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

2. Sealing Elements (Natural Gas and Propane Gas Systems): NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Stainless steel, Type 316.

4. Connecting Bolts and Nuts: Stainless steel, Type 316 of length required to secure pressure plates to sealing elements.

2.3 PENETRATION FIRESTOPPING

A. Comply with requirements for sealants in fire rated penetrations specified in Section 07 84 13 “Penetration Firestopping” and Section 22 05 00 “Common Work Results for Plumbing”.

2.4 GROUT

A. Refer to grout product requirements specified in Section 22 05 00 “Common Work Results for Plumbing”

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.
C. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

3.2 SLEEVE INSTALLATION

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

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

1. Sleeves are not required for core-drilled holes.

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

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.

2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.

3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 07 92 00 "Joint Sealants."

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 07 84 13 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls, 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.

C. Insulate sleeves on exterior walls with spray polyurethane foam flush with interior wall: Comply with requirements for spray polyurethane foam specified in Section 07 21 00 "Thermal Insulation."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

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

1. Concrete Masonry Unit (CMU) Partitions: Flanged galvanized-steel sheet sleeves with joint sealant.

2. Concrete Walls (above and below grade) and Floors:

a. Piping Smaller than NPS 6: Flanged galvanized-steel pipe sleeves with sleeve-seal fittings.

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

b. Piping NPS 6 and Larger: Flanged galvanized-steel sheet sleeves with sleeve-seal fittings.

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

3. Interior Metal Stud Partitions: Galvanized-steel sheet sleeves with joint sealant.

a. In lieu of joint sealant, provide penetration firestopping at the following locations:

1) Penetrations in fire-resistance-rated walls.
2) Penetrations in smoke barriers.

3.6 GROUTING

A. Mix and install grout for plumbing sleeves and anchors as specified in Section 22 05 00 "Common Work Results for Plumbing"

END OF SECTION 22 05 17

SECTION 22 05 18 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes escutcheons and floor plates.

1.3 ACTION SUBMITTALS

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

B. As-Specified Data: If the product to be incorporated in the Work is as specified by manufacturer name and product designation in this Specification Section, submit the "**As-Specified Verification Form**" (attached to Section 01 33 00 "Submittal Procedures") for each item listed below; otherwise submit full Product Data for the following:

1. Escutcheons.
2. Floor plates.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.
E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.
F. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.
C. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 INSTALLATION

A. Install escutcheons for exposed piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

    a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern type with polished, chrome-plated finish and spring clip fastener.
    b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
    c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
    d. Bare Piping at Wall, Floor or Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
    e. Bare or Insulated Piping in Unfinished Service Spaces and Equipment Rooms: No escutcheons required.

2. Escutcheons for Existing Piping (only required where impacted by new walls, floors or ceilings):

    a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
    b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
    c. Bare Piping at Wall, Floor or Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
    d. Bare or Insulated Piping in Unfinished Service Spaces and Equipment Rooms: No escutcheons required.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.
2. Existing Piping: Split-casting, floor-plate type.

3.3 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 22 05 18

SECTION 22 05 19 - METERS AND GAUGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Thermometers.
2. Gauges.
3. Test plugs and kits.
4. Sight flow indicators.

1.3 SUBMITTALS, GENERAL

A. General: Submit all action submittals required by this Section concurrently.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sleeves and sleeve seals. Include rated capacities, and furnished specialties and accessories.

1. Liquid thermometers.
2. Thermowells.
3. Dial-type pressure gauges.
4. Snubbers.
5. Valves.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Plastic-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Weiss Instruments, Inc; Vari-angle Model 9VU Series or comparable product by one of the following:

a. Ernst Flow Industries.

b. Tel-Tru Manufacturing Company.
c. Trerice, H. O. Co.
d. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.

2. Standard: ASME B40.200.

3. Case: GE Valox® polyester, 40 percent glass/mineral reinforced; 9-inch nominal size unless otherwise indicated.

4. Case Form: Adjustable angle unless otherwise indicated.

5. Tube: Glass with magnifying lens and blue organic liquid.

6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.

7. Window: Glass.

8. Stem: Die cast Zamac alloy and of length to suit installation.

a. Design for Thermowell Installation: Bare stem.

9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.

10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 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: Lead-free brass or stainless steel.
4. Type: Stepped shank unless straight or tapered shank is indicated.
5. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
6. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
7. Bore: Diameter required to match thermometer bulb or stem.
8. Insertion Length: Length required to match thermometer bulb or stem.
9. Lagging Extension: Include on thermowells for insulated piping and tubing.
10. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.3 PRESSURE GAUGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gauges:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Weiss Instruments, Inc; Series 4CTSLF or comparable product by one of the following:

   a. Ernst Flow Industries.
   b. Tel-Tru Manufacturing Company.
   c. Trerice, H. O. Co.

2. Standard: ASME B40.100.

3. Case: Liquid-filled, sealed, solid-front, pressure relief type(s); stainless steel; 4-1/2-inch nominal diameter.

4. Pressure-Element Assembly: Phosphorus bronze tube unless otherwise indicated.

5. Pressure Connection: Lead-free brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.

6. Movement: Mechanical, with link to pressure element and connection to pointer.

7. Dial: White coated metal lithographed with black scale markings graduated in psi.

8. Pointer: Dark-colored metal.

9. Window: Safety glass lens.

10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.4 GAUGE ATTACHMENTS

A. Snubbers: ASME B40.100, lead-free 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. Valves: Lead-free brass or stainless-steel needle valve, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

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 direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position.

G. Install valve and snubber in piping for each pressure gauge for fluids.

H. Install thermometers in the following locations:

1. Inlet and outlet of water storage tank.

I. Install pressure gauges in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.
3. Suction and discharge of each domestic water pump.

3.2 CONNECTIONS

A. Install meters and gauges adjacent to machines and equipment to allow service and maintenance of meters, gauges, machines, and equipment.

3.3 ADJUSTING

A. Adjust faces of meters and gauges to proper angle for best visibility.

B. Locate and adjust reading angle of nearby and groups of thermometers, i.e. multiple temperature water heating systems thermometers, so that multiple readings can be made easily from floor level and from one location.

C. Locate and adjust reading angle of thermometers to be read from floor level without obstructions.

3.4 THERMOMETER SCHEDULE

A. Install an industrial-style, liquid-in-glass type thermometers at the following locations:

1. Inlet and outlet of each domestic water storage tank.

B. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Water Piping: 30 to 180 deg F.

3.6 PRESSURE-GAUGE SCHEDULE

A. Install liquid-filled sealed solid-front, pressure-relief, direct-mounted, metal case pressure gauges at the following locations:

1. Water service piping at point of entry into building.
2. Inlets and outlets of each water service backflow preventer.
3. Inlets and outlets of each water booster pump.

B. Install liquid-filled, sealed, solid-front, pressure-relief, direct-mounted, metal case pressure differential gauges at inlets and outlets of circulation pumps.

3.7 PRESSURE-GAUGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping: 0 to 100 psi.
B. Scale Range for Domestic Water Piping: 0 to 100 psi.

END OF SECTION 22 05 19

SECTION 22 05 23 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Ball valves.
2. Butterfly valves.
3. Check valves.
4. Plug valves.
5. Chainwheels.

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 SUBMITTALS, GENERAL

A. General: Submit all action submittals required by this Section concurrently.

1.5 ACTION SUBMITTALS

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

1. Two-Piece Bronze ball valves.
2. Ductile iron, single-flange butterfly valves.
3. Ductile iron, grooved-end butterfly valves.
4. Bronze lift check valves.
5. Bronze swing check valves.
6. Iron swing check valves.
7. Iron, grooved-end swing check valves.
8. Lubricated plug valves.

B. As-Specified Data: If the product to be incorporated in the Work is as specified by manufacturer name and product designation in this Specification Section, submit the "**As-Specified Verification Form**" (attached to Section 01 33 00 "Submittal Procedures") for each item listed below; otherwise submit full Product Data for the following:

1. Bronze lift check valves.
2. Bronze swing check valves.

1.6 QUALITY ASSURANCE

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

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B16.18 for solder-joint connections.
5. ASME B31.9 for building services piping valves.

C. NSF Compliance:

1. NSF/ANSI-61- Drinking Water System Components - Health Effects.
2. NSF/ANSI-61-8 Commercial Hot 180°F (includes Annex F and G).
3. NSF/ANSI-372 for lead-free valve materials for potable-water service.

D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

1.7 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 angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

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

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

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to 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 except plug valves.
3. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 5 plug valves, for each size square plug-valve head.
4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 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.

3. 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.

2.2 BRONZE BALL VALVES

A. Bronze Ball Valves, Lead-Free, Two-Piece with Full Port, and Stainless-Steel Trim, Solder or Threaded Ends (NPS 2 and smaller):

1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO INC.; Model S-585-66-LF-NS or T-585-66-LF-NS or a comparable product by one of the following:

a. Conbraco Industries, Inc.; Apollo Valves; 70LF-140, 70LF-240.
b. Hammond Valve.

c. Milwaukee Valve Company.
d. Watts Regulator Co.; a division of Watts Water Technologies, Inc; LFB6000-SS, LFB6001-SS.

2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Soldered or threaded.
g. Seats: PTFE or TFE.
h. Stem: Type 316 stainless steel.
i. Ball: Type 316 stainless steel, vented.
j. Port: Full.
k. Handle: Insulated extension handle.

B. Bronze Ball Valves, Lead-Free, Two-Piece with Full Port, and Stainless-Steel Trim, Press Ends (NPS 2 and smaller):

1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO INC.; Model PC-585-70 or a comparable product by one of the following:

a. Apollo Flow Controls; Conbraco Industries, Inc.
b. Hammond Valve.
c. Milwaukee Valve Company.
d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-110 or MSS-145.
b. CWP Rating: Minimum 200 psig.
c. Body Design: Two piece.
d. Body Material: Bronze.
e. Ends: Press.
f. Press Ends Connections Rating: Minimum 200 psig.
g. Seats: Reinforced PTFE.
h. Stem: Bronze or brass.
i. Ball: Chrome/Nickel Plated Brass.
j. Port: Full.
k. O-Ring Seal: EPDM.

2.3 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO INC.; Model LD-2000-3/5 or a comparable product by one of the following:

a. Conbraco Industries, Inc.; Apollo Valves.
b. Hammond Valve.
c. Milwaukee Valve Company.
d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 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 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Aluminum bronze.

2.4 IRON, GROOVED-END BUTTERFLY VALVES

A. 300 CWP, Iron, Grooved-End Butterfly Valves:

1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO INC.; Model GD-4765-3/5 or a comparable product by one of the following:

a. Tyco Fire Products LP; Grinnell Mechanical Products.
b. Victaulic Company; Series 608N.

2. Description:

a. Standard: MSS SP-67, Type I.
b. NPS 8 and Smaller CWP Rating: 300 psig.
c. NPS 10 and Larger CWP Rating: 200 psig.
d. Body Material: Polyamide coated, ductile iron ASTM A 395, or cast bronze, conforming to UNS C87850.
e. Stem: Two-piece stainless steel.
f. Disc: EPDM-encapsulated, ductile iron conforming to ASTM A 395, or aluminum bronze, conforming to UNS C95500.
g. Seal: Pressure responsive EPDM.

2.5 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Nonmetallic Disc:

1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO INC.; Model S-480 or T-480 or a comparable product by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Hammond Valve.
c. Kitz Corporation.
d. Milwaukee Valve Company.

e. Powell Valves.
f. Red-White Valve Corporation.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig.
c. Body Design: Vertical flow.
d. Body Material: ASTM B 61 or ASTM B 62, bronze.
e. Ends: Threaded or soldered.
f. Disc: NBR.

2.6 BRONZE SWING CHECK VALVES

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

1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO INC.; Model S-413-Y-LF or T-413-Y-LF or a comparable product 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 Division.
d. Hammond Valve.
e. Milwaukee Valve Company.
f. Powell Valves.
g. Red-White Valve Corporation.
h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 200 psig.
c. Body Design: Y-pattern horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded or soldered.
f. Disc: NBR.

2.7 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:

1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO INC.; Model F-918-B-LF or a comparable product 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 Division.
d. Hammond Valve.

e. Milwaukee Valve Company.
f. Powell Valves.
g. Red-White Valve Corporation.
h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Gasket: Asbestos free.

2.8 IRON, GROOVED-END SWING CHECK VALVES

A. 250 CWP, Iron, Grooved-End Swing Check Valves:

1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO INC.; Model G-920-W-LF or a comparable product by one of the following:

a. Anvil International, Inc.
b. Shurjoint Piping Products.
c. Tyco Fire Products LP; Grinnell Mechanical Products.
d. Victaulic Company.

2. Description:

a. CWP Rating: 250 psig.
b. Body Material: ASTM A 536, ductile iron.
c. Seal: EPDM.
d. Disc: Spring-operated, ductile iron or stainless steel.
e. Hammond Valve.
f. Milwaukee Valve Company.
g. Powell Valves.
h. Red-White Valve Corporation.
i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2.9 LUBRICATED PLUG VALVES

A. Class 125, Cylindrical, Lubricated Plug Valves with Threaded Ends:

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. Homestead Valve; a division of Olson Technologies, Inc.
b. Milliken Valve Company.
c. R & M Energy Systems; a unit of Robbins & Myers, Inc.

2. Description:

a. Standard: MSS SP-78, Type IV.
b. CWP Rating: 200 psig.
c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
d. Pattern: Regular or short.
e. Plug: Cast iron or bronze with sealant groove.

B. Class 125, Cylindrical, Lubricated Plug Valves with Flanged Ends:

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. Homestead Valve; a division of Olson Technologies, Inc.
b. Milliken Valve Company.
c. R & M Energy Systems; a unit of Robbins & Myers, Inc.

2. Description:

a. Standard: MSS SP-78, Type IV.
b. CWP Rating: 200 psig.
c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
d. Pattern: Regular or short.
e. Plug: Cast iron or bronze with sealant groove.

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.

F. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

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. Water Service Entry: Gate valve.

2. Shutoff Service: Ball or butterfly valves.

3. Butterfly Valve Dead-End Service: Single-flange (lug) type.

4. Throttling Service: Ball, or butterfly valves.

5. Pump-Discharge Check Valves:

a. NPS 2 and Smaller: Bronze swing check valves with nonmetallic disc.
b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring or iron, center-guided, resilient-seat check valves.

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

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

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option or press-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 Steel Piping, NPS 2 and Smaller: Threaded ends.

4. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
5. For Grooved-End Copper Tubing: Valve ends may be grooved.

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Ball Valves: Two-piece with full port and stainless steel trim. Provide with threaded, solder or press connection-joint ends.
3. Bronze Swing Check Valves: Class 125, nonmetallic disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, aluminum-bronze disc.
2. Iron, Grooved-End Butterfly Valves: 300 CWP.
3. Iron Swing Check Valves: Class 125, metal seats.
4. Iron, Grooved-End Swing Check Valves: 300 CWP.
5. Iron Gate Valves: Class 250, OS&Y.

END OF SECTION 22 05 23

SECTION 22 05 29 - 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 Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

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

1.3 DEFINITIONS

A. Hostile Environments: Water pump house or spaces where corrosive chemicals are stored.

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 plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

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

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sleeves and sleeve seals. Include rated capacities, and furnished specialties and accessories.

1. Roof mounted pipe supports.
2. Insulation shields.

B. As-Specified Data: If the product to be incorporated in the Work is as specified by manufacturer name and product designation in this Specification Section, submit the "**As-Specified Verification Form**" (attached to Section 01 33 00 "Submittal Procedures") for each item listed below; otherwise submit full Product Data for the following:

1. Threaded rod.
2. Adjustable clevis hanger.
3. Adjustable swing-ring band hangers.
4. Adjustable swivel-ring band hangers.
5. Hinged pipe clamps.
6. Pipe stanchion saddles.
7. Adjustable pipe saddle supports.
8. Riser clamps.
9. Beam Clamps.

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

1. Trapeze pipe hangers.

D. 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.

1.6 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 processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Anvil International; a subsidiary of Mueller Water Products Inc.
2. Cooper B-Line, Inc.
3. ERICO International Corporation.
4. PHD Manufacturing, Inc.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:

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

C. Copper Pipe Hangers:

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

2.3 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.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Thermal-Hanger Shield Insert Material: MSS SP-69 and SP-58, Type 40, pre-galvanized carbon steel or stainless steel, one piece pipe sheet metal shield for insulation support assembly.

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

    a. NPS 1/2 to NPS 3: 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.

B. Insulation-Insert Material for Piping:

1. Type "B" and “E” Insulated Piping Support Assemblies: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

2. Type "C" and “F” Insulated Piping Support Assemblies: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig minimum compressive strength.

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

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

5. Insert Length: Extend 2 inches beyond sheet metal shield for piping.

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, zinc-coated or 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 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; pre-galvanized finish.

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

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

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

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

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

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.

2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

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

D. Fastener System Installation:

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

2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

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

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

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

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

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

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

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

L. Insulated Piping:

1. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 40, protective shields on over-sized clevis hanger supporting insulated piping. Shields shall span an arc of 180 degrees.

3. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

4. Install cellular glass, polyisocyanurate or calcium silicate insulation inserts to support insulated piping as a part of Insulated Piping Support Assemblies indicated on drawing details.

3.2 METAL FABRICATIONS

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

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.

3.3 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.

3.4 PAINTING

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

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

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 09 91 00 "Painting." And Section 09 96 00 "High-Performance Coatings."

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

3.5 HANGER AND SUPPORT SCHEDULE

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

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

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

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

E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.

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

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

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

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

1. Piping in general service applications:

a. Bare Copper Piping Systems:

1) NPS 1-1/4 and Smaller: Adjustable, plastic coated copper swivel loop hanger for suspension of non-insulated stationary pipes.
2) NPS 1-1/2 and Larger: Copper plated clevis hanger for suspension of non-insulated stationary pipes. Hanger sized on outside pipe diameter.

b. Bare Ferrous Piping Systems:

1) NPS 1-1/4 and Smaller: Heavy duty electro-galvanized steel swivel loop hanger for suspension of non-insulated stationary pipes.

2) NPS 1-1/2 and Larger: Electro-galvanized clevis hanger for suspension of non-insulated stationary pipes. Hanger sized on outside pipe diameter.

c. Bare Plastic Piping Systems:

1) NPS 1-1/4 and Smaller: Heavy duty electro-galvanized steel swivel loop hanger for suspension of non-insulated stationary pipes.

2) NPS 1-1/2 and Larger: Electro-galvanized clevis hanger with 12 inches long galvanized steel thermal-hanger shield insert for suspension of non-insulated stationary pipes. Hanger sized on outside pipe diameter.

d. Insulated Piping Systems:

1) NPS 2 and Smaller: Electro-galvanized clevis hanger with galvanized steel thermal-hanger shield insert for suspension of insulated stationary pipes. Hanger sized on outside insulation diameter.

2) NPS 2-1/2 and Larger: Electro-galvanized clevis hanger with separate or integral galvanized steel thermal-hanger shield insert for suspension of insulated stationary pipes. Hanger sized on outside insulation diameter.

2. Piping in hostile environment applications:

a. Bare Copper and Ferrous Piping Systems: Stainless steel clevis hanger for suspension of non-insulated stationary pipes. Hanger sized on outside pipe diameter.

b. Bare Plastic Piping Systems: Stainless steel clevis hanger with 18 inch stainless steel thermal-hanger shield insert for suspension of non-insulated stationary pipes. Hanger sized on outside pipe diameter.

c. Insulated Piping Systems: Stainless steel clevis hanger with stainless steel thermal-hanger shield insert for suspension of insulated stationary pipes. Hanger sized on outside insulation diameter.

3. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.

4. 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.

5. 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.

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

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.

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

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

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

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

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

6. C-Clamps (MSS Type 23): For structural shapes.

7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

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

8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

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

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

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

1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.

2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.

3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.

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

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

END OF SECTION 22 05 29

SECTION 22 05 33 - HEAT TRACING FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes plumbing piping heat tracing for freeze prevention, domestic hot-water-temperature maintenance, and snow and ice melting on roofs and in gutters and downspouts with the following electric heating cables:

1. Self-regulating, parallel resistance.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories.

1. Heating cable.
2. Connection kits.
3. Controller.
4. Warning labels.

B. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

C. Shop Drawings: For electric heating cable.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.
B. Warranty: 10-year standard warranty on all cable and components.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Manufacturers Qualifications:

1. Manufacturer to provide products consistent with UL 515, CSA 22.2 No 130-03 and IEEE 515.1 requirements.

B. Installer Qualifications:

1. System installer shall have complete understanding of product and product literature from manufacturer or authorized representative prior to installation. Electrical connections shall be performed by a licensed electrician.

C. Regulatory Requirements and Approvals:

1. The system (heating cable, connection kits, and controller) shall be UL Listed, CSA Certified and FM Approved for freeze protection of aboveground water lines.

D. Electrical Components, Devices, and Accessories: Listed and labelled as defined in NFPA 70, Article 100, by a Nationally Recognized Testing Laboratory (NRTL), and marked for intended use.

1.7 WARRANTY

A. Heating Cables and Components: Manufacturer agrees to repair or replace electric heating cable that fails in materials within specified warranty period.

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

B. Controllers: Manufacturer agrees to repair or replace electric heating cable controllers that fail in materials or workmanship within specified warranty period.

1. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING 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. Nelson Heat Trace; a division of EGS Electrical Group LLC.
2. Pyrotenax; a brand of Pentair Thermal Management LLC.
3. Raychem; a brand of Pentair Thermal Management LLC.
4. Thermon Americas Inc.

B. Comply with IEEE 515.1.

C. Heating Element: Pair of parallel [**No. 16**] [**No. 18**] AWG, nickel-coated, stranded copper bus wires embedded in cross-linked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, non-heating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

D. Electrical Insulating Jacket: Flame-retardant polyolefin.

E. Cable Cover: Tinned-copper braid and polyolefin outer jacket with ultraviolet inhibitor.

F. Maximum Operating Temperature (Power On): 150 deg F.

G. Maximum Exposure Temperature (Power Off): 185 deg F.

H. 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.

I. Capacities and Characteristics:

1. Maximum Heat Output: 8 W/ft..

2. Piping Diameter: As indicated on plans.

3. Electrical Characteristics for Single-Circuit Connection:

a. Volts: 208.
b. Phase: 1 ph
c. Hertz: 60

2.2 CONTROLS

A. Pipe-Mounted Digital Controller with Built in Ground Fault Protection for Freeze Protection:

1. Pipe sensing thermistor with adjustable temperature range.
2. Ground Fault Protection shall be provided by the controller.
3. Digital display showing measured temperature, set point temperature, and alarm conditions. Thermistor for directly sensing pipe-wall temperature.
4. NEMA 4X Corrosion-resistant, waterproof control enclosure.

2.3 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Labels: Refer to Section 22 05 53 "Identification for Plumbing Piping and Equipment."

C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

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

3.2 APPLICATIONS

A. Install the following types of electric heating cable for the applications described:

1. Freeze Protection for Water Lines: Self-regulating, parallel-resistance heating cable.

3.3 INSTALLATION

A. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.

B. Electric Heating-Cable Installation for Freeze Protection for Piping:

1. Install electric heating cables after piping has been tested and before insulation is installed.
2. Install electric heating cables according to IEEE 515.1.
3. Install insulation over piping with electric cables according to Section 220719 "Plumbing Piping Insulation."
4. Install warning tape on piping insulation where piping is equipped with electric heating cables.

C. Set field-adjustable switches and circuit-breaker trip ranges.

3.4 CONNECTIONS

A. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
B. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

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

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
2. Test cables for electrical continuity and insulation integrity before energizing.
3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

C. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

D. Cables will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed heating cables, including non-heating leads, from damage during construction.
B. Remove and replace damaged heat-tracing cables.

END OF SECTION 22 05 33

SECTION 22 05 48.13 - VIBRATION CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Restrained elastomeric isolation mounts.

1.3 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 type required.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment.

C. Delegated-Design Submittal: For each vibration isolation device.

1. Include design calculations for selecting vibration isolators.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation device installation for plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Qualification Data: For testing agency.

C. Welding certificates.

1.5 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts:

1. Isotech, Inc

2. Description: All-directional isolator with 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.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation 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 VIBRATION CONTROL 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."

B. Installation of vibration isolators must not cause any change of position of equipment, or piping, resulting in stresses or misalignment.

END OF SECTION 22 05 48.13

SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Equipment and piping labels.
2. Valve tags and signage.
3. Warning tape.

1.3 SUBMITTALS, GENERAL

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Warning signs/labels.
2. Valve function signage.

B. As-Specified Data: If the product to be incorporated in the Work is as specified by manufacturer name and product designation in this Specification Section, submit the "**As-Specified Verification Form**" (attached to Section 01 33 00 "Submittal Procedures") for each item listed below; otherwise submit full Product Data for the following:

1. Equipment labels.
2. Pipe labels.
3. Stencils.
4. Valve tags.
5. Warning tape.

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

D. Valve numbering scheme.

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

1.5 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 EQUIPMENT LABELS

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. Brady, Inc.
2. Craftmark Pipe Markers.
3. Seton, Inc.

B. Plastic Labels:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 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.

8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

2.2 PIPE LABELS

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. Brady, Inc.
2. Craftmark Pipe Markers.
3. Seton, Inc.

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

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

D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing and separate self-adhesive direction arrow tape on each end fully wrapped around pipe.

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

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

2.3 STENCILS

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. Brady, Inc.
2. Craftmark Pipe Markers.
3. Seton, Inc.

B. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.

1. Stencil Paint: Exterior, gloss, acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
2. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

2.4 VALVE TAGS

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. Brady, Inc.
2. Craftmark Pipe Markers.
3. Seton, Inc.

B. Valve Tags: 1-1/2 inches diameter, stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

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

C. 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.

2.5 VALVE FUNCTION SIGNAGE

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. Brady, Inc.
2. Craftmark Pipe Markers.
3. Seton, Inc.

B. Plastic Signage:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 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.

8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Signage Content: Include valve's unique verbiage where indicated on Drawings, unless otherwise specified.

1. Bypass valves: Text to read “Bypass Valve-Normally Closed”.

2.6 WARNING TAPE

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. Presco, Inc.; Sherman, Texas
2. EMED Co., Buffalo, New York.
3. Seton Identification Products, A Tricor Direct Company.

B. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep

1. Color Code:

a. Blue: Water & Associated Lines.
b. Brown: Force Mains & Associated Lines.
c. Green: Sanitary & Associated Lines.
d. Purple: Reclaimed Water Lines.
e. Yellow: Gas & Associated Lines.

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 LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.
B. Locate equipment labels where accessible and visible.
C. Provide nameplates for equipment with identifying name of equipment and function.
D. Provide name plates for panels identifying name of panel and function, function of switches, control devices, panel lights, and buttons and securely fasten to panels.
E. Locate warning signs for high efficiency water heater vents run horizontally through an exterior wall at a minimum of 8 feet above finished grade.

3.3 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Section 09 91 00 "Painting."

B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

C. 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 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings.

D. Pipe Label Color Schedule:

1. Domestic Cold Water Piping:

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

2. Domestic Hot Water Piping:

   a. Background Color: Yellow.
   b. Letter Color: Black.

3. Sanitary Waste Piping:

   a. Background Color: Yellow.
   b. Letter Color: Black.

4. Interior Natural Gas Piping:

   a. Background Color: Yellow.
   b. Letter Color: Black.

E. Trap Primer Water Piping: Provide Piping Identification Labels on exposed water piping between trap primers and drain connections exceeding 10 feet in length at 5 foot intervals. Text to read “Non-potable Water”.

3.4 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 Color: Natural.
2. Letter Color: Black.

C. Provide valve tag for each piping systems valve located above grade.

1. Valve Directory: Provide neat typewritten directory listing valve function, location and identification number.
2. Valve Numbering System: Extension of and compatible with existing valve numbering system, where valves are installed in existing building or in addition to existing building.
3. Verification: Verify existing valve numbers in field and provide valve numbering avoiding duplication of existing numbers.

3.5 VALVE FUNCTION SIGNAGE INSTALLATION

A. Provide signage and wording as indicated.
B. Securely fasten to valve using self-locking nylon fasteners.

3.6 WARNING-TAPE INSTALLATION

A. Install warning tape 2 feet below finished grade in buried piping trenches exterior to building foundation wall for piping systems.

END OF SECTION 22 05 53

SECTION 22 07 19 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulating the following plumbing piping services:

1. Domestic cold-water piping.
2. Domestic hot-water piping.
3. Domestic recirculating hot-water piping.

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. Flexible elastomeric insulation.
2. Mineral-fiber, preformed pipe insulation.
3. Exterior piping jacketing.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Provide insulation system installation by qualified Installers who are trained in installation of each proposed insulation material and product with at least one of the following qualifications:

1. Have successfully completed a Mechanical Insulation Apprenticeship program by the Department of Labor, Bureau of Apprenticeship and Training,
2. Have successfully completed an ASHRAE / NIA 8-hour Mechanical Insulation Training course or equal, or
3. Have five years documented experience as a mechanical insulation specialist with references attesting to successful completion of at least three comparable projects.

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 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 22 05 29 "Hangers and Supports for Plumbing 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.

1.8 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.

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

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

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

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

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

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

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

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

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

G. Mineral-Fiber, Preformed Pipe Insulation:

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

a. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; 1000-Degree Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

H. Glass-Fiber Loose-Fill Insulation: Comply with requirements for glass-fiber loose-fill insulation specified in Section 07 21 00 "Thermal Insulation."

I. Spray polyurethane foam: Comply with requirements for spray polyurethane foam specified in Section 07 21 00 "Thermal Insulation."

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

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

a. Aeroflex USA, Inc.; Aeroseal.

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

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).

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. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

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

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
d. Mon-Eco Industries, Inc.; 22-25.

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."

2.3 FIELD-APPLIED JACKETS

A. Exterior Pipe and Fitting Insulation Protective Jacket: Modified bituminous, aluminum skinned, peal and stick membrane, similar to Polyguard “Alumaguard 60”, with the following properties:

1. Minimum 54 mils thick
2. Permeance less than 0.01 Perms
3. Puncture resistance per ASTM E154 >40lbs.
4. Overlap bond peal adhesion per ASTM D1000 never less than 11lb/in.
5. UV stabilized.
6. Self healing when punctured.

2.4 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

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

    a. ABI, Ideal Tape Division; 428 AWF ASJ.
    b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
    c. Compac Corporation; 104 and 105.
    d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.

3. Thickness: 11.5 mils.

4. Adhesion: 90 ounces force/inch in width.

5. Elongation: 2 percent.

6. Tensile Strength: 40 lbf/inch in width.

7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

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

    a. ABI, Ideal Tape Division; 370 White PVC tape.
    b. Compac Corporation; 130.
    c. Venture Tape; 1506 CW NS.

2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

2.5 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 and Seals.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 316; 0.015 inch thick, 1/2 inch wide with wing seal.

B. Wire: 0.062-inch soft-annealed, stainless 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.

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.

C. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 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. 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.

3.3 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. 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.

3. 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 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.

P. Miscellaneous Voids: Install insulation where indicated and in miscellaneous openings and penetrations in the exterior building envelope, including pipe sleeves, exterior wall hydrants, roof drains, downspout nozzles, pipe chases located on exterior walls, voids and cavity spaces created by Plumbing Work where required to provide continuity and integrity to the building exterior envelope insulation system, sealing gaps and preventing air infiltration, using the following materials:

1. Loose-Fill Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft.

2. Spray Polyurethane Foam: Apply according to manufacturer's written instructions.

   a. Trim and dress surface of spray polyurethane foam to provide smooth, flush surface.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.

4. Seal jacket to roof flashing with flashing sealant.

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

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

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.

4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies.
3. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.5 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. 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.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

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

C. Insulation Installation on Pipe Fittings and Elbows:

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

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.

2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation to flanges as specified for flange insulation application.

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

3.7 INSTALLATION OF MINERAL-FIBER 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. Seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. Secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 FIELD-APPLIED JACKET INSTALLATION

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

3.9 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099000 "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.

3.10 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.

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water (General Building Areas):

1. Mineral-Fiber, Preformed Pipe Insulation with factory applied jacket, Type I:1-inch thickness.

B. Domestic Cold Water located within Masonry Block Wall cores or buried conduits:

1. Flexible Elastomeric Insulation: 1/2-inch thick.

C. Domestic Hot and Recirculation Water (General Building Areas):

1. Mineral-Fiber, Preformed Pipe Insulation with factory applied jacket, Type I:

a. Pipes sizes 1 1/4" or smaller: 1-inch thickness.
b. Pipes sizes 1 1/2" or larger: 1-1/2-inch thickness.

D. Domestic Hot and Recirculation Water located within Masonry Block Wall cores or buried conduits:

1. Flexible Elastomeric Insulation:

a. Pipes sizes 1 1/4" or smaller: 1/2-inch thickness.
b. Pipes sizes 1 1/2" or larger: 1-inch thickness.

3.12 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Domestic Water Piping:

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

a. Flexible Elastomeric: 2 inches thick.

3.13 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, Smooth: 54 mils thick.

END OF SECTION 22 07 19

SECTION 22 11 13 - FACILITY WATER DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General 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 water 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. EPDM: Ethylene propylene diene terpolymer rubber.
B. PE: Polyethylene plastic.
C. PVC: Polyvinyl chloride plastic.
D. AWWA: American Water Works Association

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Submit manufacturer's product literature including material specifications and other information demonstrating compliance with specified requirements. Products may include, but are not limited to:

1. Piping and fittings
2. Gate valves and curb boxes
3. Corporation and curb valves
4. Water meters
5. Backflow preventers
6. Water meter boxes
7. Precast concrete vaults, frames and covers
8. Protective enclosures
9. Fire hydrants
10. Yard hydrant assemblies
11. Quick connect valves and quick connect key assemblies
12. Identification materials
13. Miscellaneous components and accessories

B. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.

C. Coordination Drawings: For piping and specialties including relation to other services in same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.

D. Field quality-control test reports.

1. Test Reports: Submit test reports specified in "Field Quality Control" in Part 3 below.

E. Operations and Maintenance data: For water valves and specialties to include in emergency, operation, and maintenance manuals.

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.

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

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

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. Existing Conditions: Subsurface investigation reports are available for informational purposes only; data in reports not intended as a warranty or representation of accuracy or continuity of conditions. Owner assumes no responsibility for interpretations or conclusions drawn from this information.

B. 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 Owner no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of water-distribution service without Owner's written permission.

1.8 COORDINATION

A. Water Connection and Service: Coordinate and arrange for installation of domestic water meter, fire and domestic water main connections to existing water main with owner/operator of existing water distribution system or main.

1. Provide all products, materials and services required for the complete installation, testing, disinfection and activation of this water service except for those products, materials and services which are provided by the utility company or owner of the existing distribution system.

2. Pay for all costs and fees associated with connection to existing system including, but not limited to, inspection, meter costs, testing, wet taps, road opening permits, connection permit costs, and other utility company requirements.

B. Coordinate laying pipe, bedding, and backfill with other prime Contracts.

PART 2 - PRODUCTS

2.1 PVC PIPE AND FITTINGS

A. PVC, AWWA Pipe: AWWA C900, Class 150, DR-25 with bell end with gasket, and with spigot end.

1. Comply with UL 1285 for fire-service mains if indicated.

2. PVC Molded Fittings: AWWA C907, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.

3. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110 and C153, ductile-iron compact pattern.

    a. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile iron, class 350, AWWA C153 and C111.
    b. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

4. 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:

    a. U.S. Plastic Corp.
    b. J.M. Eagle
    c. National Plastics

B. PVC, SDR-21 solvent-weld 200-psi rated pipe: Pipe and fittings shall be manufactured from virgin rigid PVC (polyvinyl chloride) vinyl compounds with a Cell Class of 12454 as identified in ASTM D 1784.

1. SDR piping to be Iron Pipe Size (IPS) conforming to ASTM D 2241 for plain-end pipe and ASTM D 2672 for belled-end pipe.

2. PVC Schedule 40 (IPS) fittings shall conform to ASTM D 2466. Pipe and fittings shall be manufactured as a system and be the product of one manufacturer. All pipe and fittings shall be manufactured in the United States.

3. Certified to CSA B137.3. Hydrostatic design basis (HDB) of 4000 psi.

4. Pipe and fittings shall conform to NSF International Standard 61 and the health effects portion of NSF Standard 14.

5. 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:

    a. U.S. Plastic Corp.
    b. Charlotte Pipe
    c. Cresline

2.2 JOINING MATERIALS

A. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

2.3 PIPING SPECIALTIES

A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

B. Tubular-Sleeve Pipe Couplings:

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:

   a. Cascade Waterworks Manufacturing.
   b. Dresser, Inc.; Dresser Piping Specialties.
   c. Ford Meter Box Company, Inc. (The); Pipe Products Div.

2. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.

   a. Standard: AWWA C219.
   b. Center-Sleeve Material: Manufacturer's standard.
   c. Gasket Material: Natural or synthetic rubber.
   d. Pressure Rating: 200 psig minimum.
   e. Metal Component Finish: Corrosion-resistant coating or material.

2.4 GATE VALVES

A. AWWA, Ductile-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:

   a. McWane, Inc.; Kennedy Valve Div.
   b. Mueller Co.; Water Products Div.
   c. U.S. Pipe and Foundry Company.

2. Nonrising-Stem, High-Pressure, Resilient-Wedge 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.
      3) End Connections: Push on or mechanical joint.
      4) Interior Coating: Complying with AWWA C550.

2.5 GATE VALVE ACCESSORIES AND SPECIALTIES

A. 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 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 for every 6 valve boxes installed.

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:

a. Ford Meter Box Company, Inc. (The); Pipe Products Div.
b. Jones, James Company.
c. Mueller Co.; Water Products Div.

B. Corporation Valve: Bronze body and ground-key plug type valve, with AWWA C800, threaded inlet and outlet matching service piping material. Shall have a maximum working pressure of 100 psi in ¾ inch and 1 inch diameters and 80 psi for larger diameters.

C. Curb Valves: Comply with AWWA C800. Include bronze body, ball valve type, 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 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. Provide 1 rod for every 6 service boxes installed.

2.7 FIRE HYDRANTS

A. Dry-Barrel Fire Hydrants:

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:

a. McWane, Inc.; Kennedy Valve Div.
b. Mueller Co.; Water Products Div.
c. U.S. Pipe and Foundry Company.

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

a. Standards: AWWA C502.

b. Pressure Rating: 250 psig.
c. Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Verify local fire and water department standards.
d. Include cast-iron caps with steel chains.
e. Operating and Cap Nuts: Pentagon, 1-1/2 inches point to flat.
f. Direction of Opening: Open hydrant valve by turning operating nut to left or counterclockwise.
g. Exterior Finish: Alkyd-gloss enamel paint, colored in coordination with local water authority standards.

3. At proposed fire hydrant adjacent to new water tank pump building, provide post mounted 12”x18” signage with the following text: “MANUAL WET HYDRANT”. Sign to be red lettering on white background. See traffic signage specifications and details for similar signage size and type requirements.

2.8 YARD HYDRANTS

A. Ground-Type Yard Hydrant Assembly: (For Synthetic Turf Areas)

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:

a. Basis of Design: TCITQCV - TurfCool® Quick Coupler or Gate Valve Box for Synthetic Infill Turf as Manufactured and Supplied by:

Sportsfield Specialties, Inc.
P.O. Box 231
41155 State Highway 10
Delhi, NY 13753
p. 888-975-3343
www.sportsfieldspecialties.com

2. Components:

a. TCITQCV - TurfCool® Quick Coupler Valve Box for Synthetic Infill Turf, or equal.

1) Dimensions: 18”W x 15”L x 18”H

2) Box: 3/16" (0.1875”) Aluminum Construction, Welded Frame with Open Bottom Having the Following Attributes:

a) 1/8" (0.125”) Aluminum Cover Ledge
b) Integrated Synthetic Infill Turf Attachment Ledge
c) Infill Retainer System with 1-1/4” (1.25”) Flexible Gasket Seals Specifically Designed for Synthetic Infill Turf Applications
d) 2” O.D. Pipe Clamps and Mounting Brackets
e) 1” PVC Drain Stub for Positive Drainage Connection
f) Leveling Bolts

b. Solid Cover: 1/8" (0.125”) Aluminum Construction with the following attributes:

1) Infill Retainer System with 1-1/4” (1.25”) Flexible Gasket Seals Specifically Designed for Synthetic Infill Turf Applications

2) Designed to Allow Synthetic Turf Material to be Adhered Directly to the Aluminum Surface with Appropriate Adhesive and/or Mechanical Fasteners as Determined by Others

c. Assembly Hardware

d. Quick Connect Valve

1) One-Piece Body Bronze 1” NPT Quick Connect Valve with Rubber Cover. Include two Quick Connect Valve Key assemblies to include matching Quick Connect Valve Key, Hose Swivel and Ball Valve Shut-Off at end of swivel.

2) Model Numbers and Available Manufacturers:

a) Hunter Industries, Model # HQ-5RC
b) Rain Bird, Model # 5RC
c) Buckner Superior, Model # QB5RC10

2.9 IDENTIFICATION

A. Underground Warning Tape:

1. Material: 2 inch wide color coded, heavy gauge 0.04 inch, detectable aluminum film
2. Text: “CAUTION BURIED WATER LINE BELOW”
3. Location: Provide warning tape 2 feet below finished grade in buried piping trenches.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 VERIFICATION OF CONDITIONS

A. Before proceeding with water main installation, examine conditions existing at Site and notify affected Contractors and Architect of any construction or any other conditions prevailing which prevent, inhibit, or otherwise interfere with water main installation. Contact utility-location service prior to commencing work.

B. Verify depth of water main and pipe sizes of existing buried piping where new connections are indicated and verify depths of existing utilities crossing or located in the area of water main installation. Do not start buried water main installation until these site conditions have been verified and indicated on shop drawings. Report to Architect any discrepancies.

C. Beginning installation constitutes Contractor's acceptance of areas and condition.

3.3 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 shall be the following:

1. Soft copper tube, ASTM B 88, Type K; copper, pressure-seal fittings; and pressure-sealed joints.
2. PE, ASTM pipe; insert fittings for PE pipe; and clamped joints.

F. Underground water and fire-service piping NPS 4 to NPS 8 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 joints.
2. PVC, AWWA Class 200 pipe; mechanical-joint, ductile-iron fittings; and gasketed joints.

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

H. Aboveground and Vault Water and Fire-Service Piping NPS 4 to NPS 8 shall be the following:

1. Ductile-iron, Flanged pipe; ductile-iron, Flanged appurtenances and joints.

3.4 VALVE APPLICATIONS

A. General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use flanged-end valves for installation in vaults. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 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 and Larger: AWWA, ductile iron, nonrising-stem, high-pressure, resilient-wedge gate valves with valve box.

2. Use the following for valves in vaults and aboveground:

    a. Gate Valves, NPS 3 and Larger: AWWA, ductile iron, OS&Y rising stem, resilient wedge.

3.5 PIPING INSTALLATION

A. Provide all products, materials and services required for complete installation, testing, disinfection and activation of water services.

B. Pipe Handling:

1. Provide proper implements, tools, and facilities for safe and convenient handling of pipe.
2. Carefully lower pipe and fittings into trench piece-by-piece to prevent damage to pipe. Do not drop or dump pipe into trench.
3. Lay pipe with ends abutting and true to line and grade, fitted and matched to form smooth uniform invert, with bell ends upstream.
4. Shape bottom of trench to conform as nearly as possible to outside of pipe, taking particular care to recess trench bottom to relieve bell of all load.

C. Pipe Cleaning:

1. Clean interior of pipe as pipe installation progresses. Maintain swab or drag in line and pull past each joint as joint is completed.
2. Place plugs in ends of uncompleted pipe line at end of day or whenever installation stops.

D. Water-Main Connection: Arrange with utility company for tap of size and in location indicated in water main.

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

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

G. Install PE pipe according to ASTM D 2774 and ASTM F 645.

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

I. Bury piping with depth of cover over top at least 54 inches to compacted finished grade (or as indicated on plans).

J. 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.

1. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.

K. Install underground piping with restrained joints at horizontal and vertical changes in direction. Acceptable methods include:

1. Restrained-joint piping.
2. Thrust blocks.
3. Anchors.
4. Tie-rods and clamps.

3.6 JOINT CONSTRUCTION

A. Make pipe joints according to the following:

1. Copper-Tubing, Pressure-Sealed Joints: Use proprietary crimping tool and procedure recommended by copper, pressure-seal-fitting manufacturer.

2. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.

3. PE Piping Insert-Fitting Joints: Use plastic insert fittings and fasteners according to fitting manufacturer's written instructions.

4. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.

5. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.

3.7 ANCHORAGE INSTALLATION

A. Anchorage, General: Provide restrained joints and/or anchorage on ductile iron mechanical joints at each change in direction of piping. 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.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

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

3.9 DETECTOR-CHECK VALVE INSTALLATION

A. Install in vault or aboveground.
B. Install for proper direction of flow. Install bypass with water meter, gate valves on each side of meter, and check valve downstream from meter.
C. Support detector check valves, meters, shutoff 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 written instructions.

3.11 BACKFLOW PREVENTER INSTALLATION

A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks.

1. Comply with manufacturer's specific instructions for installation.
2. Install and test according to requirements of plumbing and health department and authorities having jurisdiction.

B. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.

C. Do not install bypass piping around backflow preventers.

D. Support NPS 2-1/2 and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.

3.12 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.

3.13 CONCRETE VAULT INSTALLATION

A. Install precast concrete vaults according to ASTM C 891.

3.14 PROTECTIVE ENCLOSURE INSTALLATION

A. Install concrete base level and with top approximately 2 inches above grade.
B. Install protective enclosure over valves and equipment.
C. Anchor protective enclosure to concrete base.

3.15 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.
B. Locate thrust block at fire hydrant to avoid preventing hydrant from draining.
C. Provide 3 foot square by 3 foot deep granular fill "dry well" adjacent to base of riser drain.
D. Set hydrant with lowest nozzle outlet 18 inches above finished grade.
E. Secure hydrant bowl to next preceding bell with anchoring, retaining gland or rods.
F. AWWA Fire Hydrants: Comply with AWWA M17.

3.16 YARD HYDRANT INSTALLATION (At Synthetic Turf Areas)

A. Yard Hydrant Boxes shall be installed as recommended per manufacturer's written instructions and as indicated on the drawings.

3.17 IDENTIFICATION

A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping.

3.18 FIELD QUALITY CONTROL

A. Tests:

1. Responsibility: Testing provided by Contractor includes (but not limited to) required equipment, material and labor for specified testing.

2. General Requirements for Testing:

   a. Test in presence of Architect or Architect’s delegated representative and jurisdictional authority. Notify Architect's representative at least 48 hours in advance of each test and provide opportunity for Architect to witness pressure gauge readings at beginning, during and end of testing period.

   b. Test entire piping systems or in sections after rough piping systems are installed where required to meet construction schedule and sequencing of construction by other Contractors.

   c. Disconnect apparatus for developing required pressures during stated periods.

d. Reconstruct, replace or repair, leaking piping, joints or system components. Retest piping section failing tests until successful tests results are obtained.

e. Do not cover or conceal water distribution system or portion of water distribution system until after testing and approval by jurisdictional authority. Expose systems covered or concealed before testing or inspection and retest.

3. Reports: Provide written reports in approved format including following:

a. Flushing information including date of flushing, volume of flushing, length of time and witnesses present.

b. Testing information including date of testing, starting pressure, pressure after test and length of test, pressure loss after test and witnesses present. Record same testing information for any repeated tests.

c. Any additional criteria and information critical to establishing that testing procedures have been completed and witnessed in conformance with specified requirements for each piping system.

4. Buried Domestic Water Piping Systems:

a. Prior to testing, flush piping with clean water at flow rate of not less than 2.5 feet per second for specific pipe size or no less than 100 gpm for 4 inch pipe size, 200 gpm for 6 inch pipe size, or 400 gpm for 8 inch pipe size, in accordance with AWWA Standards C600.

b. Test pressure shall not be less than 1.5 times the working pressure at the point of testing for a minimum of two hours without test pressure varying more than five psi during the test. Slowly fill each valved section with water, and apply the specified test pressure using a pump connected to the pipe.

c. Before applying the specified test pressure, expel air completely from the section of piping under test. Provide corporation stops with copper tubing to grade as necessary at all high points to expel any air trapped, provide curb stop at end of tubing. Remove all curb stop and copper tubing to corporation stop. Leave the corporation stops in place

d. When hydrants are in test section, the test shall be made against the hydrant valve.

e. Acceptance determined on the basis of testing allowance. Testing allowance is defined as the quantity of makeup water that must be supplied into the newly laid pipe or any valved section thereof to maintain pressure within 5 psi of the specified test pressure after the pipe has been filled with water and the air has been expelled. No pipe installation will be accepted if the amount of makeup water is greater than that determined by the following formula:

$$L = \frac{SD\sqrt{P}}{133{,}200}$$

Where:

L = Testing Allowance (makeup water), in gallons per hour
S = Length of pipe tested, in feet
D = nominal diameter of the pipe, inches
P = Average test pressure during the hydrostatic test, in pounds per square inch (psi)

f. Proceed with disinfection procedures following successful testing of water main.

g. Reports: Provide written reports in approved format including following:

1) Testing information including allowable leakage rate, and actual leakage rate.
2) Contractor's Material and Test Certificate countersigned by Owner's representative.

3.19 CLEANING

A. Disinfection of Potable Water Systems: Comply with local requirements, where local code requirements are more stringent. Provide necessary labor, equipment, material and test kits for chlorine application and tests. Make all arrangements with jurisdictional water authority for witnessing chlorination and tests of proper disinfection. Pay all fees and costs including water sample testing.

1. Exterior Water Service Line: Perform disinfection of water main piping in conformance of applicable local jurisdictional authorities standards and requirements of AWWA Standard C651 "Disinfecting Water Mains".

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. Following flushing of chlorinated main, provide for collection of samples of water by local water authority or local Department of Health.

f. Do not place main in service until water has been approved and notification received from local water authority or local Department of Health.

B. Upon completion of work of this section, leave all components of the water main system completely free from silt, debris, or obstruction.

C. Prepare reports of purging and disinfecting activities.

END OF SECTION 22 11 13

SECTION 22 11 16 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Copper tube and fittings.
2. Appurtenances for grooved-end copper tubing.
3. Ductile-iron pipe and fittings.
4. Appurtenances for grooved-end ductile iron pipe.

B. As-Specified Data: If the product to be incorporated in the Work is as specified by manufacturer name and product designation in this Specification Section, submit the "**As-Specified Verification Form**" (attached to Section 01 33 00 "Submittal Procedures") for each item listed below; otherwise submit full Product Data for the following:

1. Copper pressure-seal-joint fittings.
2. Transition coupling.
3. Solder.

1.4 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.
B. Field quality-control reports.
C. Lab results for biological testing showing samples negative for coliform bacteria.

1.5 FIELD CONDITIONS

A. Interruption of Existing Water Service: Refer to "Existing Utility Interruptions" paragraph of Section 01 12 00 "Multiple Contract Summary-Project Schedule" for requirements associated with interrupting the existing water service to facilities occupied by the Owner.

B. Coordinate potable water lead testing with Owner prior to starting any construction.

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 61.
C. Comply with NSF 372 for low lead.

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.

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. Elkhart Products Corporation.
b. Lee Brass.
c. NIBCO INC.

D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure 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. Elkhart Products Corporation.
b. Mueller Streamline Company.
c. NIBCO Inc.

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

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. Elkhart Products Corporation.
b. Lee Brass.
c. NIBCO Inc.

F. Copper Unions:

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

a. Elkhart Products Corporation.
b. Lee Brass.
c. NIBCO Inc.

2. MSS SP-123.

3. Cast-copper-alloy, hexagonal-stock body.

4. Ball-and-socket, metal-to-metal seating surfaces.

5. Solder-joint or threaded ends.

G. Copper Pressure-Seal-Joint Fittings: ASME B16.18, pressure fittings.

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

a. Apollo Flow Controls; Conbraco Industries, Inc.
b. Elkhart Products Corporation.
c. Mueller Industries, Inc.
d. NIBCO INC.
e. Zero Lead ProPress; Viega LLC.

2. Fittings: Cast-brass, cast-bronze or wrought-copper with EPDM O-ring seal in each end. Sizes NPS 2-1/2 and larger with stainless steel grip ring and EPDM O-ring seal.

3. Minimum 200-psig working-pressure rating at 250 deg F.

H. Wrought-Copper Fittings for Grooved-End Copper Tubing: ASME B16.22.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Shurjoint Piping Products USA Inc.; Wrought copper fittings C10W, C11W, C20W, C21W, C26W, C50W, C52W, or comparable products by one of the following:

a. Anvil International.
b. Grinnell Mechanical Products.
c. Victaulic Company.

2. Bronze Fittings for Grooved-End, Copper Tubing: ASTM B 75/B 75M copper tube or ASTM B 584 bronze casting.

I. Mechanical Couplings for Grooved-End Copper Tubing:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Shurjoint Piping Products USA Inc.; C305, C306, C307, C341, or comparable products by one of the following:

a. Anvil International.
b. Grinnell Mechanical Products.
c. Victaulic Company.

2. Copper-tube dimensions and design similar to AWWA C606.

3. Ferrous housing sections.

4. EPDM-rubber gaskets suitable for hot and cold water.

5. Bolts and nuts.

6. Minimum Pressure Rating: 300 psig.

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: ANSI/AWWA C151/A21.51, Thickness Class 52, cement lined with asphalt coating in accordance with ANSI/AWWA C104/A21.4 with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.

1. Standard-Pattern, Mechanical-Joint Fittings: ANSI/AWWA C110/A21.10, cement lined fittings with asphalt coating in accordance with ANSI/AWWA C104/A21.4 ductile or gray iron.

B. Push-on-Joint, Ductile-Iron Pipe: ANSI/AWWA C151/A21.51, Thickness Class 52, cement lined with asphalt coating in accordance with ANSI/AWWA C104/A21.4 with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.

1. Standard-Pattern, Push-on-Joint Fittings: ANSI/AWWA C110/A21.10, cement lined fittings with asphalt coating in accordance with ANSI/AWWA C104/A21.4 ductile or gray iron.

C. Flanged Ductile-Iron Pipe: ANSI/AWWA C115/A21.51 flanges with pipe barrels conforming to ANSI/AWWA C151/A21.51, Thickness Class 52, cement lined with asphalt coating in accordance with ANSI/AWWA C104/A21.4.

1. Standard-Pattern, Flanged Joint Fittings: ANSI/AWWA C110/A21.10, cement lined fittings with asphalt coating in accordance with ANSI/AWWA C104/A21.4 ductile or gray iron and flanges compatible with Class 125 ANSI B16.1 and ANSI A21.15.

D. Plain-End, Ductile-Iron Pipe: ANSI/AWWA C151/A21.51, Thickness Class 52, cement lined with asphalt coating in accordance with ANSI/AWWA C104/A21.4.

2.4 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.

2.5 TRANSITION FITTINGS

A. Install transition couplings at joints of piping with small differences in OD's. Refer to transition fitting products specified in Section 22 05 00 “Common Work Results for Plumbing”.

2.6 DIELECTRIC FITTINGS

A. Dielectric Unions and Flanges: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined. Comply with requirements in Section 22 05 00 "Common Work Results for Plumbing."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before proceeding with water piping installation, examine conditions existing at Site and notify affected Contractors and Architect of any construction or any other conditions prevailing which prevent, inhibit, or otherwise interfere with water piping installation.

B. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

3.2 EARTHWORK

A. Comply with requirements in Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 22 05 19 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 22 11 19 "Domestic Water Piping Specialties."

E. Install shutoff valve immediately upstream of each dielectric fitting.

F. Install domestic water piping level without pitch and plumb.

G. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

H. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

I. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

J. Install piping to permit valve servicing.

K. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

L. Install piping free of sags and bends.

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

N. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

O. Install pressure gages on suction and discharge piping for each packaged booster pump. Comply with requirements for pressure gages in Section 22 05 19 "Meters and Gages for Plumbing Piping."

P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

R. Install escutcheons for exposed piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

3.4 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

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

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

1. Apply appropriate tape or thread compound to external pipe threads.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer. Leave insertion marks on pipe after assembly.

G. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.

H. 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.

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

3.5 TRANSITION FITTING INSTALLATION

A. Comply with requirements for transition fittings specified in Section 22 05 00 "Common Work Results for Plumbing."

B. Transition Fittings in Underground Domestic Water Piping:

1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
2. Fittings for NPS 2 and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.6 DIELECTRIC FITTING INSTALLATION

A. Comply with requirements for dielectric fittings specified in Section 22 05 00 "Common Work Results for Plumbing."
B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or unions.
C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges or flange kits.

3.7 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger, support products, and installation in Section 22 05 29 "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.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4and Smaller: 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 to NPS 5: 10 feet with 1/2-inch rod.

E. Install supports for vertical copper tubing every 10 feet.

F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
2. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.

G. Install supports for vertical steel piping every 15 feet.

H. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.8 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. Domestic Water Booster Pumps: Cold-water suction and discharge piping.

2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.

3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.9 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.10 FIELD QUALITY CONTROL

A. Potable water testing for lead:

1. Coordinate with Owner on any potable water system lead testing previously performed in each building where modifications to the potable water systems are to take place.

B. Perform the following tests and inspections:

1. Lead Testing Prior to Commencing Construction:

a. All water sample collection and testing shall be in accordance with NYS Law 10 CRR-NY 67-4.

b. Collect a first-draw sample from a cold-water outlet in the vicinity of the building where work is to be performed.

c. Have samples analyzed for lead content by a State Certified testing lab approved to perform such analyses by the Department's Laboratory Approval Program (ELAP). Submit copy of results to Architect/Engineer as a base line of water quality in the building before construction.

2. Lead Testing After Construction is Complete:

a. All water sample collection and testing shall be in accordance with NYS Law 10 CRR-NY 67-4.

b. Collect a first-draw sample from a cold-water outlet in the vicinity of the building where work was performed.

c. Have samples analyzed for lead content by a State Certified testing lab approved to perform such analyses by the Department's Laboratory Approval Program (ELAP). Submit copy of results to Architect/Engineer.

3. 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.

4. Buried Pipe Tests:

a. Prior to pressure testing buried water piping, flush piping with clean water at flow rate of not less than 10 feet per second 10 feet per second for specific pipe size or no less than 50 gpm for NPS 3 and smaller, 390 gpm for NPS 4 pipe size in accordance with NFPA 24 standards.

b. Backfill trench between joints before testing to prevent movement of pipe during tests. Expose joints to detect visible leaks. Sufficiently harden thrust blocks prior to tests. Fill pipe with water for minimum 24 hours prior to applying test pressure to stabilize system. Use blind flanges in piping to isolate from valves when testing segments of piping.

c. Procedure:

1) Increase water pressure in 50 psig increments until hydrostatically test pressure reaches 200 psig pressure.

2) Inspect stability of joints between pressure increases. Do not proceed to next pressure increase until stability of joints has been verified.

3) Reduce pressure to zero after 1 hour of pressure holding for 200 psig and check for leaks at joints.

4) Repeat pressure test again with pressure of 200 psig holding for 1 hour and inspect for zero tolerances for leakages at joints.

5) Do not vary test pressure more than 5 psig during test. If test pressure drops by more than 5 psig during the test, bring test pressure back to specified pressure and measure amount of water added.

6) Measure amount of leakage in exterior underground piping at specified test pressure by pumping from calibrated container. Do not exceed maximum 0.5 gallon per hour per 100 gaskets or joints leakage at joints. Leakage of main is total of amounts necessary to maintain test pressure and may not exceed allowable leakage allowed by more stringent amount listed by NFPA 24 or local water authority standards.

5. Above Grade Piping Tests:

a. Initial Test:

1) Do not connect fixtures, equipment and solenoid valves into system during this test.

2) Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.

3) 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.

4) 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.

5) Cap and subject piping to static water pressure of 150 psig, 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.

6) Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.

7) Prepare reports for tests and for corrective action required.

b. Test After Fixtures are Connected:

1) Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.

2) Test system again for 2 hours at 75 psigor prevailing water pressure, whichever is higher.

3) Repair leaks and defects at fixture and equipment connections or at solenoid valves, and retest piping or portion thereof until satisfactory results are obtained.

4) Prepare reports for tests and for corrective action required.

C. Domestic water piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.11 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. Open throttling valves to proper setting.

4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

   a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
   b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.

6. Remove and clean strainer screens. Close drain valves and replace drain plugs.

7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.

8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.12 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.

2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

   a. Flush piping system with clean, potable water until dirty water does not appear at outlets.

   b. Fill and isolate system according to either of the following:

      1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
      2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

c. After contact period, flush all parts of system with clear water until system tests at no more than 0.2-PPM residual chlorine.

d. Repeat procedures if biological examination shows contamination.

e. Have samples analyzed by a State Certified testing lab. Submit copy of results to Architect/Engineer showing samples test negative for coliform bacteria.

B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.13 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. Under-building-slab, domestic water, building-service piping, NPS 4 and larger, shall be one of the following:

1. Mechanical-joint, ductile-iron pipe; standard-pattern, mechanical-joint fittings; and mechanical joints.
2. Push-on-joint, ductile-iron pipe; standard-pattern, push-on-joint fittings; and gasketed joints.

D. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be one of the following:

1. Hard or soft copper tube, ASTM B 88, Type L; wrought-copper, solder-joint fittings; and brazed joints.

E. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

F. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
3. Hard copper tube, ASTM B 88, Type L; grooved-joint, copper-tube appurtenances; and grooved joints.

3.14 VALVE SCHEDULE

A. General valve installation requirements are specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping."

B. 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 valves with flanged ends for piping NPS 2-1/2 and larger.
2. Throttling Duty: Use ball valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
3. Drain Duty: Hose-end drain valves.
4. Exterior Hose Bibbs and Hydrants: Use Stop-and-waste drain valves specified in Section 22 11 19 "Domestic Water Piping Specialties."

C. Use check valves to maintain correct direction of domestic water flow to and from equipment.

D. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION 22 11 16

SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Backflow preventers.
2. Strainers.
3. Drain valves.
4. Trap-seal primer valves.
5. Specialty valves.
6. Flexible connectors.
7. Water meters.

B. Regulatory Requirements:

1. Backflow Preventers: Provide devices complying with applicable provisions of Section 5-1.31 of the New York State Sanitary Code and listed as approved by current edition of the List of Approved Backflow Prevention Assemblies generated by the University of Southern California Foundation for Cross- Connection Control and Hydraulic Research (FCCCHR).

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for domestic water piping specialties. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1. Double-check backflow-prevention assemblies.
2. Water hammer arresters.
3. Air vents.
4. Trap-seal primer device.
5. Stainless-steel-hose flexible connectors.

B. As-Specified Data: If the product to be incorporated in the Work is as specified by manufacturer name and product designation in this Specification Section, submit the "**As-Specified Verification Form**" (attached to Section 01 33 00 "Submittal Procedures") for each item listed below; otherwise submit full Product Data for the following:

1. Y-pattern strainers.
2. Hose-end drain valves.

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. NSF Compliance:

1. NSF/ANSI-61- Drinking Water System Components - Health Effects.
2. NSF/ANSI-61-8 Commercial Hot 180°F (includes Annex F and G).
3. NSF/ANSI-372 for lead-free valve materials for potable-water service.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 BACKFLOW PREVENTERS

A. Double-Check, Backflow-Prevention Assemblies NPS 2-1/2 and Larger:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Watts; a Watts Water Technologies Company; Model LF709 or comparable product by one of the following:

a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
b. Conbraco Industries, Inc.
c. FEBCO; a division of Watts Water Technologies, Inc.
d. Flomatic Corporation.
e. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standards: ASSE 1015, AWWA C510-92.

3. Operation: Continuous-pressure applications unless otherwise indicated.

4. Body: 304 (Schedule 40) Stainless steel housing and sleeve.

5. End Connections: AWWA 150# Class Flanges.

6. Configuration: Designed for horizontal, straight-through flow.

7. Accessories: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.

8. Refer to schedule on Drawings for flow and pressure characteristics.

2.4 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO Inc; Model T-222-A or F-721-A or comparable product by one of the following:

   a. Conbraco Industries, Inc.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Crane Co.; Crane Valve Group; Jenkins Valves.
   d. Crane Co.; Crane Valve Group; Stockham Div.
   e. Hammond Valve.
   f. Milwaukee Valve Company.
   g. Red-White Valve Corp.

2. Pressure Rating: 125 psig minimum unless otherwise indicated.

3. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 and larger.

4. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.

5. Screen: Stainless steel with round perforations unless otherwise indicated.

6. Perforation Size:

   a. Strainers NPS 2 and Smaller: 0.020 inch.
   b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.

7. Drain: Pipe plug.

2.5 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO Inc; Model T-585-70-HC or comparable product by one of the following:

   a. Conbraco Industries, Inc.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Crane Co.; Crane Valve Group; Jenkins Valves.
   d. Crane Co.; Crane Valve Group; Stockham Div.
   e. Hammond Valve.
   f. Milwaukee Valve Company.
   g. Red-White Valve Corp.

2. Standard: MSS SP-110 for standard-port, two-piece ball valves.

3. Pressure Rating: 400-psig minimum CWP.

4. Size: NPS 3/4.

5. Body: Copper alloy.

6. Ball: Chrome-plated brass.

7. Seats and Seals: Replaceable.

8. Handle: Vinyl-covered steel.

9. Inlet: Threaded or solder joint.

10. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.6 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Precision Plumbing Products, Inc., Model P1-500 Prime Rite or comparable product by one of the following:

   a. MIFAB, Inc.
   b. Sioux Chief Manufacturing Company, Inc.

2. Standard: ASSE 1018.

3. Pressure Rating: 125 psig minimum.

4. Body: Bronze.

5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.

6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.

7. Distribution Unit: Multiple gravity drain connections for servicing multiple floor drains. Copper body distribution unit with (4) FTS 3/8 brass discharge fittings and NPT 1/2 composite inlet for servicing up to (4) floor drains. Similar to Precision Plumbing Products, Inc., Model DU-4 or comparable product.

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.

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 250 psig.
2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

2.8 WATER METERS

A. Compound-Type Water Meters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide Badger Meter or comparable product by one of the following:

    a. ABB.
    b. Badger Meter, Inc.
    c. Master Meter, Inc.
    d. Mueller Co. Ltd.; a subsidiary of Mueller Water Products Inc.
    e. Schlumberger Limited; Water Services.
    f. Sensus.

3. Description:

    a. Standard: AWWA C702.
    b. Pressure Rating: 150-psig working pressure.
    c. Body Design: With integral mainline and bypass meters; totalization meter.
    d. Registration: In gallons or cubic feet as required by utility company.
    e. Case: Bronze.
    f. Pipe Connections: Flanged.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.

2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.

3. Do not install bypass piping around backflow preventers.

B. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

1. Install cabinet-type units recessed in or surface mounted on wall as specified.

C. Install Y-pattern strainers for water on supply side of each pump.

D. Install water-hammer arresters in water piping according to PDI-WH 201.

E. Install air vents at high points of water piping.

F. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

G. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

H. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 CONNECTIONS

A. Comply with requirements for ground equipment in Section 26 05 26 “Grounding and Bonding for Electrical Systems”.

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Double-check, backflow-prevention assemblies.

2. Primary water tempering valves.
3. Supply-type, trap-seal primer valves.
4. Trap-seal primer systems.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 22 05 53 “Identification for Plumbing Piping and Equipment”.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test each double-check, backflow-prevention assembly according to authorities having jurisdiction and the device's reference standard.

B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.
B. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION 22 11 19

SECTION 22 11 23.13 – DOMESTIC WATER PACKAGED BOOSTER PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Multiplex, variable-speed booster pump systems.

1.3 DEFINITIONS

A. VFC: Variable-frequency controller(s).

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, and dimensions of individual components and profiles. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For booster pumps. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Wiring Diagrams: For power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

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

B. Completed manufacturer’s installation checklist showing that the pumps and wet well were installed in accordance with the manufacturer’s requirements.

1.6 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. NSF Compliance:

1. NSF/ANSI-61- Drinking Water System Components - Health Effects.
2. NSF/ANSI-372 for lead-free valve materials for potable-water service.

C. ASME Compliance: Comply with ASME B31.9 for piping.

D. UL Compliance for Packaged Pumping Systems:

1. UL 508, "Industrial Control Equipment."
2. UL 508A, "Industrial Control Panels."
3. UL 778, "Motor-Operated Water Pumps."
4. UL 1995, "Heating and Cooling Equipment."

E. Booster pumps shall be listed and labeled as packaged pumping systems by testing agency acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Retain protective coatings and flange's protective covers during storage.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 MULTIPLEX, VARIABLE-SPEED BOOSTER PUMPS

A. Base Mounted, Duplex Packaged Booster Pump System (BP-1, BP-2 and BP-3)

1. Basis-of-Design Product: Subject to compliance with requirements, provide Grundfos; Hydro Multi-B/E or a comparable product by one of the following:

a. Bell & Gossett; A Xylem Company.
b. ITT Industries; Goulds Pumps.

2. Description: Factory-assembled and -tested, fluid-handling system for domestic water, with pumps, piping, valves, specialties, and controls, and mounted on base.

3. Pumps:

a. Type: End suction as defined in HI 1.1-1.2 and HI 1.3 for end-suction, close-coupled, multiple-stage, overhung-impeller, centrifugal pump.
b. Casing: Radially split; stainless steel.
c. Impeller: Closed, stainless steel; statically and dynamically balanced and keyed to shaft.
d. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve and deflector.

e. Seal: Mechanical.
f. Orientation: Mounted horizontally.

4. Motors: Multiple speed, with pre-greased, permanently shielded, ball-type bearings. Select motors that will not overload through full range of pump performance curve.

5. Piping: Stainless-steel pipe and fitting headers and copper tube and copper fittings between headers and pump.

6. Valves:

   a. Shutoff Valves NPS 2-1/2 and Larger: Lug-type butterfly valve, in each pump's suction and discharge piping and in inlet and outlet headers.
   b. Check Valves NPS 2-1/2 and Larger: Silent type in each pump's discharge piping.
   c. Thermal-Relief Valve: Temperature-and-pressure relief type in pump's discharge header piping.

7. Dielectric Fittings: With insulating material isolating joined dissimilar metals.

8. Control Panel: Factory installed and connected as an integral part of booster pump; automatic for multiple-pump, variable-speed operation, with load control and protection functions.

   a. Control Logic: Solid-state system with transducers, programmable microprocessor, VFC, and other devices in controller. Install VFC for pump motors larger than 25 hp in separate panel; same type as motor control panel enclosure.

   b. Motor Controller: NEMA ICS 2, variable-frequency, solid-state type.

      1) Control Voltage: 24-V ac, with integral control-power transformer.

   c. Enclosure: NEMA 250, Type 4.

   d. Motor Overload Protection: Overload relay in each phase. For each of the pumps being fed from this control panel overload protection shall be 40 amps maximum.

   e. Starting Devices: Hand-off-automatic selector switch for each pump in cover of control panel, plus pilot device for automatic control.

      1) Duplex, Automatic, Alternating Starter: Switches lead pump to lag main pump and to two-pump operation.

   f. Pump Operation and Sequencing: Pressure-sensing method for lead pump and flow-sensing method for lag pumps.

      1) Time Delay: Controls pump on-off operation; adjustable from 1 to 300 seconds.

   g. VFC: Voltage-source, pulse-width, modulating-frequency converter for each pump.

h. Manual Bypass: Magnetic contactor arranged to transfer to constant-speed operation upon VFC failure.

i. Instrumentation: Suction and discharge pressure gages.

j. Lights: Running light for each pump.

k. Alarm Signal Device: Sounds alarm when backup pumps are operating.

1) Time Delay: Controls alarm operation; adjustable from 1 to 300 seconds, with automatic reset.

l. Thermal-bleed cutoff.

m. High-suction-pressure cutout.

n. Low-discharge-pressure cutout.

o. High-discharge-pressure cutout.

p. Direct Digital Control (DDC) System for HVAC: Provide auxiliary contacts for interface to BACnet DDC system. DDC systems are specified in Section 23 09 23 "Direct Digital Control (DDC) System for HVAC." Include the following:

1) On-off status of each pump.
2) Alarm status.

9. Capacities: Refer to Schedule on Drawings.

B. Base Mounted, Triplex Packaged Booster Pump System (BP-4)

1. Basis-of-Design Product: Subject to compliance with requirements, provide Grundfos; Hydro Multi-B/E or a comparable product by one of the following:

a. Bell & Gossett; A Xylem Company.
b. ITT Industries; Goulds Pumps.

2. Description: Factory-assembled and -tested, fluid-handling system for domestic water, with pumps, piping, valves, specialties, and controls, and mounted on base.

3. Pumps:

a. Type: End suction as defined in HI 1.1-1.2 and HI 1.3 for end-suction, close-coupled, multiple-stage, overhung-impeller, centrifugal pump.
b. Casing: Radially split; stainless steel.
c. Impeller: Closed, stainless steel; statically and dynamically balanced and keyed to shaft.
d. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve and deflector.
e. Seal: Mechanical.
f. Orientation: Mounted horizontally.

4. Motors: Multiple speed, with pre-greased, permanently shielded, ball-type bearings. Select motors that will not overload through full range of pump performance curve.

5. Piping: Stainless-steel pipe and fitting headers and copper tube and copper fittings between headers and pump.

6. Valves:

    a. Shutoff Valves NPS 2-1/2 and Larger: Lug-type butterfly valve, in each pump's suction and discharge piping and in inlet and outlet headers.
    b. Check Valves NPS 2-1/2 and Larger: Silent type in each pump's discharge piping.
    c. Thermal-Relief Valve: Temperature-and-pressure relief type in pump's discharge header piping.

7. Dielectric Fittings: With insulating material isolating joined dissimilar metals.

8. Control Panel: Factory installed and connected as an integral part of booster pump; automatic for multiple-pump, variable-speed operation, with load control and protection functions.

    a. Control Logic: Solid-state system with transducers, programmable microprocessor, VFC, and other devices in controller.

    b. Motor Controller: NEMA ICS 2, variable-frequency, solid-state type.

        1) Control Voltage: 24-V ac, with integral control-power transformer.

    c. Enclosure: NEMA 250, Type 4.

    d. Motor Overload Protection: Overload relay in each phase. For each of the (3) pumps being fed from this control panel overload protection shall be 40 amps maximum.

    e. Starting Devices: Hand-off-automatic selector switch for each pump in cover of control panel, plus pilot device for automatic control.

        1) Triplex, Automatic, Alternating Starter: Switches lead pump to lag main pump and to two-pump operation.

    f. Pump Operation and Sequencing: Pressure-sensing method for lead pump and flow-sensing method for lag pumps.

        1) Time Delay: Controls pump on-off operation; adjustable from 1 to 300 seconds.

    g. VFC: Voltage-source, pulse-width, modulating-frequency converter for each pump.

    h. Manual Bypass: Magnetic contactor arranged to transfer to constant-speed operation upon VFC failure.

    i. Instrumentation: Suction and discharge pressure gages.

j. Lights: Running light for each pump.

k. Alarm Signal Device: Sounds alarm when backup pumps are operating.

1) Time Delay: Controls alarm operation; adjustable from 1 to 300 seconds, with automatic reset.

l. Thermal-bleed cutoff.

m. High-suction-pressure cutout.

n. Low-discharge-pressure cutout.

o. High-discharge-pressure cutout.

p. Direct Digital Control (DDC) System for HVAC: Provide auxiliary contacts for interface to BACnet DDC system. DDC systems are specified in Section 23 09 23 "Direct Digital Control (DDC) System for HVAC." Include the following:

1) On-off status of each pump.
2) Alarm status.

9. Capacities: Refer to Schedule on Drawings.

C. Sequence of Operation

1. The system controller to operate equal capacity variable speed pumps to maintain a constant discharge pressure or differential pressure (system set-point), depending on the application. The system controller to receive an analog signal [4-20mA] from the factory installed pressure transducer on the discharge manifold, indicating the actual system pressure.

2. Standard Cascade Control (Pumping Efficiency Based):

a. The pump system controller to adjust pump speed as necessary to maintain system set-point pressure as flow demand increases. Utilizing the pump curve information (5th order polynomial), the pump system controller will stage on additional pumps when pump hydraulic efficiency will be higher with additional pumps in operation. Exception: When the flow and head are outside the operating pump(s) allowable operating range the controller, an additional pump will engauge thus distributing flow and allowing all pump(s) to operate in allowable operating range. When the system pressure is equal to the system set-point, all pumps in operation will reach equal operating speeds. The pump system controller to have field adjustable Proportional Gain and Integral time (PI) settings for system optimization.

3. The system controller to be capable of switching pumps on and off to satisfy system demand without the use of flow switches, motor current monitors or temperature measuring devices.

4. All pumps in the system will alternate automatically based on demand, time and fault. If flow demand is continuous (no flow shut-down does not occur), the system controller will have the capability to alternate the pumps once per week. The interval and actual time of the pump change-over to be field adjustable.

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.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in NFPA 70.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for booster pumps to verify actual locations of piping connections before booster-pump installation.

3.2 INSTALLATION

A. Equipment Mounting:

1. Install booster pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 53 "Miscellaneous Cast-in-Place Concrete."

B. Support connected domestic-water piping so weight of piping is not supported by booster pumps.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Section 22 11 16 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect domestic-water piping to booster pumps. Install suction and discharge pipe equal to or greater than size of system suction and discharge headers.

1. Install shutoff valves on piping connections to booster-pump suction and discharge headers. Install ball, butterfly, or gate valves same size as suction and discharge headers. Comply with requirements for general-duty valves specified in Section 22 05 23 “General Duty Valves for Plumbing Piping."

2. Install union, flanged, or grooved-joint connections on suction and discharge headers at connection to domestic-water piping. Comply with requirements for unions and flanges specified in Section 22 11 16 "Domestic Water Piping."

3. Install piping adjacent to booster pumps to allow service and maintenance.

3.4 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.5 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 visual and mechanical inspection.
2. Leak Test: After installation, charge booster pump and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start booster pumps to confirm proper motor rotation and booster-pump 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.

3.6 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.

3.7 ADJUSTING

A. Adjust booster pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust pressure set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting booster pump to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.8 DEMONSTRATION

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

END OF SECTION 22 11 23.13

SECTION 22 12 19 - FACILITY GROUND-MOUNTED, POTABLE-WATER STORAGE TANKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes glass-fused-to-bolted-steel tank for storage of domestic water.

1.3 DEFINITIONS

A. Bottom Capacity Level (BCL): Water level above which the specified capacity is provided. In a ground-supported tank (reservoir or standpipe), the BCL is the water level in the tank shell when the tank is emptied through the specified discharge fittings, unless otherwise specified.

B. Capacity: Net volume, in gallons, that may be removed from a tank filled to TCL and emptied to BCL.

C. CR: Chlorosulfonated polyethylene synthetic rubber.

D. Minimum Capacity within Operating Range: Capacity when water level is at BCL.

E. NR: Natural rubber.

F. Range of Head: Vertical distance between TCL and BCL.

G. Reservoir: Flat-bottomed, cylindrical, steel ground-mounted water-storage tank with shell height equal to or less than its diameter.

H. SDWA: Safe Drinking Water Act.

I. Standpipe: Flat-bottomed, cylindrical, ground-mounted water-storage tank with shell height greater than its diameter.

J. Top Capacity Level (TCL): Water level defined by the lip of the overflow elevation.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of facility ground-mounted, potable-water storage tank, include rated capacities, accessories, appurtenances, and furnished specialties.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details for each facility ground-mounted, potable-water storage tank, including the following:

1. Tank, roof, and shell openings.
2. Safety railings and ladders.
3. Plans, elevations, sections, and attachment details.
4. Structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
5. Diagram power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.
B. Welding certificates.
C. Bacteriological test results.
D. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

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

1. Obstruction lighting.
2. Lightning protection.
3. Cathodic protection.
4. Tank heaters.

1.8 QUALITY ASSURANCE

A. Fabricator Qualifications: Employ a qualified structural engineer to prepare calculations, Shop Drawings, and other structural data for fabrication and erection of ground-mounted, potable-water storage tanks.

1. Engineering Responsibility: Preparation of data for ground-mounted, potable-water tanks, accessories, specified appurtenances, and concrete supports and foundations, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

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

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
3. AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

1.9 PACKAGING, DELIVERY AND HANDLING

A. Protect sheets that pass factory inspection and quality control checks from damage prior to packaging for shipment.

B. Place heavy paper or plastic foam sheets between each panel to eliminate sheet-to-sheet abrasion during shipment.

C. Wrap individual stacks of panels in heavy waterproof cover and steel banded to special wood pallets built to the roll-radius of the tank panels. Minimize contact or movement of finished panels during shipment.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of glass lined bolted steel tank that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including storage tank and supports.
b. Faulty operation of controls.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Periods: From date of Substantial Completion.

a. Tank structure or any part thereof: One (1) year from date of completion (or 14 months after delivery).

b. Manufacturer supplied Cathodic Protection system: 60 months after liquid is first introduced into the tank or 62 months after shipment from the factory. The glass coated product zone surfaces, that portion of the tank interior below the normal high elevation of the contained liquid will not corrode under normal and proper use, maintenance and operation during the warranty period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Ground-mounted, potable-water tank, including structural reinforcement and foundation, shall withstand the effects of dead and live gravity loads and winds of 100 mph.

B. Thermal Movements: Ground-mounted, potable-water tank, including structural reinforcement and foundation, shall allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

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.

D. Comply with NSF 61 and NSF 372.

E. Comply with 29 CFR 1910.

2.2 BOLTED-STEEL, GROUND-MOUNTED, POTABLE-WATER STANDPIPES

A. Description: Manufactured tank with glass fused to bolted-steel plates, bolts, rods, and reinforcing steel.

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

1. American Tank Company, Inc.
2. CST Industries.
3. Pittsburg Tank & Tower Co., Inc.
4. Superior Tank Co., Inc.

C. Standard: Designed and fabricated according to AWWA D103 and AWWA M42.

D. Design Requirements:

1. Vertical, cylindrical, flat bottom, glass coated, bolt together steel construction. Epoxy, powder coated, galvanized or stainless steel are not considered equal and will not be considered.

2. Loads to be considered in the tank and roof design shall include basic live, seismic and snow loads.

3. Specific Gravity: Minimum design shall be 1.0.

4. Net allowable soil bearing capacity 4,000 PSF (per Geotechnical report)

E. Snow Load:

1. Ground Snow Load: 30 PSF.
2. Importance Factor 1.1 (Is)
3. Thermal Factor 1.0 (Ct)
4. Exposure Factor 1.0 (Ce)

F. Wind Load (AWWA D103-09/ASCE 7-10):

1. Basic Wind Speed: 120 mph
2. Risk Category III
3. Exposure Category B

G. Frost Depth: 3’-0”

H. Load cases (include the self-weight of the structure in all of the following load combinations) shall be analyzed to determine the controlling stresses, as follows:

1. Normal operating conditions (full tank) with a full snow load.
2. Empty tank, no snow.
3. Wind, or earthquake, on empty tank, full snow.
4. Wind, or earthquake, on empty tank, snow on leeward side of dome.
5. Wind, or earthquake, on empty tank, no snow

I. Concrete Floor:

1. Contractor designed reinforced concrete. See Section 03 30 00 "Cast-in-Place Concrete." If fill is used, the fill under the floor/footing shall be compacted and tested to a minimum of 95% of proctor.

2. The floor design shall include an embedded glass-coated starter sheet ring per the manufacturers design and in accordance with AWWA D103. The floor and foundation are an integral part of the tank assembly: therefore the tank foundation and floor slab shall be constructed by the MATD.

3. If a concrete floor slab is used it shall be constructed of reinforced concrete as specified in the contract documents. If fill is used, the fill under the floor shall be compacted and tested to a minimum of 95% of proctor.

J. Glass Fused to Steel Knuckle Roof:

1. Constructed of glass coated steel panels. Roofs shall be clear span and self-supporting. Center post supports are not permitted.

2. Roof live loads and dead loads shall be carried by tank sidewalls, without additional support. A roof hatch, with a hinged gasket cover and locking hasp, shall be provided near the outside tank ladder.

3. Roof shall be fabricated of radially sectioned, glass coated bolt together steel panels. Roof panel fabrication shall be similar to that for sidewall panels, employing the same sealing and bolting techniques to ensure a weather tight assembly.

4. Roof shall be a rolled knuckle design, with no rolled angle connection between sidewall and panels.

5. The roof manway opening shall have a clear dimension of at least 24” in one direction and 18” in the other direction. The opening shall have a curb of at least 4” in height, and the cover shall have a downward overlap of at least 2”, or a gasket weather-tight cover in lieu of the 4” curb and 2” overlap. Roof exterior color shall standardly be Cobalt Blue.

6. The walkway and handrail, if supplied with the roof, shall be constructed of Hot Dipped Galvanized steel.

K. Shell Roof: Comply with AWWA D103.

L. Capacity and Characteristics:

1. Capacity: 64,000 gallons at 35 feet liquid depth.
2. Nominal diameter: 18 feet
3. Sidewall height: 35 feet from top of foundation to overflow level.

M. Pipe Connection: Comply with AWWA D103. Match size of water-distribution pipe.

N. Overflow Piping: ASTM A53/A53M, Grade B, Schedule 40, welded-steel pipe with ASTM A234/A234M, Grade W.B., Schedule 40, carbon-steel butt-weld fittings.

O. Roof Opening Hatch above TCL: Comply with AWWA D103. Steel, hinged cover, 24 by 15 inches minimum or as required by OSHA, with 4-inch curb and 2-inch downward overlap with hasp and lock, and adjacent to exterior ladder.

P. Roof Center Opening: Comply with AWWA D103. steel, removable, 20-inch minimum-diameter cover with 4-inch-minimum-height neck and minimum 2-inch downward overlap with hasp and lock. Construct opening with capability of supporting ventilation fan.

Q. Shell Sidewall Manholes: Comply with AWWA D103. Provide two steel manholes, circular, minimum 24 inches in diameter

R. Tank Vent: Steel pipe with stainless-steel screen, constructed to prevent entrance of rain, insects**,** birds, and animals.

2.3 MANUFACTURING PROCESS

A. Glass coating: The glass coating system shall be in full accordance with the requirements of AWWA D103, latest revision. Individually test coating frits in accordance with PE1 Test T-2. (Citric acid at room temperature). Employ coating process equipment that evenly coats the sheet surface and all four exposed sheet edges.

B. Surface Preparation: Following the de-coiling and shearing process, steel grit blast on both sides to the equivalent of SSPC PC 10 (near white metal blast cleaning). Sandblasting and chemical pickling of steel sheets is not acceptable. The surface anchor pattern shall be not be less than 1.0 mils. (.0001inches). Evenly oil sheets on both sides to protect them from corrosion during fabrication.

C. Cleaning: After fabrication and prior to application of the coating system, thoroughly clean sheets with Coral COR Clene 16 caustic wash with 140°F hot water, then a two-stage rinse followed immediately by hot air drying. Inspect sheets for traces of foreign matter, soil particles, grease or rust. Re-cleaned or grit-blasted sheets to an acceptable level of quality.

D. Coating Application:

1. Manufacturer shall maintain and use supplementary directional spray nozzles using an automated machine process to consistently coat the sheet edge profiles per PE 101 standard. The sheet edges shall be coated with the same vitreous enamel glass coating as the panel surface.

2. All sidewall sheets shall receive one coat of a catalytic nickel oxide glass pre-coat to both sides, followed by air-drying.

3. A second coat of milled cobalt blue glass shall be made to both sides of the sheets and then dried.

4. A third cover coat of milled titanium dioxide white glass shall then be applied to the inside of the sheet. This milled glass shall be formulated with 18% to 22% titanium dioxide to produce a finish interior surface with optimum toughness and resistance to conditions normally found in potable water storage tanks. This specific coating shall be Aquastore Vitrium. Any alternate three coat system must be submitted for approval and acceptance prior to bid.

5. The sheets shall then be fired at a minimum temperature of 1500 °F in strict accordance with ISO 9001 quality process control procedures, including firing time, furnace humidity, temperature control, etc.

6. The 4 continuous sheet edge enamel thickness shall be 5 mils.

7. The dry film interior coating thickness shall be 10-18 mils min. The dry film exterior coating thickness shall be 7-15 mils min. This is a three-coating process.

8. The finished tank inside sidewall glass coating shall be white. Cobalt Blue finished interior color will not be accepted. The standard tank sidewall finished outside color shall be Cobalt Blue. (Munsell standard 7.5 PB 2/4.) Finished outside colors shall not vary noticeably among tank panels. Off color panels will be rejected; replacement panels of matching color shall be supplied by the tank manufacturer.

E. Sheet Edge Coating

1. Prior to sheet glassing all four (4) exposed rectangular continuous sheet edges, including starter sheets, for each specific sheet radii shall be mechanically rounded in profile resulting in an optimized radius and adhere to The Porcelain Enameling Institute's Technical Manual PEI-101.

2. The sheet surface next to the edge must remain flat, post process, to prevent 'bulging' to less than 0.030 inches (0.79mm) relative to the flat, while being rolled. All (4) exposed sheet edges will then be directionally sprayed by nozzles, using an automated machine process, and coated with the same vitreous enamel glass coating as the sheet surface.

3. Sheet edge encapsulation will have an enamel coating minimum DFT (dry film thickness) of 5 mils (127 microns). Coating adhesion shall be tested in accordance with ISO 28765 Class 2 or better. Sheet face and sheet edge must meet the same glass quality test. Rounded sheet edge encapsulation will not have exposed uncoated steel.

4. The process shall be equal in all respects to Edge Coat II by CST Industries. Sealer or glass overspray as edge coating shall not be an acceptable alternative and nozzle spray must be directionally oriented toward the edges to ensure consistency of coverage. The coating shall have a tensile strength of 1500 psi.

F. Source Quality Control

1. The manufacturers quality system shall be ISO 9001 certified and refer to ISO (International Organization of Standardization) for the following testing and procedures.

2. Inspect coated sheets for mil thickness using a calibrated magnetic induction type electronic dry film thickness gage with a valid calibration record. Test frequency shall be a minimum of every gage change and/or a minimum of every half hour.

3. Measure coated sheets for color using an electronic colorimeter with a valid calibration record. Test frequency shall be a minimum of every gage change and/or a minimum of every half hour. The color must fall within the specified tolerance or it shall be rejected.

4. Perform an electrical leak detection test on the interior and exterior surface of each panel after fabrication. Inspect inside wet sheet surfaces using a low voltage wet sponge holiday tester in accordance with ASTM D5162-91 Method A. Use the tester at a voltage of 67.5 volts (+/- 10 %) and set so the alarm is sounded if the electrical resistance of the glass coating falls below 125,000. The tester shall have a valid calibration record. Use a low-suds testing solution at a ratio of not more than 1/2 fluid oz. per gallon of water to wet the sponge. Test every sheet for holidays in the factory and reject any sheet with a discontinuity.

5. Test adherence of the glass coating to the tank steel in accordance with ISO standards. Any sheet that has poor adherence will be rejected. Test coating adhesion in accordance with ISO 28765 Class 2 or better. Sheet face and sheet edge must meet the same glass quality test.

6. Test glass coating for fishscale by placing the full size production sheets in an oven 400°F for one hour. The sheets will then be examined for signs of fishscale. Reject any sheet exhibiting fishscale and all sheets from that gage lot will be similarly tested. The minimum frequency of testing for this shall be five times per month.

7. The tank manufacturer shall provide documentation upon request (prior to tank fabrication), of the above tests including mill reports and traceable documents to demonstrate the source of steel used in the manufacture of this project specific tank

2.4 MATERIALS

A. Plates and Sheets:

1. Plates and sheets used in the construction of the tank shell, floor, or roof shall comply with the minimum standards of AWWA D103, latest edition and AWWA D103a-14 addendum. All steel shall be smelted and produced in the United States of America.

2. The annealing effect created from the glass coated firing process shall be considered in determining ultimate steel strength and yield strength of the steel used for calculations detailed in AWWA D103, Equations 5-4 and 5-5 and in accordance with the AWWA D103a-14 Addenda such that Fu and Fy shall be reduced by a factor of 0.7 from the published steel values. In no event shall a yield strength greater than 50,000 psi be utilized for such calculations detailed in AWWA D103 unless the tank manufacturer can substantiate the use of higher values because of a documented testing program.

3. The tank manufacturer shall have and provide for the Engineer's review, upon request, published ultimate tensile and yield strength values for the proposed steel. In addition, per AWWA D103a-14 the tank manufacturer shall have test results for the most recent two (2) year period to substantiate the use of Fu and Fy values used in the tank manufacturer's design calculations if the values exceed 70 percent of the published values.

4. Design requirements for mild strength steel shall be ASTM A-1011 Grade 30 with a maximum allowable tensile stress of 12,135 psi. High strength steel shall be ASTM A-1011 Grade 50 with a maximum allowable tensile stress of 21,167 psi.

5. When multiple vertical bolt line sheets and plates of ASTM A-1011 Grade 50 are used, the effective net section area shall not be taken as greater than 85% of the gross area. Manufacture multiple vertical bolt line sheets and plates such that holes are staggered in the vertical bolt lines and that no two adjoining holes are in-line horizontally, except at the center of the sheet or plate.

6. When Rolled Structural Shapes are used, the material shall conform to minimum standards of ASTM A36 or ASTM A992.

B. State chemical compositions for mild steel and high strength steel in the submitted mill certifications. Raw steel for plates and sheets shall conform to the following composition requirements. These specifications refer to the design tensile strength after firing. The steel shall have the following chemical composition

1.	Carbon (Mild):	0.06%	maximum
2.	Carbon (HSS):	0.10%	maximum
3.	Manganese:	1.50%	maximum
4.	Phosphorus:	0.04%	maximum
5.	Sulfur:	0.05%	maximum
6.	Aluminum:	0.08%	maximum

C. Offset vertical tank seams. Straight seam 4 corner joints are not acceptable.

D. Horizontal Web Stiffeners

1. Stiffeners shall be of the "web truss" design, with extended tail to create multiple layers of stiffener, permitting wind loads to be distributed around the tank. Fabricate stiffeners of steel with hot dipped galvanized or epoxy coating. Rolled angle stiffeners shall not be permitted for intermediate horizontal wind stiffeners.

E. Bolt Fasteners:

1. Bolts used in tank lap joints shall be 1/2 13 UNC 2A rolled thread and shall meet the minimum requirements of AWWA D103. Bolt material shall be SAE J429 Grade 5 (1" bolt length) with a tensile strength of 74,000-psi minimum, and a proof load of 55,000-psi min. and an allowable shear stress with threads excluded from the shear plane of 18,163-psi min.

2. SAE J429 Grade 5/ASTM A325 (1-1/4” bolt length) and heat treated to a tensile strength of 120,000 psi min and a proof load of 85,000 psi min. and having an allowable shear stress with threads excluded from the shear plane of 29,454 psi min.

3. SAE J429 Grade 8/ASTM A490 (bolts greater than 1-1/4”) and heat treated to a tensile strength of 150,000 psi min and a proof load of 120,000 psi min. and having an allowable shear stress with threads excluded from the shear plane of 36,818 psi min.

4. The bolt finish shall be zinc coated, mechanically deposited 2.0 mils minimum per ASTM B695.

5. The entire bolt head shall be encapsulated up to the splines on the shank with high impact polypropylene copolymer. Resin shall be stabilized with an ultraviolet light resistant material such that the color shall appear black. The bolt head encapsulation shall be certified to meet the ANSI/NSF Standard 61 for indirect additives.

6. All lap joint bolts shall be properly selected such that threaded portions will not be exposed in the "shear plane" between the sheets. In addition, bolt lengths shall be sized as to achieve a neat and uniform appearance. Excessive threads extending beyond the nut will not be permitted.

7. All lap joint bolts shall include a minimum of four (4) splines, .002 inches minimum on the underside of the bolt head at the shank in order to resist rotation during torque wrench application.

F. Sealants

1. The lap joint sealant shall be a one component, moisture cured, polyurethane compound. The sealant shall be manufactured by a United States supplier as well as be suitable for contact with potable water and shall be certified to meet ANSI/NSF Additives Standard No. 61.

2. The sealant shall be used to seal lap joints, bolt connections and for sheet edge fillets. The sealant shall be CST Industries, Manus Bond 98 Sealer. The sealant should have a curing rate at 73°F and 50% RH and be tack free in 6 to 8 hours. Final cure time should be 10 to 12 days. Sealer shall be resistant up to 100-ppm chlorine concentration during disinfection. Neoprene gaskets and tape type sealer shall not be used.

3. The sealant shall cure to a rubber like consistency, have excellent adhesion to the glass coating, low shrinkage and be suitable for interior and exterior use.

4. Due to poor compatibility with chlorine, the sealant Sika 1A shall not be used on potable water storage tanks.

G. Roof Vent:

1. Provide a properly sized aluminum vent assembly in accordance with AWWA D103, installed above the maximum water level. Provide a curbed opening at the apex of the dome. Size vent to not exceed 0.5-inch water column interior pressure or vacuum at maximum possible rate of water fill or withdrawal.

2. Provide protection against birds and protection against ice plugging. Provide an insect screen designed to open should the screen become plugged by ice formation.

3. Construct the vent of aluminum such that the hood can be unbolted and used as a secondary roof access.

H. Pipe Connections

1. Where pipe connections are shown to pass through tank panels, field locate, saw cut, (acetylene torch cutting or welding is not permitted), and utilize an interior and exterior flange assembly. Comply with AWWA D103 latest edition for tank shell reinforcing. Apply sealer on any cut panel edges or bolt connections.

2. Overflow piping shall be irrigation grade seamless aluminum tubing with twenty-four mesh non corrodible screen installed within the pipe.

I. Ladder Assemblies

1. Provide an AWWA D103 and OSHA 1910 compliant external aluminum tank ladder utilizing grooved, skid-resistant rungs.

2. Fabricate personal fall arrest system, safety cage and step-off platforms (as required by OSHA 1910 or customer submittal drawings) of galvanized steel. Equip ladders with a hinged lockable entry device at the bottom of the ladder. Provide step off platforms at maximum intervals of every 30’.

J. Access Doors

1. Provide tank with one (1) 24-inch diameter bottom access door per AWWA D103. The manhole opening shall be a minimum of 24 inches in diameter. The access door and tank shell reinforcing shall comply with AWWA D103 latest edition.

2. Provide a davit to hold the cover plate.

K. Identification Plate: Manufacturer’s nameplate shall list the tank serial number, tank diameter and height, maximum design capacity, intended storage use, and date of installation. The nameplate shall be affixed to the tank exterior sidewall at a location approximately 5' from grade elevation in a position of unobstructed view.

L. Cathodic Protection System

1. Provide a passive cathodic protection system designed by the tank manufacturer specifically for the project tank, consisting of sacrificial anodes which provide protection for the portion of the structure immersed in liquid. The anodes are attached to the floor and bolted through existing shell sheet bolt holes. Lead wires and buss bars are used to ensure continuity between anodes and all structure shell sheets.

2. The cathodic protection system shall be designed by a licensed professional engineer employed by the tank manufacturer. The system shall be designed to protect the tank.

3. The resistivity of the water to be stored in the tank will determine the type and number of anodes.

M. Plastic Encapsulated Cap: Use high density polyethylene co-polymer caps and sealant to cover the bolts, nuts and washers exposed on the exterior sidewall of the tank.

2.5 GROUND-MOUNTED, POTABLE-WATER STORAGE TANK APPURTENANCES

A. Water-Level Controls: Automatic controls for maintaining water level in tank, with valves, piping, and audible and visual alarms to indicate the following:

1. High- and low-water levels.
2. Tank overflowing or tank not filling.

B. Lightning Protection: Comply with requirements in Section 26 41 13 "Lightning Protection for Structures."

C. Tank circulator:

1. Continuous Operation Equipment: The mixer shall operate continuously, all day and all night, using 120 VAC as the power source.

2. Specified Equipment: The mixer shall be manufactured by Ixom Watercare, Inc. of Dickinson, ND,

3. Complete Water Circulation Required: To meet the project objectives, the tank or reservoir circulation shall be achieved by a single submerged units within the reservoir capable of providing long distance circulation of water. The mixer shall have a direct measurable flow rate where suction shall enter specified mixer's intake positioned within 2 inches of reservoir floor and discharging water vertically in a sheet flow pattern to induce a large volume, low velocity flow to reach the tank or reservoir water surface. The mixer must be placement flexible in design to allow best hydraulic positioning for tank or reservoir conditions to prevent hydraulic short circuiting within tank or reservoir. Suction not within 2 inches of tank or reservoir floor is not allowed.

4. Complete Mix: The mixer manufacturer guarantees that the subject tank will be completely mixed by the mixer. In continuous operation of the mixer:

   a. At least once per 24 hours all water temperatures within the tank shall converge to within 0.8 degrees C.
   b. At least once per 72 hours all chlorine concentrations within the tank shall converge to within 0.18 mg/l.

5. Stainless Steel Construction: The mixer shall be constructed primarily of Type 316 stainless steel metal for strength and superior corrosion resistance.

6. Motor: The mixer shall be mechanically operated by a submersible motor that meets the following criteria.

7. Direct Drive, with no gearbox and no lubrication maintenance required.

8. Designed for submersible operation: Mixer design shall include flow sleeve or housing around motor to provide water flow past motor per submersible motor design criteria to lower the total motor temperature and increase winding life.

9. SCADA and Controls: The mixer shall have the option to add an Electric Control Box including a motor current indicator in a 4-20mA analog output and remote on/off control via 24VDC relay.

10. Accessories: 75 feet cable and chain, roof junction box, chain grab tools

11. Equipment Support: The mixer manufacturer shall offer full factory support with the following staff and support services.

2.6 STEEL, GROUND-MOUNTED, POTABLE-WATER STORAGE TANK INSTALLATION

A. Bolted-Steel Tanks:

1. Erect tank shell, accessories, and appurtenances according to AWWA D103 and AWWA M42.
2. Fabricate tank sections and drill or punch bolt holes in the shop. Install bolts during field erection of tank.

B. Set top of reinforced-concrete foundation at least 6 inches above finish grade.

C. Install roof hatch near exterior ladder.

D. Install roof center opening near center of roof.

E. Install tank vent at center of roof.

F. Install manholes in tank wall near grade.

G. Employees of the MATD shall be experienced in the construction of the specified glass fused to steel tank and should be trained in a factory training program receiving builder certification by the tank manufacturer and shall be employed full time by the authorized dealer.

H. Tank Foundation: Build in accordance with the approved shop drawings, designed by the manufacturers licensed engineer and built by the MATD to safely sustain the structure and its live loads. Floor rebar shall be epoxy coated.

I. Concrete Floor

1. Only embedded starter ring designs are acceptable for concrete floors. Slot mount base foundations, rebate base, and flat base designs which do not include an embedded base ring will not be allowed.

2. Leveling of the starter ring shall be required and the maximum differential elevation with the ring shall not exceed 1/8 inch, nor exceed 1/16 inch within any 10 feet of circumference.

3. A leveling plate assembly, consisting of two anchor rods and a slotted plate shall be used to secure the starter ring, prior to encasement in concrete. Installation of the starter ring on concrete blocks or bricks, using shims for adjustment, is not permitted.

4. Place one butyl rubber elastomeric waterstop seal on the inside surface of the starter ring below the concrete floor line. Place one bentonite impregnated water seal below the butyl rubber seal. After the previous water seals have been installed, install a continuous fillet of “Sika Swell” on top of the butyl rubber elastomeric waterstop at the juncture of the tank sidewall and butyl waterstop. Install materials in accordance with CST Industries instructions.

5. Tank footing design shall be based on the soil bearing capacity given by the engineer, as determined by geotechnical analysis performed by a licensed soils engineer. Copies of the soil report will be provided to the bidder prior to submission of submittal by the Owner or Engineer.

6. Concrete floors may be poured monolithically for all tank diameters. For larger structures, floors shall be quadrant poured. Concentric ring pouring shall not be allowed. Floors shall be designed ACI 350.

J. Tank Structure

1. Field erection of the glass-coated, bolted-steel structures and components shall be in strict accordance with the procedures established by the manufacturer and performed by MATD who is regularly engaged in erection of the manufacturers glass fused to steel tanks, using experienced factory-trained certified erectors fully employed by the Dealer.

2. Only specialized erection jacks and building equipment developed and supplied by the tank manufacturer shall be used to erect the tanks. Every sheet shall be 100% tested for interior holidays in the field.

3. Take particular care in handling and bolting of the glass-coated steel tank panels, appurtenances and members to avoid abrasion of the coating system. Prior to liquid test, visually inspect all surface areas. Repair chips or scrapes in the glass coating per the tank manufacturer's recommended procedure.

4. Perform an electrical coating leak test during erection using a wet sponge nine-volt leak detection device. Repair electrical leak points found on the inside surface in accordance with manufacturers published touch-up procedures.

2.7 FIELD TESTING

A. Following completion of erection and cleaning of the tank, test the structure for liquid tightness by filling to its overflow elevation.

B. Correct any leaks disclosed by this test in accordance with the manufacturer's recommendations.

C. Water required for testing following completion of tank erection will be furnished by the owner. Disposal of water, if required, following testing is by the Owner. Labor and equipment necessary for hydrostatic tank testing shall be included in the contract price of the tank.

2.8 DISINFECTION

A. The tank structure shall be disinfected at the time of testing by chlorination in accordance with AWWA C652 11, or latest revision, "Disinfection of Water Storage Facilities".
B. Acceptable method of disinfection: Chlorination Method 1, 2 or 3 per AWWA C652-11.
C. Acceptable form of chlorine for disinfection: Sodium Hypochlorite, as specified in AWWA C652-11.
D. Disinfection shall not take place until the tank sealant is fully cured (10 to 12 days at 73°F and 50% relative humidity or equivalent).

2.9 FIRST YEAR INSPECTION

A. On or near the (1) year anniversary date of initial tank use (but not more than (14) months from date of delivery of tank materials to job site), the MATD shall make a visual inspection of the tank interior coating and appurtenances, tank exterior coating and appurtenances, and the immediate area surrounding the tank for evidence of leakage. A written summary of the inspection report will be filed with the tank owner and the tank manufacturer.

B. Water required for the inspection process will be furnished and disposed of by the Owner.

2.10 PIPING CONNECTIONS

A. Connect tanks to water-distribution piping.
B. Connect drains to storm-drainage piping.

2.11 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53 "Identification for Electrical Systems."

2.12 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.
B. Connect control wiring according to Section 26 05 23 "Control-Voltage Electrical Power Cables."

2.13 SURFACE WATER-STORAGE TANK APPURTENANCE INSTALLATION

A. Install and adjust water-level control valves, piping, and alarms.
B. Install lightning protection according Section 26 41 13 "Lightning Protection for Structures."
C. Install cathodic protection according to Section 13 47 13 "Cathodic Protection" and AWWA D104.

2.14 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 test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Tank Weld Test: Use radiographic method according to AWWA D100. Repair failures and retest.

2. Leak Test: Comply with AWWA D100. Fill tanks with potable water and test for leaks after installation. Repair leaks and retest until no leaks exist.

    a. Water will be furnished by Owner.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Unit will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

2.15 CLEANING

A. Clean interior and exterior of ground-mounted, potable-water storage tanks.
B. Disinfect surface water-storage tanks according to AWWA C652.

2.16 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the following:

1. Obstruction lighting.
2. Water-level controls.
3. Tank circulator.

END OF SECTION 22 12 19

SECTION 22 12 23 - INDOOR POTABLE-WATER STORAGE TANKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pressure type potable-water storage tanks.

1.3 ACTION SUBMITTALS

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

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water storage tanks.

2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

a. Steel, precharged, potable-water storage tanks

1.4 INFORMATIONAL SUBMITTALS

A. Pressure test reports.
B. Purging and disinfecting activities reports.
C. Lab results for biological testing showing samples negative for coliform bacteria.

1.5 QUALITY ASSURANCE

A. ASME Compliance for Steel Tanks: Fabricate and label steel, ASME-code, potable-water storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

B. Comply with NSF 61, "Drinking Water System Components - Health Effects," for potable-water storage tanks. Include appropriate NSF marking.

1.6 COORDINATION

A. Coordinate size and location of concrete bases with actual equipment provided. Formwork, reinforcement, and concrete requirements are specified in Section 03 30 00 "Cast-in-Place Concrete.".

PART 2 - PRODUCTS

2.1 STEEL, PRECHARGED, POTABLE-WATER STORAGE TANKS

A. Steel, Precharged, Bladder, Water Storage Tanks:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Wood, John Co; or comparable product by one of the following:

    a. Armstrong Pumps, Inc.
    b. Flo Fab inc.
    c. Taco, Inc.
    d. Wessels Company.

2. Description: Steel, vertical, pressured-rated tank with cylindrical sidewalls and with air-charging valve and air precharge.

3. Operation: Factory-installed, replaceable butyl-rubber bladder.

B. Construction: ASME code, steel, constructed with nontoxic welded joints, for 125-psig working pressure.

C. Tappings: Factory-fabricated stainless steel or non-ferrous, welded to tank before testing and labeling.

1. NPS 2 and Smaller: ASME B1.20.1, with female thread.
2. NPS 2-1/2 and Larger: ASME B16.5, flanged.

D. Specialties and Accessories: Include tappings in tank and the following:

1. Pressure gage.

E. Vertical Tank Supports: Factory-fabricated steel legs or steel skirt, welded to tank before testing and labeling.

F. Tank Interior Finish: Materials and thicknesses complying with NSF 61 barrier materials for potable-water tank linings. Extend finish into and through tank fittings and outlets.

G. Exterior Coating: Primer paint.

H. Capacities: Refer to Schedule on Drawings.

2.2 SOURCE QUALITY CONTROL

A. Test and inspect potable-water storage tanks according to the following tests and inspections and prepare test reports:

1. Pressure Testing for ASME-Code, Potable-Water Storage Tanks: Hydrostatically test to ensure structural integrity and freedom from leaks. Fill tanks with water, vent air, pressurize to 1-1/2 times tank pressure rating, disconnect test equipment, hold pressure for 30 minutes with no drop in pressure, and check for leaks.

B. Repair or replace tanks that fail test with new tanks and repeat until test is satisfactory.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install water storage tanks on concrete bases, level and plumb, firmly anchored. Arrange so devices needing servicing are accessible.

B. After installing tanks with factory finish, inspect finishes and repair damages to finishes.

3.2 CONNECTIONS

A. Piping installation requirements are specified in Section 22 11 16 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to potable-water storage tanks to allow service and maintenance.

C. Connect water piping to water storage tanks with unions or flanges and with shutoff valves. Connect tank drains with shutoff valves and discharge over closest floor drains.

1. General-duty valves are specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping."

    a. Valves NPS 2 and Smaller: Ball.

    b. Valves NPS 2-1/2 and Larger: Butterfly.

    c. Drain Valves: NPS 3/4 gate or ball valve. Include outlet with, or nipple in outlet with, ASME B1.20.7, 3/4-11.5NH thread for garden-hose service, threaded cap, and chain.

2. Water Piping Connections: Make connections to dissimilar metals with dielectric fittings. Dielectric fittings are specified in Section 22 05 00 "Common Work Results for Plumbing."

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform the following final checks before filling:

1. Verify that air precharge in precharged tanks is correct.

2. Test operation of tank accessories and devices.

3. Verify that pressure relief valves have correct setting.

    a. Manually operate pressure relief valves.
    b. Adjust pressure settings.

4. Verify that vacuum relief valves are correct size.

    a. Manually operate vacuum relief valves.
    b. Adjust vacuum settings.

B. Filling Procedures: Follow manufacturer's written procedures. Fill tanks with water to operating level.

3.5 CLEANING

A. Clean and disinfect potable-water storage tanks.

B. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed, use procedure described in AWWA C652 or as described below:

1. Purge water storage tanks with potable water.

2. Disinfect tanks by one of the following methods:

    a. Fill tanks with water-chlorine solution containing at least 50 ppm of chlorine. Isolate tanks and allow to stand for 24 hours.
    b. Fill tanks with water-chlorine solution containing at least 200 ppm of chlorine. Isolate tanks and allow to stand for three hours.

3. Flush tanks, after required standing time, with clean, potable water until chlorine is not present in water coming from tank.

4. Repeat procedures if biological examination shows contamination.

5. Have samples analyzed by a State Certified testing lab. Submit copy of results to Architect/Engineer showing samples test negative for coliform bacteria.

C. Prepare written reports for purging and disinfecting activities.

END OF SECTION 22 12 23

SECTION 22 13 13 - FACILITY SANITARY SEWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General 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.
3. Cleanouts.

1.3 SUBMITTALS

A. Product Data: For the following:

1. Pipe and fittings
2. Cleanouts.
3. Frames and covers.
4. Underground warning tape

B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

C. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewer system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

D. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.

E. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Provide installation, testing and materials in accordance with all applicable federal, state and local building, health, plumbing and electrical codes, laws, ordinances, and regulations.

2. Comply with applicable utility company regulations.

   a. Municipal Sewer Connection: Coordinate connection to existing municipal sewer with local sewer authority. Pay for all fees associated with connection to municipal sewer.

      1) Install connections to municipal sewer in accordance with local sewer authority standards and OSHA regulations. Provide materials complying with local sewer authority standards.

3. Obtain and pay for necessary inspections, certificates, and permits from applicable agencies. Perform required tests in accordance with regulations of agency having jurisdiction. Submit certificates of approval.

B. In event of a conflict between the codes identified above and Contract Documents, comply with more stringent requirement.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: Ship materials in manufacturer's containers, fully identified with manufacturer's name, trade name, type, class, style, model, grade, size, and color.

B. Storage and Protection:

1. Store materials, equipment, fixtures, pipe, fittings and attachments, under cover, off ground in original containers as applicable, and protect from physical and weather damage while in storage and during construction.

2. Replace or repair damaged, rusted, corroded or otherwise unusable materials physically damaged or weather damaged equipment as determined by Architect, at no change in Contract Sum.

1.6 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 Owner no less than 1 week in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Owner's written permission.
3. Coordinate laying pipe, bedding, backfill etc. with other prime Contracts.

PART 2 - PRODUCTS

2.1 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service and Extra-Heavy classes, with compression one-piece molded dual-O-ring, annular type gasket specially designed to use with hub and plain end soil pipe.

B. Gaskets: ASTM C 564, rubber.

2.2 PVC PIPE AND FITTINGS

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:

1. Charlotte Pipe and Foundry.
2. J-M Manufacturing Co.
3. North American Pipe Corporation.

B. PVC Gravity Sewer Piping:

1. Polyvinyl Chloride Gravity Sewer Pipe: SDR 26, ASTM D3034 with elastomeric seal push-on joint.

2. Polyvinyl Chloride Gravity Sewer Pipe Fittings: Polyvinyl Chloride fittings with SDR, wall thickness, matching piping, bell and spigot joints with locked in rubber sealing ring complying with ASTM D3212.

2.3 NONPRESSURE-TYPE TRANSITION COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:

1. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
2. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
3. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

2.4 CLEANOUTS

A. Cast-Iron Cleanouts:

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.
c. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

2. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.

3. Top-Loading Classification: Heavy Duty.

4. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

2.5 CONCRETE

A. General: Cast-in-place concrete complying with ACI 318, ACI 350/350R, 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 minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi 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: 0.1ft across manhole, unless otherwise indicated.

2. Benches: Concrete, sloped to drain into channel.

a. Slope: 4 percent minimum, unless otherwise indicated.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel.

2.6 IDENTIFICATION

A. Underground Warning Tape

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. Presco, Inc.; Sherman, Texas
   a. EMED Co., Buffalo, New York.
   b. Seton Identification Products, A Tricor Direct Company.

2. Material: 6-inch wide, color-coded, heavy gauge 5-mil tape with aluminum backing.

3. Text: "CAUTION BURIED SANITARY LINE BURIED BELOW". All tapes printed with black ink on APWA (American Public Works Association) approved colors to meet or exceed industry standards.

4. Location: Provide warning tape 18 inches feet below finished grade in buried piping trenches and at foundation wall.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 VERIFICATION OF CONDITIONS

A. Before proceeding with sanitary sewer installation, examine conditions existing at site in coordination with Installer and notify affected Contractors and Architect of any construction or any other conditions prevailing which prevent, inhibit, or otherwise interfere with sanitary sewer installation.

B. Verify invert elevation and pipe sizes of existing buried piping where new connections are indicated and verify depths of existing utilities crossing, or in the area of, sanitary sewer installation. Do not install buried sanitary sewers until these site conditions have been verified and indicated on Shop Drawings. Report to Architect any discrepancies.

C. Verify invert elevation at connection point of piping systems installed by other Contractors prior to installing sanitary sewers. Do not install buried sanitary sewers until building sewer invert elevations by other Contractors have been verified and indicated on Shop Drawings. Report to Architect any discrepancies.

D. Prior to installation, identify any discrepancies between specifications and field conditions or changes required due to specific equipment selection. Corrective work required by discrepancies after installation at responsible Contractor's expense.

E. Beginning installation constitutes Contractor's acceptance of areas and conditions.

3.3 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.

1. Check alignment and grade along center of pipe every 20 feet.

2. Pipeline Invert Elevation Tolerances: Finish all surfaces and inverts to +/- 0.05 foot from elevations shown on Drawings.

3. Pipe Handling: Provide proper implements, tools, and facilities for safe and convenient pipe handling. Carefully lower pipe and fittings into trench piece-by-piece to prevent damage to pipe. Do not drop or dump pipe into trench under any circumstances.

4. Shape bottom of trench to conform as nearly as possible to outside of pipe, taking particular care to recess trench bottom to relieve bell of all load.

C. Install cleanouts 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. 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 on plans.
2. Install piping with 48-inch minimum cover unless otherwise indicated.
3. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
4. Install ductile-iron, gravity sewer piping according to ASTM A 746.
5. Install PVC gravity sewer piping according to ASTM D 2321 and ASTM F 1668.

F. 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.

3.4 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure, drainage piping according to the following:

1. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

2. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.
3. Join PVC gravity sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
4. Join dissimilar pipe materials with nonpressure-type, flexible or rigid couplings.

B. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

1. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.

3.5 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.6 CLEANOUT INSTALLATION

A. Cleanouts: Provide cleanouts on sanitary lines as shown on Drawings and additional cleanouts as required by local code.

1. Use Heavy-Duty, top-loading classification cleanouts in all areas.

2. Provide cleanouts at ends of horizontal branches and mains, at changes in direction greater than 45 degrees, and where necessary to remove obstructions.

3. Provide cleanouts and related covers in following sizes:

a. 4 inch pipes and smaller: Full size.
b. 6 inch pipes: Not less than 4 inch.
c. 8 inch and 10 inch pipes: Not less than 6 inch.
d. 12 inch and 15 inch pipes: Not less than 8 inch.

4. Thoroughly coat threads on removable parts with graphite.

5. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 6 inches deep. Set with tops 0.10 foot above surrounding grade, unless otherwise indicated.

6. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.7 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 22 Section "Sanitary Waste and Vent Piping."

B. Make connections to existing piping and underground manholes.

1. Make branch connections from side into existing piping. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches crushed stone structure bedding..

2. Make branch connections from side into underground manholes by one of the following methods:

a. Cut opening into existing unit large enough to allow 3 inches 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 a minimum 6 inches of crushed stone structure bedding for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

1) Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

b. Use commercially manufactured resilient pipe connectors meeting the requirements ASTM C 923, fitted into existing manhole walls, for each pipe connection.

1) Install connectors in accordance with manufacturer's recommendations.

3. 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.

3.8 IDENTIFICATION

A. Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.

1. Use warning tape or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.9 FIELD QUALITY CONTROL

A. 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. Submit separate written report for each system inspection in approved format including the following information:

a. Testing information to include date of testing, starting pressure, pressure after test and length of test, pressure loss after test and witnesses present. Record testing information for any repeated tests.

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. Test in presence of the Architect or Architect's designated representative and jurisdictional authority.

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 48 hours advance notice.

4. Submit separate report for each test.

5. Pipe and Fittings: Leakage testing shall be either of the following:

    a. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:

        1) Fill sewer piping with water. Test with pressure of at least 10-foot head of water, and maintain such pressure without leakage for at least 15 minutes.
        2) Close openings in system and fill with water.
        3) Purge air and refill with water.
        4) Disconnect water supply.
        5) Test and inspect joints for leaks.
        6) Maximum Leakage Rate: 200 gallons/inch/diameter/mile/day

    b. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:

        1) Test plastic gravity sewer piping according to ASTM F 1417.

        2) Procedure:

            a) Plug all openings in the test section.

b) Add air until the internal pressure of the line is raised to approximately 4.0 psi. After this pressure is reached, allow the pressure to stabilize due to temperature variances (will take approximately 2 to 5 minutes).

c) Add/remove air until internal pressure is 3.5 psi.

d) Start test. If a 1 psi drop does not occur the line has passed. If the pressure drop is greater than 1 psi the section has failed.

e) Below is the minimum Air Test time:

Pipe Size, inches	**Time, min/ 100 feet (sec/100 feet)**
4	0.3 (18)
6	0.7 (42)
8	1.2 (72)
12	1.8 (108)
18	2.4 (144)

C. Provide additional tests as required and specified by the local sewer authority

D. Leaks and loss in test pressure constitute defects that must be repaired.

E. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.10 CLEANING

A. Pipe Cleaning: Clean interior of pipe as installation progresses. Maintain swab or drag in line and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe line at end of day or whenever installation stops.

B. Leave all components of sanitary sewer system completely free from silt, debris, or obstruction.

END OF SECTION 22 13 13

SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General 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.
2. Waste, Force-Main Piping: 100 psig.

1.4 ACTION SUBMITTALS

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

1. Heavy-duty, high torque hubless-piping couplings.

B. As-Specified Data: If the product to be incorporated in the Work is as specified by manufacturer name and product designation in this Specification Section, submit the "**As-Specified Verification Form**" (attached to Section 01 33 00 "Submittal Procedures") for each item listed below; otherwise submit full Product Data for the following:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless, cast-iron soil pipe and fittings.
3. CISPI, low torque hubless-piping couplings.
4. Galvanized-steel pipe and fittings.
5. Copper pipe and fittings.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
B. Provide pipe and fittings produced by a single manufacturer for each type of system.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Sewer: Refer to “Existing Utility Interruptions” paragraph ofSection 01 12 00 “Multiple Contract Summary-Project Schedule” for requirements associated with interrupting the existing sanitary sewer service to facilities occupied by the Owner.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

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

1. AB&I Foundry; a division of McWane, Inc.
2. Charlotte Pipe and Foundry Company.
3. Tyler Pipe; a division of McWane, Inc.

B. Pipe and Fittings: Centrifugally cast gray cast iron pipe and static cast fittings conforming to requirements of ASTM Standard A 74, service weight (SV) type with coating on interior and exterior in accordance with ANSI/AWWA C104/A21.4. Pipe and fittings marked with the collective trademark of the Cast Iron Soil Institute and listed by NSF® International.

C. Gaskets: ASTM C 564, rubber.

D. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

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

1. AB&I Foundry; a division of McWane, Inc.
2. Charlotte Pipe and Foundry Company.
3. Tyler Pipe; a division of McWane, Inc.

B. Pipe and Fittings: Centrifugally cast gray cast iron pipe and static cast fittings conforming to requirements of ASTM A 888 or CISPI with coating on interior and exterior in accordance with ANSI/AWWA C104/A21.4. Pipe and fittings marked with the collective trademark of the Cast Iron Soil Institute and listed by NSF® International.

C. CISPI, Low Torque 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; a division of McWane, Inc.
b. Ideal Clamp Products, Inc.; a Tomkins Company.
c. Mission Rubber Company; a division of MCP Industries, Inc.
d. Tyler Pipe; a division of McWane, Inc.

2. Standards: ASTM C 1277, CISPI 310 and listed by NSF® International.

3. Description: Type 301 stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

D. Heavy-Duty, High Torque 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; a division of McWane, Inc.
b. Clamp-All Corp.
c. MIFAB, Inc.
d. Mission Rubber Company; a division of MCP Industries, Inc.
e. Tyler Pipe.

2. Standards: ASTM C 1540.

E. Description: Type 304 stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Standard Weight class. Include threaded ends matching joining method.

B. Galvanized-Cast-Iron Drainage Fittings: ASME B16.12, threaded.

C. Steel Pipe Pressure Fittings:

1. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Schedule 40, seamless steel pipe. Include ends matching joining method.

2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.

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

D. Grooved-Joint, Galvanized-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; a subsidiary of Mueller Water Products, Inc.
b. Grinnell Mechanical Products.
c. Shurjoint Piping Products.
d. Victaulic Company.

2. Galvanized, Grooved-End Fittings for Galvanized-Steel Piping: ASTM A 536 ductile-iron castings, ASTM A 47/A 47M malleable-iron castings, ASTM A 234/A 234M forged steel fittings, or ASTM A 106/A 106M steel pipes with dimensions matching ASTM A 53/A 53M steel pipe, and complying with AWWA C606 for grooved ends.

3. Grooved Mechanical Couplings for Galvanized-Steel Piping: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber gasket suitable for hot and cold water; and bolts and nuts.

2.5 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 and Type M, water tube, drawn temper.

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

E. Copper Pressure Fittings:

1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

F. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.6 TRANSITION FITTINGS

A. Install transition couplings at joints of piping with small differences in OD's. Refer to transition fitting products specified in Section 22 05 00 “Common Work Results for Plumbing”.

2.7 DIELECTRIC FITTINGS

A. Dielectric Unions and Flanges: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined. Comply with requirements in Section 22 05 00 "Common Work Results for Plumbing."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which drainage and vent systems, e.g., storm drainage, sanitary sewer, laboratory waste, etc., are to be installed in coordination with Installer of materials and components specified in this Section. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

1. Verify invert elevation of existing piping when new connections are indicated. Do not install buried sewer work until existing sewer invert elevation has been verified to meet required slope and bury depth requirements of new sewer piping.

2. Determine inverts and routing of piping systems and interferences with other building piping systems, building structure, lights, ductwork, foundations prior to installation.

B. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

3.2 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 31 20 00 "Earth Moving."

3.3 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 vent piping to allow application of insulation within 6 feet of a roof penetration.

J. 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.

K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

L. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 2 and smaller; 1 percent downward in direction of flow for piping NPS 3 and larger.
2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

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 steel piping according to applicable plumbing code.

O. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

P. Install engineered soil and waste drainage and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.

Q. Install force mains at elevations indicated.

R. 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. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Section 22 13 19 "Sanitary Waste Piping Specialties".

2. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Section 22 13 19 "Sanitary Waste Piping Specialties".

S. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

T. Insulate vent piping within 6 feet of roof penetrations, all directions. Comply with requirements for insulation specified in Section 22 07 19 " Plumbing Piping Insulation".

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping".

V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping".

W. Install escutcheons for exposed piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping".

3.4 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

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

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. 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.

E. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

3.5 SPECIALTY PIPE FITTING INSTALLATION

A. Comply with requirements for transition and dielectric fittings specified in Section 22 05 00 "Common Work Results for Plumbing."

B. Transition Couplings:

1. In Drainage Piping: Unshielded, nonpressure transition couplings.
2. In Aboveground Force Main Piping: Fitting-type transition couplings.

C. Dielectric Fittings:

1. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
2. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges or flange kits.
3. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.6 VALVE INSTALLATION

A. General valve installation requirements are specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping".

B. Shutoff Valves:

1. Install shutoff valve on each sewage pump discharge.
2. Install full-port ball valve for piping NPS 2 and smaller.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

3.7 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install galvanized carbon-steel pipe hangers for horizontal piping in noncorrosive environments.

2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.

3. Install galvanized carbon-steel pipe support clamps for vertical piping in noncorrosive environments.

4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.

5. Vertical Piping: MSS Type 8 or Type 42, clamps.

6. Install individual, straight, horizontal piping runs:

   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

8. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
5. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.

H. Install supports for vertical steel piping every 15 feet.

I. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2: 84 inches with 3/8-inch rod.
2. NPS 3: 96 inches with 1/2-inch rod.
3. NPS 4: 108 inches with 1/2-inch rod.

J. Install supports for vertical stainless-steel piping every 10 feet.

K. 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.

L. Install supports for vertical copper tubing every 10 feet.

M. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.8 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. 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. Connect force-main piping to the following:

1. Sewage Pump: To sewage pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. 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.

3.9 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.10 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 wc. 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.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

2. 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 to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

4. Prepare reports for tests and required corrective action.

3.11 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.

3.12 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil, waste and vent piping NPS 3 and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Copper DWV tube, copper drainage fittings, and soldered joints.
5. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

C. Aboveground, soil, waste and vent piping NPS 4 and larger shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

D. Underground, soil, waste, and vent piping NPS 12 and smaller shall be the following:

1. Extra Heavy Service class, cast-iron soil piping; gaskets; and gasketed joints.
2. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

E. Aboveground sanitary-sewage force mains NPS 1-1/2 and NPS 2 shall be any of the following:

1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.

END OF SECTION 22 13 16

SECTION 22 13 19 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Cleanouts.
2. Floor drains.
3. Floor sinks.
4. Air-admittance valves.
5. Miscellaneous sanitary drainage piping specialties.
6. Solids interceptors.

1.3 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.
B. HDPE: High-density polyethylene plastic.
C. PE: Polyethylene plastic.
D. PP: Polypropylene plastic.
E. PVC: Polyvinyl chloride plastic.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:

1. Floor cleanouts, general building areas.
2. Wall cleanouts.
3. Exterior cleanouts.
4. Floor drain "A".
5. Floor sink “A”.
6. Vent caps.
7. Solids interceptors.

B. As-Specified Data: If the product to be incorporated in the Work is as specified by manufacturer name and product designation in this Specification Section, submit the “**As-Specified Verification Form**” (attached to Section 01 33 00 “Submittal Procedures”) for each item listed below; otherwise submit full Product Data for the following:

1. Fixture air-admittance valves.

2. Deep-seal traps.
3. Floor-drain, trap-seal primer fittings.
4. Air-gap fittings.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

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

1.7 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

1.8 COORDINATION

A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Exposed Metal Cleanouts (CO):

1. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
2. Size: Same as connected drainage piping
3. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or hubless, cast-iron soil pipe test tee as required to match connected piping.
4. Closure: Countersunk or raised-head, brass plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Floor Cleanouts, General Building Areas (CODP):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Mfg. Co.; Division of Smith Industries, Inc.; No. 4021-U Series or comparable product by one of the following:

    a. Josam Company; Josam Div.
    b. MIFAB, Inc.
    c. Watts Drainage Products Inc.
    d. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M, for adjustable housing cleanouts.

3. Size: Same as connected branch.

4. Type: Adjustable housing.

5. Body or Ferrule Material: Cast iron.

6. Outlet Connection: Spigot.

7. Closure: Brass plug with straight threads and gasket or plastic plug and gasket.

8. Adjustable Housing Material: Nickel-bronze with threads.

9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy with scoriated, vandal resistant top.

10. Frame and Cover Shape: Round.

11. Top-Loading Classification: Medium Duty.

12. Carpet Clamping Collar: Required in carpeted areas.

13. Riser: ASTM A 74, Extra-Heavy or Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Heavy Duty Floor Cleanouts (HD CODP):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Mfg. Co.; Division of Smith Industries, Inc.; No. 4220-U-G Series or comparable product by one of the following:

   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Watts Drainage Products Inc.
   d. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M, for adjustable housing cleanouts.

3. Size: Same as connected branch.

4. Type: Adjustable housing.

5. Body or Ferrule Material: Cast iron.

6. Outlet Connection: Spigot.

7. Closure: Brass plug with straight threads and gasket or plastic plug and gasket.

8. Adjustable Housing Material: Galvanized cast iron with threads.

9. Frame and Cover Material and Finish: Galvanized cast iron with scoriated, vandal resistant top.

10. Frame and Cover Shape: Round.

11. Top-Loading Classification: Heavy Duty.

12. Riser: ASTM A 74, Extra-Heavy or Service class, cast-iron drainage pipe fitting and riser to cleanout.

D. Wall Cleanouts (COWP):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Mfg. Co.; Division of Smith Industries, Inc.; No. 4531-U or comparable product by one of the following:

   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Watts Drainage Products Inc.
   d. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M, for cleanouts. Include wall access.

3. Size: Same as connected drainage piping.

4. Body Material: Hubless, cast-iron soil-pipe test tee as required to match connected piping.

5. Closure: Countersunk, drilled-and-threaded bronze plug and gasket.

6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with vandal resistant screw.

E. Exterior Cleanouts (EXT CO):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Mfg. Co.; Division of Smith Industries, Inc.; No. 4251-U Series or comparable product by one of the following:

   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Watts Drainage Products Inc.
   d. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M, for heavy-duty, adjustable housing cleanouts.

3. Size: Same as connected branch.

4. Type: Heavy-duty, adjustable housing with vandalproof top.

5. Body or Ferrule Material: Cast iron.

6. Clamping Device: Required.

7. Outlet Connection: Spigot.

8. Closure: Brass plug with tapered threads.

9. Adjustable Housing Material: Cast iron with threads, set-screws or other device.

10. Frame and Cover Material and Finish: Painted cast iron.

11. Frame and Cover Shape: Round.

12. Top-Loading Classification: Heavy Duty.

13. Riser: ASTM A 74, Extra-Heavy or Service class, cast-iron drainage pipe fitting and riser to cleanout.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains (FD "A"):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Mfg. Co.; No. 2010-A or 2005-A or a comparable product by one of the following:

   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Tyler Pipe; Wade Div.
   d. Watts Drainage Products Inc.
   e. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.6.3.

3. Pattern: Floor drain.

4. Body Material: Gray iron.

5. Outlet: Bottom.

6. Backwater Valve: Not required.

7. Top or Strainer Material: Nickel bronze.

8. Top Shape: Round.

9. Dimensions of Top or Strainer: 7-inch diameter.

10. Trap Features: Trap-seal primer valve drain connection.

B. Cast-Iron Floor Drains (FD "B"):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Mfg. Co.; No. 2250 series or a comparable product by one of the following:

a. Josam Company; Josam Div.
b. MIFAB, Inc.
c. Tyler Pipe; Wade Div.
d. Watts Drainage Products Inc.
e. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.6.3.

3. Pattern: Floor drain.

4. Body Material: Gray iron.

5. Seepage Flange: Not required.

6. Anchor Flange: Required.

7. Clamping Device: Not required.

8. Outlet: Bottom.

9. Sediment Bucket: Removable slotted bucket with lift bar.

10. Top or Strainer Material: Bronze.

11. Top of Body and Strainer Finish: Nickel bronze.

12. Top Shape: Square.

13. Dimensions of Top or Strainer: 14” x 14” square strainer

14. Top Loading Classification: Heavy Duty.

15. Trap Material: Cast iron.

16. Trap Pattern: Deep-seal P-trap.

2.3 FLOOR SINKS

A. Cast-Iron Floor Sinks (FS “A”):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Mfg. Co.; No. 3140-CI-11 or a comparable product by one of the following:

a. Josam Company; Josam Div.
b. MIFAB, Inc.
c. Tyler Pipe; Wade Div.
d. Watts Drainage Products Inc.
e. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.6.3.

3. Pattern: Sanitary drain.

4. Body Material: Gray iron.

5. Seepage Flange: Not required.

6. Anchor Flange: Not required.

7. Clamping Device: Not required.

8. Outlet: Bottom.

9. Backwater Valve: Not required.

10. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel.

11. Strainer: Aluminum domed.

12. Sediment Bucket: Not required.

13. Top or Strainer Material: Nickel bronze.

14. Top of Body Finish: Nickel bronze.

15. Top Shape: Square.

16. Top Loading Classification: Medium Duty.

17. Funnel: Not required.

18. Trap Material: Cast iron.

19. Trap Pattern: Deep-seal P-trap.

2.4 AIR-ADMITTANCE VALVES

A. Fixture Air-Admittance 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. Durgo, Inc.
    b. Oatey.
    c. RectorSeal.
    d. Studor, Inc.

2. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.

3. Housing: Plastic.

4. Operation: Mechanical sealing diaphragm.

5. Size: Same as connected fixture or branch vent piping.

2.5 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.

2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.

2. Size: Same as connected waste piping.

   a. NPS 2: 4-inch-minimum water seal.
   b. NPS 2-1/2 and Larger: 5-inch-minimum water seal.

C. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

D. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

E. Vent Caps:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Thaler Metal Industries Ltd; Model VPC Vandalproof Vent Stack Cap with perforated collar or comparable product by one of the following:

   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Watts Drainage Products Inc.
   d. Zurn Plumbing Products Group; Specification Drainage Operation

2. Description: Vandal-proof, .064” mill finish 1100 0T alloy aluminum vent stack cap with perforated collar, supporting cross member secured with vandal resistant stainless steel mounting screws.

3. Size: Same as connected stack vent or vent stack.

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. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:

1. General Applications: 12 oz./sq. ft..
2. Vent Pipe Flashing: 8 oz./sq. ft..

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B 32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

2.7 SOLIDS INTERCEPTORS

A. Solids Interceptors:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Mfg. Co.; Division of Smith Industries, Inc.; No. 8714ARIO or comparable product by one of the following:

a. Josam Company.
b. MIFAB, Inc.
c. Rockford Sanitary Systems, Inc.
d. Schier Products Company.
e. Tyler Pipe.

f. Watts Drainage Products.
g. Zurn Plumbing Products Group.

2. Type: Factory-fabricated interceptor made for removing and retaining sediment from wastewater.

3. Body Material: Cast iron or steel.

4. Interior Separation Device: Baffles and stainless steel perforated basket.

5. Interior Lining: Corrosion-resistant enamel.

6. Exterior Coating: Corrosion-resistant enamel.

7. Body Dimensions: 12-1/8 inches wide by 12-3/4 inches high.

8. Inlet and Outlet Size: NPS 1 1/2

9. End Connections: Threaded.

10. Mounting: Above floor.

11. Clear space required above unit for basket removal: 4-1/2 inches

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of sanitary drainage and vent piping systems to verify actual locations of specialties installations.
B. Proceed with installation only after unsatisfactory conditions have been corrected.
C. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 INSTALLATION

A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.

2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.

4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

E. Install fixture air-admittance valves on fixture drain piping.

F. Install stack air-admittance valves at top of stack vent and vent stack piping.

G. Install air-admittance-valve wall boxes recessed in wall.

H. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

I. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

J. Install deep-seal traps on floor drains and other waste outlets, if indicated.

K. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

L. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

M. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

N. Install vent caps on each vent pipe passing through roof.

O. Install solids interceptors with cleanout immediately downstream from interceptors that do not have integral cleanout on outlet. Install trap on interceptors that do not have integral trap and are connected to sanitary drainage and vent systems.

P. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.3 CONNECTIONS

A. Comply with requirements in Section 22 13 16 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.4 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, according to Section 07 62 00 "Sheet Metal Flashing and Trim."

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.5 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.

3.6 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 22 13 19

SECTION 22 13 29 - SANITARY SEWERAGE PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Packaged wastewater-pump units.

1.3 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.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 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.

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 PACKAGED WASTEWATER-PUMP UNITS

A. Packaged, Submersible Wastewater-Pump Units:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Liberty Pumps; Model 404 or comparable product by one of the following:

a. ABS Pumps Inc.; Sulzer Corporation.
b. Bell & Gossett Domestic Pump; ITT Corporation.
c. Goulds Pumps; ITT Corporation.
d. Grundfos Pumps Corp.
e. Little Giant Pump Co.
f. McDonald, A. Y. Mfg. Co.
g. Pentair Pump Group; Myers.
h. Sta-Rite Industries, Inc.
i. Zoeller Company.

2. Description: Factory-assembled and -tested, automatic-operation, effluent-pump unit with basin.

3. Pump Type: Submersible, end-suction, single-stage, overhung-impeller, centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.

4. Pump Body and Impeller: Corrosion-resistant materials.

5. Pump Seals: Mechanical.

6. Motor: Hermetically sealed, capacitor-start type, with built-in overload protection.

7. Power Cord: Three-conductor, waterproof cable of length required but not less than 72 inches and with grounding plug and cable-sealing assembly for connection at pump.

8. Control: Float switch.

9. Pump Discharge Piping: Factory or field fabricated, DWV copper.

10. Basin: Watertight plastic with inlet pipe connection and gastight cover with vent and pump discharge connections.

2.2 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

3.1 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of sanitary drainage and vent piping connections before sewage pump installation.

3.2 INSTALLATION

A. Pump Installation Standards:

1. Comply with HI 1.4 for installation of centrifugal pumps.

B. Wiring Method: Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Section 22 13 16 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to equipment to allow service and maintenance.

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.

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.

3.5 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.

3.6 ADJUSTING

A. Adjust pumps to function smoothly and lubricate as recommended by manufacturer.
B. Adjust control set points.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION 22 13 29

SECTION 22 16 23 - NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.

B. Natural-Gas System Pressure within Buildings: 0.5 psig or less.

C. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig, and is reduced to secondary pressure of 0.5 psig or less.

1.5 ACTION SUBMITTALS

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

1. Piping specialties.

2. Corrugated, stainless-steel tubing with associated components.
3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
4. Dielectric fittings.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.
B. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

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

1.8 QUALITY ASSURANCE

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

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

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

D. Regulatory Requirements:

1. Install gas equipment, piping materials and provide testing in accordance with Fuel Gas Code of New York State, applicable American National Standards Institute (ANSI) code and NFPA 54 - National Fuel Gas Code, and rules and regulations of local gas company.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

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

1.10 PROJECT CONDITIONS

A. Interruption of Existing Natural-Gas Service: Refer to “Existing Utility Interruptions” paragraph ofSection 01 12 00 “Multiple Contract Summary-Project Schedule” for requirements associated with interrupting the existing natural gas supply to facilities occupied by the Owner.

1.11 COORDINATION

A. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Section 08 31 13 "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Seamless Steel Pipe: ASTM A106, black steel, Schedule 40, Grade B. ASTM A53 / A53M, black steel, Schedule 40, Type S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.

2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.

3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.

4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

a. Material Group: 1.1.
b. End Connections: Threaded or butt welding to match pipe.
c. Lapped Face: Not permitted underground.
d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

B. Drawn-Temper Copper Tube: Comply with ASTM B 88, Type L.

1. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.

2. Bronze Flanges and Flanged Fittings: ASME B16.24, Class 150.

a. Gasket Material: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
b. Bolts and Nuts: ASME B18.2.1, carbon steel or stainless steel.

3. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of 0.022 inch thick.

C. Annealed-Temper Copper Tube: Comply with ASTM B 88, Type L.

1. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.

2. Flare Fittings: Comply with ASME B16.26 and SAE J513.

   a. Copper fittings with long nuts.
   b. Metal-to-metal compression seal without gasket.
   c. Dryseal threads complying with ASME B1.20.3.

3. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of 0.022 inch thick.

2.2 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.
B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.3 MANUAL GAS SHUTOFF VALVES

A. See "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig.

2. Threaded Ends: Comply with ASME B1.20.1.

3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.

4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.

5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.

6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.

1. CWP Rating: 125 psig.

2. Flanged Ends: Comply with ASME B16.5 for steel flanges.

3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.

4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO INC.; Model T-585-70-UL or comparable product by one of the following:

    a. Jomar International Ltd.
    b. BrassCraft Manufacturing Company; a Masco company.
    c. Conbraco Industries, Inc.; Apollo Div.
    d. Lyall, R. W. & Company, Inc.
    e. McDonald, A. Y. Mfg. Co.
    f. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: Bronze, complying with ASTM B 584.

3. Ball: Chrome-plated bronze.

4. Stem: Bronze; blowout proof.

5. Seats: Reinforced TFE; blowout proof.

6. Packing: Threaded-body packnut design with adjustable-stem packing.

7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.

8. CWP Rating: 600 psig.

9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.

10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Bronze Plug Valves: MSS SP-78.

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

    a. Lee Brass Company.
    b. McDonald, A. Y. Mfg. Co.

2. Body: Bronze, complying with ASTM B 584.

3. Plug: Bronze.

4. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.

5. Operator: Square head or lug type with tamperproof feature where indicated.

6. Pressure Class: 125 psig.

7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.

8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.

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

a. McDonald, A. Y. Mfg. Co.
b. Mueller Co.; Gas Products Div.
c. Xomox Corporation; a Crane company.

2. Body: Cast iron, complying with ASTM A 126, Class B.

3. Plug: Bronze or nickel-plated cast iron.

4. Seat: Coated with thermoplastic.

5. Stem Seal: Compatible with natural gas.

6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.

7. Operator: Square head or lug type with tamperproof feature where indicated.

8. Pressure Class: 125 psig.

9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.

10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.4 MOTORIZED GAS VALVES

A. Electrically Operated Valves: Comply with UL 429.

1. Basis-of-Design Product: Subject to compliance with requirements, provide ASCO Power Technologies, LP; Division of Emerson; Model Series EF8215 or comparable product by one of the following:

a. ASCO.
b. Dungs, Karl, Inc.
c. Eclipse Combustion, Inc.
d. Goyen Valve Corp.; Tyco Environmental Systems.
e. Magnatrol Valve Corporation.
f. Parker Hannifin Corporation; Climate & Industrial Controls Group; Skinner Valve Div.
g. Watts Regulator Co.; Division of Watts Water Technologies, Inc.

2. Pilot operated.

3. Line sized.

4. Body: Aluminum.

5. Seats and Disc: Nitrile rubber.

6. Springs and Valve Trim: Stainless steel.

7. 80-90 V DC, 60 Hz, Class B, continuous-duty molded coil, replaceable.

8. NEMA ICS 6, Type 4, coil enclosure.

9. Explosion proof.

10. Normally closed.

11. Visual position indicator.

12. Solenoid Valve Control Station Assembly:

    a. Face Plate: 12 gauge 304 stainless steel brushed No. 4 Finish on one both sides.
    b. Box: Galvanized steel flush back electrical box.
    c. Fasteners: Vandal resistant, stainless steel, fine thread.
    d. Control Panel: Key switch, mushroom pushbutton switch, normally closed contacts, similar to "No. 216C89" by ASCO.
    e. Relay Panel: 120-volt, 60 Hz with transformer reducing voltage for control of solenoid valve at 80- 90 V DC; similar to "No. 108DIOC" by ASCO.

13. Function:

    a. Control opening and closing of solenoid valve by operating key switch.
    b. De-energize normally closed solenoid valve to shutoff flow of gas in event of control voltage is lost or reduces to approximately 50% of normal value.
    c. De-energize normally closed solenoid valve to shutoff flow of gas when mushroom button is depressed and re-opened with key switch only.
    d. Key is removable when contacts are closed.

2.5 LABORATORY GAS SERVICE FITTINGS

A. Gas Cock – Type “A”: Deck mounted turret with two side outlets located at 90 degrees apart.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Chicago Faucets; a Geberit company; Model 982-VP909CAGCP or comparable product by one of the following:

    a. T & S Brass and Bronze Works, Inc.
    b. WaterSaver Faucet Company.
    c. Zurn Plumbing Products Group.

B. Service Fittings: Provide units that comply with SEFA 7, "Laboratory and Hospital Fixtures - Recommended Practices." Provide fittings complete with washers, locknuts, nipples, and other installation accessories. Include wall and deck flanges, escutcheons, handle extension rods, and similar items.

1. Provide units that comply with "Vandal-Resistant Faucets and Fixtures" recommendations in SEFA 7.
2. Provide units certified for gas service per ANSI Z21.15B-2006/CSA by the Canadian Standards Association.

C. Materials: Fabricated from cast or forged red brass unless otherwise indicated.

D. Finish: Chromium plated.

E. Ball Valves: Chrome-plated ball and PTFE seals. Handle requires no more than 5 lbf to operate. Provide units designed for working pressure up to 75 psig, with serrated outlets with integral ball check.

F. Handles: Provide lever-type handles for ball valves unless otherwise indicated. Lever handle aligns with outlet when valve is closed and is perpendicular to outlet when valve is fully open.

G. Service-Outlet Identification: Provide color-coded plastic discs with embossed identification, secured to each service-fitting handle to be tamper resistant. Comply with SEFA 7 for colors and embossed identification.

2.6 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. Refer to Section 22 05 00 "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

2.7 LABELING AND IDENTIFYING

A. Identify system components. Comply with requirements for identification materials and installation in Section 22 05 53 "Identification for Plumbing Piping and Equipment."
B. Paint: Refer to Section 09 91 00 "Painting" for interior natural-gas piping paint materials and basic installation requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
B. Inspect natural-gas piping according to Fuel Gas Code of New York State to determine that natural-gas utilization devices are turned off in piping section affected.
C. Comply with Fuel Gas Code of New York State requirements for prevention of accidental ignition.

3.3 INDOOR PIPING INSTALLATION

A. Comply with Fuel Gas Code of New York State for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

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

K. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

N. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

O. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.

2. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.

a. Exception: Tubing passing through partitions or walls does not require striker barriers.

3. Prohibited Locations:

a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.

b. Do not install natural-gas piping in solid walls or partitions.

P. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

Q. Connect branch piping from top or side of horizontal piping.

R. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

S. Do not use natural-gas piping as grounding electrode.

T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

V. Install escutcheons for exposed piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

3.4 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.

3.5 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

3.6 HANGER AND SUPPORT INSTALLATION

A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing."

B. Comply with requirements for pipe hangers and supports specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

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

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

D. Install hangers for horizontal drawn-temper copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
2. NPS 1/2 and NPS 5/8: Maximum span, 72 inches; minimum rod size, 3/8 inch.
3. NPS 3/4 and NPS 7/8: Maximum span, 84 inches; minimum rod size, 3/8 inch.
4. NPS 1: Maximum span, 96 inches; minimum rod size, 3/8 inch.

E. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:

1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
2. NPS 1/2: Maximum span, 72 inches; minimum rod size, 3/8 inch.
3. NPS 3/4 and Larger: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.7 CONNECTIONS

A. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

B. Install piping adjacent to appliances to allow service and maintenance of appliances.

C. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment, but before the sediment trap. Install union between valve and appliances or equipment, but after the sediment trap.

D. Sediment Traps: Install tee fitting with threaded capped nipple in bottom to form a drip leg, as close as practical to inlet of each appliance. Install drip leg in a location that is both accessible and serviceable.

3.8 LABELING AND IDENTIFYING

A. Comply with requirements in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for piping and valve identification.

3.9 PAINTING

A. Comply with requirements in Section 09 90 00 "Painting" for painting interior natural-gas piping.

B. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components with factory-applied paint or protective coating.

C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Test, inspect, and purge natural gas according to Fuel Gas Code of New York State and authorities having jurisdiction.

    a. Isolate appliances and equipment prior to conducting pressure test.

    b. The test medium shall be air, nitrogen, carbon dioxide or an inert gas. Oxygen shall not be used.

    c. Leave pipe joints, including welds, exposed for examination during the test.

    d. Isolate the source of pressure before the pressure tests are made.

    e. Measure test pressure with a manometer or with a pressure-measuring device designed and calibrated to read, record or indicate a pressure loss caused by leakage during the pressure test period. Mechanical gauges used to measure test pressures shall have a range such that the highest end of the scale is not greater than five times the test pressure.

    f. Pressure test piping to no less than 1-1/2 times the proposed maximum working pressure, but not less than 30-psig irrespective of delivered gas pressure, for a duration of 2 hours.

C. Natural-gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.11 INDOOR PIPING SCHEDULE

A. Aboveground, branch piping NPS 2 and smaller shall be one of the following:

1. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
2. Annealed-temper, copper tube with wrought-copper fittings and flared joints.
3. ASTM A106 seamless steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping NPS 2 and smaller shall be one of the following:

1. ASTM A106 seamless steel pipe with malleable-iron fittings and threaded joints.
2. ASTM A106 seamless steel pipe with wrought-steel fittings and welded joints.
3. Drawn-temper copper tube with wrought-copper fittings and brazed joints.

C. Aboveground, distribution piping NPS 2 1/2 and larger shall be the following:

1. ASTM A53 / A53M steel pipe with wrought-steel fittings and welded joints.

END OF SECTION 22 16 23

SECTION 22 31 00 - DOMESTIC WATER SOFTENERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Commercial water softeners.
2. Chemicals.
3. Water-testing sets.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, including material descriptions, dimensions of individual components and profiles, rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1. Duplex water softener system.
2. Softener resin.
3. Water testing set.

B. Shop Drawings: For water softening equipment. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.
B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

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

1.6 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. Salt for Brine Tanks: Furnish in same form as and at least four times original load, but not less than 200 lb. Deliver on pallets according to the following:

a. Crystallized Solar Salt: In 40- or 50-lb packages.

2. Store salt on raised platform where directed by Owner. Do not store in contact with concrete floor.

1.7 QUALITY ASSURANCE

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

B. UL Compliance: Fabricate and label water softeners to comply with UL 979, "Water Treatment Appliances."

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water softeners that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures of mineral and brine tanks.

b. Faulty operation of controls.

c. Deterioration of metals, metal finishes, and other materials beyond normal use.

d. Attrition loss of resin exceeding 3 percent per year.

e. Mineral washed out of system during service run or backwashing period.

f. Effluent turbidity greater and color darker than incoming water.

g. Fouling of underdrain system, gravel, and resin with turbidity or by dirt, rust, or scale from water softener or soft water, while operating according to manufacturer's written operating instructions.

2. Commercial Water Softeners, Warranty Period: From date of Substantial Completion.

a. Mechanical and electrical equipment: Eighteen month(s).

1.10 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide six months' full maintenance by skilled employees of water softener Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, cleaning, and adjusting as required for proper water softener operation at rated capacity. Provide parts and supplies the same as those used in the manufacture and installation of original equipment.

PART 2 - PRODUCTS

2.1 COMMERCIAL WATER SOFTENERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Lakeside Water Treatment, Inc.; Model LWTF600-2” Twin or comparable product by one of the following:

1. Fleck Water Softener Company.
2. US Water Systems, Inc.

B. Description: Factory-assembled, pressure-type water softener.

1. Standard: Comply with NSF 61 Annex, "Drinking Water System Components - Health Effects."

2. Configuration: Parallel demand twin unit with two mineral tanks and one brine tank.

3. Mounting: On housekeeping pad.

4. Wetted Components: Suitable for water temperatures from 40 to at least 100 deg F.

5. Mineral Tanks: FRP, pressure-vessel quality.

a. Construction: Non-ASME code, 100% composite seamless fiberglass construction manufactured with an inner shell constructed of high-density polyethylene (HDPE), wound with a continuous fiberglass roving and factory tested prior to shipping. All tanks shall meet the requirements of NSF, UL and WQA.

b. Pressure Rating: 150 psigminimum.

c. Freeboard: 50 percent minimum for backwash expansion above normal resin bed level.

d. Support Legs or Skirt: Constructed of structural steel.

e. Upper Distribution System: Single, point type, fabricated from nonmetallic pipe and fittings.

f. Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from nonmetallic pipe and fittings with individual, fine-slotted, nonclogging plastic strainers, and arranged for even flow distribution through resin bed.

g. Resin: Premium quality, bead-form, 8% cross linked, polystyrene sulfonated cation exchange resin.

6. Controls: Fully automatic; factory wired and factory mounted solid state microprocessor with front panel display, fully adjustable cycle times with 6-cycle control.

a. Adjustable duration of various regeneration steps.
b. Push-button start and complete manual operation.
c. Electric time clock and switch for fully automatic operation, adjustable to initiate regeneration at any hour of day and any day of week or at fixed intervals.
d. Sequence of Operation: Multiport pilot-control valve automatically pressure-actuates main operating valve through steps of regeneration and return to service.
e. Pointer on pilot-control valve shall indicate cycle of operation.
f. Includes means of manual operation of pilot-control valve if power fails.

7. Main Operating Valves: Top mount, hydraulically balanced valve with the following features:

a. Construction: Lead-free brass valve body and Teflon coated piston.
b. Slow opening and closing, non-slam operation.
c. Piston operated, motor driven for positive operation that controls the regeneration cycle and the service valve cycle.
d. Isolated, dissimilar metals within valve.
e. Self-adjusting, internal, automatic brine injector that draws brine and rinses at constant rate independent of pressure.
f. Sampling cocks for soft water.
g. Special tools are not required for service.

8. Flow Control: Automatic, to control backwash and flush rates over wide variations in operating pressure; does not require field adjustments.

a. Meter Control: Each mineral tank is equipped with signal-register-head water meter that produces electrical signal indicating need for regeneration on reaching hand-set total in gallons. Signal will continue until reset.

9. Brine Tank: Combination measuring and wet-salt storing system.

a. Description: Platform type brine system with dry salt storage compartment and saturated brine compartment.

b. Tank and Cover Material: Molded PE, 3/8 inch thick, including a tight fitting cover, brine well, overflow and salt platform.

c. Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawal and freshwater refill and an air check assembly to prevent drawing air into the system at the end of the brine cycle.

d. Size: Large enough for at least four regenerations at full salting.

10. Factory-Installed Accessories:

a. Piping, valves, tubing, and drains.

b. Sampling cocks.

c. Main-operating-valve position indicators.

d. Water meters: Constructed with 30% glass filled Noryl using a polypropylene turbine impeller or paddle wheel, provided to initiate regeneration based on water use to increase salt efficiency and prevent hard water bypass during periods of high water use. The accuracy shall be + or - 3% of reading using a Hall Effect switch.

11. Drain piping limits: Max. 10ft vertical and discharged to an atmospheric floor drain sized to handle the backwash rate of the system. (Max. proven length is 25ft.)

C. Capacities and Characteristics: Refer to Schedules on Drawings.

1. Water Meter Size: 2 NPS.
2. Manifold Pipe Size: 2 NPS.
3. Backwash-to-Drain Pipe Size: 1.5 NPS.
4. Water Consumption: Insert gal./day.
5. Water Demand: 12 hours/day.
6. Minimum Number of Regenerations per Refill: 4.

2.2 CHEMICALS

A. Mineral: High-capacity, sulfonated-polystyrene, ion-exchange resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock.

1. Exchange Capacity: 30,000 grains/cu. ft. of calcium carbonate of resin when regenerated with 15 lb of salt.

2.3 WATER-TESTING SETS

A. Basis-of-Design Product: Subject to compliance with requirements, provide LaMotte Company; Model SMART 2 Colorimeter or comparable product by one of the following:

1. Hach Company.
2. Thermo Fisher Scientific.

B. Description: Manufacturer's standard water-hardness testing apparatus and chemicals with testing procedure instructions. Include metal container suitable for wall mounting and the following features and functions:

1. Light Source: LED/filter setup at 430 nm, 520 nm, 570 nm, 620 nm.
2. Detector: Photodiode.
3. Display: 122 x 32 LCD, 16 x 4 line graphics display.
4. Range: 2 to 2 Absorbance Units (AU).
5. Resolution: 1% FS.
6. Accuracy: 2% FS.
7. CEMark: Yes.
8. Sample Cell: 25 mm round cell, 10 mm square cuvette, 16 mm COD tubes.
9. Power: 9V or AC adapter.
10. Battery Life: 500 tests.
11. Datalogging: RS-232, time and date stamped.
12. Calibration: Factory set.
13. Keypad: 6-button membrane switch.
14. Size: 15 x 8 x 5.5 cm; 6" x 3.25" x 2.5".
15. Weight: 11 ounces.

PART 3 - EXECUTION

3.1 WATER SOFTENER INSTALLATION

A. Equipment Mounting: Install commercial water softeners on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 53 "Miscellaneous Cast-in-Place Concrete."

B. Install brine lines and fittings furnished by equipment manufacturer but not specified to be factory installed.

C. Prepare mineral-tank distribution system and underbed for minerals and place specified mineral into mineral tanks.

D. Install water-testing sets mounted on wall, unless otherwise indicated, and near water softeners.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Section 22 11 16 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where piping is installed adjacent to equipment, allow space for service and maintenance of equipment.

C. Install shutoff valves on raw-water inlet and soft-water outlet piping of each mineral tank, and on inlet and outlet headers.

1. Metal general-duty valves are specified in Section 22 05 23 "General Duty Valves for Plumbing Piping."
2. Exception: Water softeners with factory-installed shutoff valves at locations indicated.

D. Install pressure gages on raw-water inlet and soft-water outlet piping of each mineral tank. Pressure gages are specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."

1. Exception: Water softeners with factory-installed pressure gages at locations indicated.

E. Install a valved bypass in water piping around water softeners.

1. Metal general-duty valves are specified in Section 22 05 23 "General Duty Valves for Plumbing Piping."
2. Water piping is specified in Section 22 11 16 "Domestic Water Piping."

F. Install drains as indirect wastes to spill into open drains or over floor drains.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

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. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Water softeners will be considered defective if they do not pass tests and inspections.

C. 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.

B. Add water to brine tanks and fill with the following form of salt:

1. Commercial Water Softeners: Processed, crystallized solar salt collected from shallow ponds and milled into irregular particles.

C. Sample water softener effluent after startup and at three consecutive seven-day intervals (total of four samples), and prepare certified test reports for required water performance characteristics. Comply with the following:

1. ASTM D 859, "Test Method for Silica in Water."
2. ASTM D 1067, "Test Methods for Acidity or Alkalinity of Water."
3. ASTM D 1068, "Test Methods for Iron in Water."
4. ASTM D 1126, "Test Method for Hardness in Water."
5. ASTM D 1129, "Terminology Relating to Water."
6. ASTM D 3370, "Practices for Sampling Water from Closed Conduits."

3.6 DEMONSTRATION

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

END OF SECTION 22 31 00

SECTION 22 32 00 - DOMESTIC WATER FILTRATION EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Manganese green sand filter system.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, finishes for filters and separators, rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories:

1. Filtration System
2. Filter Media
3. Sodium Hypochlorite Feed System
4. Potassium Permanganate Feed System
5. Spill containment pallet
6. Test kits

B. Shop Drawings: For water filtration equipment. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

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

1.6 MATERIALS MAINTENANCE 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. Spare Diaphragm Valve Rebuild Kits: 4 spare diaphragm valve rebuild kits of each size valves used.

1.7 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of water filtration equipment through one source from a single manufacturer.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
C. Comply with NSF 61 Annex, "Drinking Water System Components - Health Effects," for all components that will be in contact with potable water.

1.8 COORDINATION

A. Coordinate size and location of concrete bases with actual equipment provided.

1.9 WARRANTY

A. In the event of failure or malfunction during the guarantee period, the contractor shall arrange for repair, adjustment, service or replacement of equipment, as required, by a factory authorized service representative. Contractor shall pay all costs associated with such corrective work

B. The manufacturer shall further guarantee that:

1. The loss of mineral through attrition during the first 3 years of operation shall not exceed 3 percent per year.
2. The mineral shall not be washed out of the system during the service run or backwashing period.
3. The turbidity and color of the effluent, by reason of passing through the filtration system, shall not be greater than the incoming water.
4. The underdrain system, gravel and mineral shall not become fouled, either with turbidity or dirt, while operating as noted in manufacturer’s instructions.

C. Commercial Greensand Filter, Warranty Period: From date of Substantial Completion.

1. Mechanical and electrical equipment: Eighteen month(s).

1.10 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide six months' full maintenance by skilled employees of water filtration equipment Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, cleaning, and adjusting as required for proper water softener operation at rated capacity. Provide parts and supplies the same as those used in the manufacture and installation of original equipment.

PART 2 - PRODUCTS

2.1 GREENSAND FILTERS

A. General: Provide a factory assembled, duplex vertical pressure type filter system intended for iron and manganese removal, shipped with manifold piping attached to the filter tank for ease of installation and start up. All equipment and materials shall be supplied in compliance with the specifications as intended for a complete and operational system.

B. Basis-of-Design Product: Subject to compliance with requirements, provide Lakeside Water Treatment, Inc.; Model LWS-L3-4 Triple Dual Media MG Commercial Filter System with Chemical Regeneration or comparable product by one of the following:

1. Marlo Incorporated.
2. Mueller Water Conditioning, Inc.

C. Tank Construction: Electric welded pressure vessels constructed of heavy gauge low carbon steel conforming to non-code construction and designed for 100-psig working pressure and factory tested at 150-psigwith the following features:

1. One 12-by-16-inch manhole in the top head and one 4-by-6-inch hand-hole in the lower side shell.

2. Pipe Connections NPS 2 and Smaller: Threaded according to ASME B1.20.1.

3. Pipe Connections NPS 2-1/2 and Larger: Steel, Class 150 flanges according to ASME B16.5 or grooved according to AWWA C606.

4. Steel legs welded to tank.

5. Sampling taps located on the shell side of the tank at the juncture of the Anthracite cap and Manganese Greensand filter media.

6. Finishes:

a. Internal Finish: ANSI/NSF standard 61 certified, FDA approved epoxy lining of 10-12 DFT mil.
b. Exterior Finish: 6-8 mils DFT ANSI/NSF standard 61 certified, safety blue finish coating.

7. Expansion: The vessels shall be sized to allow 50% expansion during backwash without media loss.

8. Accessories:

a. Pressure gauges: 2-1/2 inch diameter liquid filled with brass wetted parts and stainless steel case on the inlet and outlet of each tank.
b. Sampling cocks: 1/4 inch PVC valves on the inlet and outlet of each tank.
c. Automatic finished water diaphragm valves supplied for each filter.

D. Upper Distributor: Single point baffle constructed of schedule 80 PVC on tanks 42" and smaller.

E. Lower Distributor: Hub and radial design distribution system constructed of high impact PVC with 0.010" slotted SDR laterals including a hide-out preventer and covered with a sub-fill of 1/8 x 1/16 washed gravel.

F. Operating Valves: Nest of individual glass-filled Noryl thermoplastic body diaphragm valves with Buna-N diaphragms, EPDM disc & seals and PVC end connections, slow opening and closing action that is free of water hammer. There shall be no special tools required to service the valves. Valves can be operated either hydraulically or pneumatically.

G. Flow Control: Automatic backwash control that maintains a proper backwash and fast flush flows over a wide variation of operating pressure. Controller shall contain no moving parts, and require no field adjustment.

H. Piping and Fittings: Factory assembled and tested main operating valves and Schedule 80 PVC manifold piping shipped attached to the filter tank for ease of installation and start-up.

I. Control and Regeneration Initiation: Automatic, 12-day electric time clock controller, mounted in a NEMA 4X fiberglass enclosure, fully adjustable to initiate regeneration at any hour of the day and any day of the week, factory wired for single, external electrical connection. System operation shall be continuous with bypass piping and not more than one tank in backwash cycle at same time.

J. Filter Media: Dual-media manganese dioxide coated greensand and anthracite filter bed, consisting of two layers to reduce filter pressure drop, provide deep bed filtration and long filter runs and provide efficient iron, manganese and suspended solids removal.

1. First layer: Hard coal anthracite with an effective size of 0.6 to 0.8mm.
2. Second layer: Manganese greensand with an effective size of 0.3 to 0.35mm.
3. 17 cubic feet manganese greensand with 9 inches anthracite coal cap.
4. Total bed depth: Minimum of 30 inches.

K. Chemical Regeneration System: Manganese greensand requires regeneration with potassium permanganate in order to provide efficient oxidation/filtration of iron and manganese.

1. Basis-of-Design Products: Subject to compliance with requirements, provide products manufactured by Pulsafeeder; an IDEX Corporation or comparable products by one of the following:

    a. Marlo Incorporated.
    b. Mueller Water Conditioning, Inc.

2. In-Line Flow Meter: Pulsafeeder 2" series 10,000 cast brass flow meter with direct multijet high-speed impeller, flanged connections, hermetically sealed contactor, 5 gallons per revolution register and magnetically operated read switches to provide a contact closure proportional to system flow rate.

    a. Supply with (2) two reed capsule assemblies; Pulsafeeder Part No. L9702300-000.

3. Chemical Feed Pumps: Pulsafeeder Model Pulsatron series E plus No. LPK5EA-VTC3-500, 60 gpd maximum, pumping against a maximum of 150 psig with external pacing control and the following features:

   a. PVC pump head, bleed valve, injection valve assembly, foot valve assembly and five-function valve.
   b. Teflon seat and ceramic ball check valve.
   c. Polyethylene tubing.
   d. Stainless steel wall mounting bracket: Pulsafeeder part No. L9902700-000.

4. Chemical Solution Tanks: Pulsafeeder Part No. J40366 polyethylene rigid tank, 55-gallon capacity with graduations on side of tank, heavy-duty cover, draw assembly and eductor for periodic batch regeneration.

5. Agitator/Mixer: Pulsafeeder Part No. 42821-F-M-TE-H/WRD/VYN 115-volt, prewired, totally enclosed, fan cooled, flange mounted mixer with vinyl corrosion resistant coating on stainless steel impeller and shaft.

6. Suction Tube Shield Assemblies: Pulsafeeder Part No. 28655/7019 32” long 1" diameter PVC tube.

7. Chemical Injectors: Pulsafeeder Part No. J61135 (3/4") corporation stop and nozzle assembly to disperse solution into the centerline of pipe for even mixing. Provide saddleblock injection adapter for connection to waterline (refer to plan for pipe size).

8. Flow indicator: Pulsafeeder Part No. U7012309, NSF approved, acrylic body, 100 PSI rating with visual ball indicator.

9. Spill containment pallet: Polyethylene plastic, two chemical tank containment pallet with no drain. Sump capacity to exceed the largest volume of chemical tank volume that is mounted on the pallet. Pulsafeeder Spill Pallets Part # 42422

L. Separate Source Backwash: Provide hardware and programming for separate source backwash water than the service water.

2.2 SOURCE QUALITY CONTROL

A. Before shipping, hydrostatically test greensand filters, to minimum of one and one-half times pressure rating.
B. Prepare test reports.

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 filters.
B. Examine roughing-in for piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls and floors for suitable conditions where filters will be installed.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SAND-FILTER INSTALLATION

A. Install sand-filter tanks on concrete base. Comply with requirements for concrete base specified in Section 03 30 00 "Cast-in-Place Concrete."
B. Prepare sand-filter tank distribution system and underbed for filter media and place specified sand and other media into tanks.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Section 22 11 16 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Make piping connections between water filtration equipment and dissimilar-metal water piping with dielectric fittings. Comply with requirements for dielectric fittings specified in Section 22 11 16 "Domestic Water Piping."

D. Install shutoff valves on feedwater-inlet and filtrate-outlet piping of each water filtration equipment filter and on inlet and outlet headers.

1. Comply with requirements for metal general-duty valves specified in Section 22 05 23 "General Duty Valves for Plumbing Piping."
2. Comply with requirements for plastic valves specified in Section 22 11 16 "Domestic Water Piping."
3. Exception: Water filtration equipment with factory-installed shutoff valves at locations indicated.

E. Install pressure gages on feedwater-inlet and filtrate-outlet piping of each water filtration equipment filter. Comply with requirements for pressure gages specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."

1. Exception: Water filtration equipment with factory-installed pressure gages at locations indicated.

F. Install valved bypass water piping around each water filtration equipment filter.

1. Comply with requirements for metal general-duty valves specified in 22 05 23 "General Duty Valves for Plumbing Piping."
2. Comply with requirements for water piping specified in Section 22 11 16 "Domestic Water Piping."

G. Install drains as indirect wastes to spill into open drains or over floor drains.

3.4 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.5 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, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Domestic water filtration equipment will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service for greensand filters.

1. Complete installation and startup checks according to manufacturer's written instructions.

B. Sample filter filtrate after startup and at three consecutive seven-day intervals (total of four samples), and prepare certified test reports for required water performance characteristics.

3.7 DEMONSTRATION

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

END OF SECTION 22 32 00

SECTION 22 42 16.16 - COMMERCIAL SINKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Sinks.
2. Sink faucets.
3. Supply fittings.
4. Waste fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sinks.

2. Include rated capacities, operating characteristics and furnished specialties and accessories.

a. Sink “A” faucet.
b. Sink “B” faucet.
c. Sink “C” faucet.
d. Sink “D” faucet.
e. Sink “E” faucet.
f. Sink “F” faucet.

B. As-Specified Data: If the product to be incorporated in the Work is as specified by manufacturer name and product designation in this Specification Section, submit the “**As-Specified Verification Form**” (attached to Section 01 33 00 “Submittal Procedures”) for each item listed below; otherwise submit full Product Data for the following:

1. Sink “A” bowl.
2. Sink “B” bowl.
3. Sink “C” bowl.
4. Sink “D” bowl.
5. Sink “E” bowl.
6. Sink “F” bowl.
7. Supply Fittings.
8. Drain Fitting.
9. Offset Drain Fitting.

10. Continuous Waste Fitting.
11. Sink Traps.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted sinks.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sinks and accessories to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Water Conservation:

1. Provide plumbing fixtures complying with applicable provisions of Section 604.4 of the Plumbing Code of New York State.

B. NSF Compliance:

1. NSF/ANSI-61- Drinking Water System Components - Health Effects.
2. NSF/ANSI-372 for lead-free valve materials for potable-water service.

C. Regulatory Requirements: Comply with requirements in 36 CFR Part 1191 – “Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines"; for plumbing fixtures for people with disabilities.

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. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
2. Science Faucet Outlets: Full flow serrated nozzles equal to 75 percent of amount of each type and size science faucet installed.

PART 2 - PRODUCTS

2.1 SINKS

A. Sink “A”: Standard stainless steel, counter mounted, accessible.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay Manufacturing Co; Model No. LRAD2521-55 or comparable product by one of the following:

a. Advance Tabco.
b. Eagle Group; Foodservice Equipment Division.
c. Griffin Products, Inc.
d. Just Manufacturing.

2. Fixture:

a. Standard: ASME A112.19.3/CSA B45.4.

b. Type: Ledge back.

c. Number of Compartments: One.

d. Overall Dimensions: 25 by 21.25 inches.

e. Metal Thickness: 18 gauge / 0.050 inch.

f. Material: Type 304 stainless steel with fully undercoated underside.

g. Compartment:

1) Dimensions: 21 by 15.75 by 5.5 inches.
2) Drain: 3.5-inch opening.
3) Drain Location: Centered, near back of compartment.

3. Faucet(s): Accessible manual type, single-control mixing valve with swing spout. Comply with requirements in “Sink Faucet” Article.

a. Number Required: One.
b. Mounting: On sink fixture ledge, in hole(s) provided.

4. Supply Fittings: Comply with requirements in "Supply Fittings" Article.

5. Waste Fittings: Offset Drain Fitting. Comply with requirements in "Drains" Article.

6. Traps: Sink Trap. Comply with requirements in "Traps" Article.

7. Mounting: On counter with manufacturer recommended sealant.

B. Sink “B”: Large stainless steel, counter mounted, deep bowl.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay Manufacturing Co; Model No. DLR 3122-12 or comparable product by one of the following:

a. Advance Tabco.
b. Eagle Group; Foodservice Equipment Division.
c. Griffin Products, Inc.
d. Just Manufacturing.

2. Fixture:

   a. Standard: ASME A112.19.3/CSA B45.4.

   b. Type: Ledge back.

   c. Number of Compartments: One.

   d. Overall Dimensions: 31 by 22 inches.

   e. Metal Thickness: 18 gauge / 0.050 inch.

   f. Material: Type 304 stainless steel with fully undercoated underside.

   g. Compartment:

      1) Dimensions: 28 by 16 by 11.625 inches.
      2) Drain: 3.5-inch opening.
      3) Drain Location: Centered in compartment.

3. Faucet(s): Accessible manual type, single-control mixing valve with swing spout. Comply with requirements in “Sink Faucet” Article.

   a. Number Required: One.
   b. Mounting: On sink fixture ledge, in hole(s) provided.

4. Supply Fittings: Comply with requirements in "Supply Fittings" Article.

5. Waste Fittings: Drain Fitting. Comply with requirements in "Drains" Article.

6. Traps: Sink Trap. Comply with requirements in "Traps" Article.

7. Mounting: On counter with manufacturer recommended sealant.

C. Sink “C”: Stainless steel, counter mounted, double bowl, accessible.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay Manufacturing Co; Model No. LRAD 3321-55 or comparable product by one of the following:

   a. Advance Tabco.
   b. Eagle Group; Foodservice Equipment Division.
   c. Griffin Products, Inc.
   d. Just Manufacturing.

2. Fixture:

   a. Standard: ASME A112.19.3/CSA B45.4.

   b. Type: Ledge back.

   c. Number of Compartments: Two.

d. Overall Dimensions: 33 by 21.25 inches.

e. Metal Thickness: 18 gauge / 0.050 inch.

f. Material: Type 304 stainless steel with fully undercoated underside.

g. Each Compartment:

1) Dimensions: 13.5 by 16 by 5.5 inches.
2) Drain: 3.5-inch openings.
3) Drain Location: Centered, near back of compartments.

3. Faucet(s): Accessible manual type, single-control mixing valve with swing spout. Comply with requirements in “Sink Faucet” Article.

a. Number Required: One.
b. Mounting: On sink fixture ledge, in hole(s) provided.

4. Supply Fittings: Comply with requirements in "Supply Fittings" Article.

5. Waste Fittings: Offset Drain Fittings and Continuous Waste Fitting. Comply with requirements in "Drains" Article.

6. Traps: Sink Trap. Comply with requirements in "Traps" Article.

7. Mounting: On counter with manufacturer recommended sealant.

D. Sink “D”: Epoxy resin sink with accessible manual type, two-lever-handle mixing valve with restricted swing spout.

1. Fixture: Refer to Specification Section 12 32 16 “Manufactured Plastic-Laminate-Faced Casework” for epoxy resin sink bowls.

2. Faucet(s): Accessible manual type, two-lever-handle mixing valve with restricted swing spout. Comply with requirements in “Sink Faucet” Article.

a. Number Required: One.
b. Mounting: On countertop, in holes provided.

3. Supply Fittings: Comply with requirements in "Supply Fittings" Article.

4. Waste Fittings: PP Sink Outlets. Comply with requirements for chemical resistant waste fittings specified in Section 22 66 00 "Chemical-Waste Systems for Laboratory Facilities."

5. Traps: Sink Trap. Comply with requirements in "Traps" Article.

E. Sink “E”: Accessible epoxy resin sink with single hole, wrist-blade-handle faucet.

1. Fixture: Refer to Specification Section 12 32 16 “Manufactured Plastic-Laminate-Faced Casework” for epoxy resin sink bowls.

2. Faucet(s): Accessible, manual type, single hole, wrist-blade-handle mixing valve science sink faucet. Comply with requirements in “Sink Faucet” Article.

   a. Number Required: One.
   b. Mounting: On countertop, in hole provided.

3. Supply Fittings: Comply with requirements in "Supply Fittings" Article.

4. Waste Fittings: PP Sink Outlets. Comply with requirements for chemical resistant waste fittings specified in Section 22 66 00 "Chemical-Waste Systems for Laboratory Facilities."

5. Traps: Corrosion-Resistant Traps. Comply with requirements for chemical resistant traps specified in Section 22 66 00 "Chemical-Waste Systems for Laboratory Facilities."

F. Sink “F”: Epoxy resin sink with single hole, two-cross-handle faucets.

1. Fixture: Refer to Specification Section 12 32 16 “Manufactured Plastic-Laminate-Faced Casework” for epoxy resin sink bowls.

2. Faucet(s): Manual type, single hole, two-cross-handle mixing valve science sink faucet. Comply with requirements in “Sink Faucet” Article.

   a. Number Required: One.
   b. Mounting: On countertop, in hole provided.

3. Supply Fittings: Comply with requirements in "Supply Fittings" Article.

4. Waste Fittings: PP Sink Outlets. Comply with requirements for chemical resistant waste fittings specified in Section 22 66 00 "Chemical-Waste Systems for Laboratory Facilities."

5. Traps: Corrosion-Resistant Traps. Comply with requirements for chemical resistant traps specified in Section 22 66 00 "Chemical-Waste Systems for Laboratory Facilities."

G. Sink “G”: Epoxy resin sink with single hole, two-cross-handle faucets.

1. Fixture: Refer to Specification Section 12 32 16 “Manufactured Plastic-Laminate-Faced Casework” for epoxy resin sink bowls.

2. Faucet(s): Manual type, single hole, two-cross-handle mixing valve science sink faucet. Comply with requirements in “Sink Faucet” Article.

   a. Number Required: Two.
   b. Mounting: On countertop, in holes provided.

3. Supply Fittings: Comply with requirements in "Supply Fittings" Article.

4. Waste Fittings: PP Sink Outlets. Comply with requirements for chemical resistant waste fittings specified in Section 22 66 00 "Chemical-Waste Systems for Laboratory Facilities."

5. Traps: Corrosion-Resistant Traps. Comply with requirements for chemical resistant traps specified in Section 22 66 00 "Chemical-Waste Systems for Laboratory Facilities."

2.2 SINK FAUCETS

A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for faucet-spout materials that will be in contact with potable water.

B. Sink Faucets: Accessible manual type, single-control mixing valve with swing spout.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay Manufacturing Co; Model LK1000CR or comparable product by one of the following:

a. American Standard America.
b. Bradley Corporation.
c. Chicago Faucets.
d. Delta Faucet Company.
e. Elkay Manufacturing Co.
f. GROHE America, Inc.
g. Just Manufacturing.
h. Kohler Co.
i. Moen Incorporated.
j. Speakman Company.
k. T & S Brass and Bronze Works, Inc.
l. Zurn Industries, LLC; Commercial Brass and Fixtures.

2. Standard: ASME A112.18.1/CSA B125.1.

3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.

4. Body Type: Widespread.

5. Body Material: General-duty, solid brass.

6. Finish: Chrome plated.

7. Maximum Flow Rate: 1.5 gpm.

8. Handle(s): Lever.

9. Mounting Type: Deck, exposed.

10. Spout Type: Swing, shaped tube.

11. Spout Outlet: Aerator.

C. Sink Faucets: Accessible manual type, two-lever-handle mixing valve with restricted swing spout.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Chicago Faucets; Model 201-RSGN8AE3VXKAB or comparable product by one of the following:

a. American Standard America.
b. Bradley Corporation.

c. Delta Faucet Company.
d. Elkay Manufacturing Co.
e. GROHE America, Inc.
f. Just Manufacturing.
g. Kohler Co.
h. Moen Incorporated.
i. Speakman Company.
j. T & S Brass and Bronze Works, Inc.
k. Zurn Industries, LLC; Commercial Brass and Fixtures.

2. Standard: ASME A112.18.1/CSA B125.1.

3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.

4. Body Type: Widespread.

5. Body Material: General-duty, solid brass.

6. Finish: Chrome plated.

7. Maximum Flow Rate: 1.5 gpm.

8. Handle(s): Lever.

9. Mounting Type: Deck, concealed.

10. Spout Type: Restricted swing, gooseneck shaped tube.

11. Spout Outlet: Aerator.

D. Science Sink Faucets: Accessible, manual type, single hole, wrist-blade-handle mixing valve.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Chicago Faucets; Model No. 930-VR317CP-E3-2JKCP or comparable product by one of the following:

a. Delta Faucet Company.
b. GROHE America, Inc.
c. Just Manufacturing.
d. Moen Incorporated.
e. Speakman Company.
f. T & S Brass and Bronze Works, Inc.
g. Zurn Plumbing Products Group.

2. Standard: ASME A112.18.1/CSA B125.1/ADA ANSI/ICC A117.1.

3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.

4. Body Type: Single hole with anti-rotational body deck pin.

5. Body Material: Commercial, solid brass.

6. Finish: Chrome plated.

7. Maximum Flow Rate: 2.2 gpm.

8. Handle(s): Wrist blade, 4 inches.

9. Mounting Type: Deck, exposed.

10. Spout Type: 6-inch rigid gooseneck with integral vacuum breaker.

11. Spout Outlet: Pressure compensating aerator with spout adapter design.

E. Science Sink Faucets: Manual type, single hole, two-cross-handle mixing valve.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Chicago Faucets; Model No. 930-VRCP-E3-2JKCP or comparable product by one of the following:

a. Delta Faucet Company.
b. GROHE America, Inc.
c. Just Manufacturing.
d. Moen Incorporated.
e. Speakman Company.
f. T & S Brass and Bronze Works, Inc.
g. Zurn Plumbing Products Group.

2. Standard: ASME A112.18.1/CSA B125.1.

3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.

4. Body Type: Single hole with anti-rotational body deck pin.

5. Body Material: Commercial, solid brass.

6. Finish: Chrome plated.

7. Maximum Flow Rate: 2.2 gpm.

8. Handle(s): Cross, four arm.

9. Mounting Type: Deck, exposed.

10. Spout Type: 6-inch rigid gooseneck with integral vacuum breaker.

11. Spout Outlet: Pressure compensating aerator with spout adapter design.

F. Science Faucets: Serrated nozzles.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Chicago Faucets; Model No. E7JKCP or comparable product by one of the following:

a. Delta Faucet Company.
b. GROHE America, Inc.
c. Just Manufacturing.
d. Moen Incorporated.
e. Speakman Company.
f. T & S Brass and Bronze Works, Inc.

2. Chrome plated.

3. 3/8 inch - 18 NPSM male inlet.

4. 10 serrations for typical Laboratory Hoses.

2.3 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.

B. Basis-of-Design Product: Subject to compliance with requirements, provide McGuire Manufacturing, Inc. No. LF2167-F or comparable product by one of the following:

1. American Standard America
2. Zurn Industries, LLC; Commercial Brass and Fixtures.

C. Standard: ASME A112.18.1/CSA B125.1.

D. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass escutcheon with set screw.

E. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

F. Operation: Wheel handle.

G. Risers:

1. NPS 1/2.
2. ASME A112.18.6, braided or corrugated stainless-steel flexible hose.

2.4 DRAINS

A. Drain Fitting:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay Manufacturing Co No. LK35 or comparable product by one of the following:

a. Just Manufacturing.
b. Zurn Industries, LLC; Commercial Brass and Fixtures.

2. Standard: ASME A112.18.2/CSA B125.2.

3. Drain: Conical basket strainer with removable stopper and chrome plated brass NPS 1-1/2 by 4-inch tailpiece.

4. Material: Stainless steel body with polished finish.

B. Offset Drain Fitting:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay Manufacturing Co No. LK35L or comparable product by one of the following:

a. Just Manufacturing.
b. Zurn Industries, LLC; Commercial Brass and Fixtures.

2. Standard: ASME A112.18.2/CSA B125.2.

3. Drain: Conical basket strainer with removable stopper and NPS 1-1/2 inch chrome plated brass 90° elbow.

4. Material: Stainless steel body with polished finish.

C. Continuous Waste Fittings:

1. Basis-of-Design Product: Subject to compliance with requirements, provide McGuire Manufacturing, Inc. No. 111C16G17 or comparable product by one of the following:

a. American Standard America.
b. Zurn Industries, LLC; Commercial Brass and Fixtures.

2. Standard: ASME A112.18.2/CSA B125.2.

3. Material: End outlet continuous waste with satin plated cast brass tee, chrome plated 17-gauge seamless brass waste arms, brass tailpiece and cast brass nuts.

4. Size: NPS 1-1/2 by NPS 1-1/2.

2.5 TRAPS

A. Sink Traps:

1. Basis-of-Design Product: Subject to compliance with requirements, provide McGuire Manufacturing, Inc. No. 8912-F or comparable product by one of the following:

a. American Standard America.
b. Zurn Industries, LLC; Commercial Brass and Fixtures.

2. Material: Chrome-plated, two-piece, cast-brass trap and ground-joint swivel elbow, 17-gauge brass tube to wall with cleanout plug. Include chrome-plated brass escutcheon with set screw.

3. Standard: ASME A112.18.2/CSA B125.2.

4. Size: NPS 1-1/2 by 1-1/2.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.
B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.
D. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 INSTALLATION

A. Install sinks level and plumb according to roughing-in drawings.

B. Install supports, affixed to building substrate, for wall-hung sinks.

C. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.

D. Install water-supply piping with stop on each supply to each sink faucet.

1. Install stops in locations where they can be easily reached for operation.

E. Install wall flanges or escutcheons at piping wall penetrations and casework penetrations. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

F. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants" and sink manufacturer's recommendations.

3.3 CONNECTIONS

A. Connect sinks with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.
B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

A. After completing installation of sinks, inspect and repair damaged finishes.
B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
C. Provide protective covering for installed sinks and fittings.
D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 42 16.16

SECTION 22 42 23 - COMMERCIAL SHOWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Individual showers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for showers. Include rated capacities, operating characteristics, and furnished specialties and accessories.

1. Shower “A” cabinet, valve and head.
2. Shower “B” cabinet, valve and head.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For shower faucets to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Water Conservation:

1. Provide plumbing fixtures complying with applicable provisions of Section 604.4 of the Plumbing Code of New York State.

B. NSF Compliance:

1. NSF/ANSI-61- Drinking Water System Components - Health Effects.
2. NSF/ANSI-372 for lead-free valve materials for potable-water service.

C. Regulatory Requirements: Comply with requirements in 36 CFR Part 1191 – “Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines"; for plumbing fixtures for people with disabilities.

1.6 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. Shower Valve Cartridge Assemblies: Equal to 5 percent (but at least one) of amount of each type and size installed.
2. Shower Valve Stem Assemblies: Equal to 5 percent (but at least one) of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 INDIVIDUAL SHOWERS

A. Preassembled Individual Showers (SHR "A"):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Bradley Corporation; Model WS-1WCA-HD-SX20-AKV-ST-RSD-SHV-VS or comparable product by one of the following:

   a. Acorn Engineering Company.
   b. Willoughby Industries, Inc.

2. Description: Factory-fabricated, surface mounted shower cabinet with shower valve, severe service head, recessed soap dish and vandal resistant screws.

3. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016.

4. Material: Type 304 stainless steel, front access.

5. Metal Nominal Thickness: 0.050 inch minimum.

6. Height to Shower Heads: 72 inches.

7. Flow Control: 2.0 gpm.

8. Shower Valve: ASSE 1016 certified, heavy duty pressure balanced mixing valve with hot- and cold-water operation 1/2- inch chrome plated brass stem, tamper resistant brass limit stop, stainless steel piston, and checkstops on inlets.

9. Shower Head: Chrome plated brass arm severe service head with stainless steel wall flange, fixed direction spray pattern adjustable only through orifice with an Allen key.

10. Supplies: NPT 1/2 flexible stainless-steel hoses.

11. Vertical piping shroud: 0.060 inch (1.5 mm) type 304 stainless steel secured to shower top with vandal resistant screws.

B. Accessible, Surface Mounted Shower with Valve on Left/Seat on Right (SHR “B”):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Bradley Corporation; Model HN250-HD-VL/SR-SX-DBS-DCR-DGB-SHV-VS or comparable product by one of the following:

   a. Acorn Engineering Company.
   b. Willoughby Industries, Inc.

2. Description: Factory-fabricated, surface-mounted accessible cabinet shower, with shower valve, severe service head, diverter valve, hand-held shower spray, recessed soap dish, vertical piping shroud, and vandal resistant screws. Less barrier-free seat, grab bar, curtain, rod and hooks.

3. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016.

4. Material: Type 304 stainless steel, front access.

5. Metal Nominal Thickness: 0.060 inch minimum.

6. Height to Shower Heads: 72 inches.

7. Flow Control: 2.0 gpm.

8. Shower Valve: ASSE 1016 certified, heavy duty pressure balanced mixing valve with hot- and cold-water operation 1/2- inch chrome plated brass stem, tamper resistant brass limit stop, stainless steel piston, and check stops on inlets.

9. Shower Head: Chrome plated brass arm severe service head with stainless steel wall flange, fixed direction spray pattern adjustable only through orifice with an Allen key.

10. Hand-Held Shower Spray: Consisting of hand shower with on-off control, a 60” stainless steel flexible hose and post style mounting bracket to hold to shower panel, elevated in-line backflow preventer with quick-disconnect and lever handle diverter valve.

11. Supplies: NPT 1/2 flexible stainless-steel hoses.

12. Vertical piping shroud: 0.060 inch (1.5 mm) type 304 stainless steel secured to shower top with vandal resistant screws.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before shower installation.
B. Examine walls and floors for suitable conditions where showers will be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.
D. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

3.2 INSTALLATION

A. Assemble shower components according to manufacturers' written instructions.

B. Install showers level and plumb according to roughing-in drawings.

C. Install water-supply piping with stop on each supply to each shower faucet.

1. Install stops in locations where they can be easily reached for operation.

D. Install shower flow-control fittings with specified maximum flow rates in shower arms.

E. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheons requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

F. Seal joints between showers and floors and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

3.3 CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
C. Comply with traps and soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Operate and adjust showers and controls. Replace damaged and malfunctioning showers, fittings, and controls.
B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

A. After completing installation of showers, inspect and repair damaged finishes.
B. Clean showers, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
C. Provide protective covering for installed fixtures and fittings.
D. Do not allow use of showers for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 42 23

SECTION 22 45 00 – EMERGENCY PLUMBING FIXTURE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Eyewash equipment.
2. Water-tempering equipment.

1.3 DEFINITIONS

A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.
B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.
C. Tepid: Moderately warm, 60-100 deg F.

1.4 SUBMITTALS, GENERAL

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.

1. Standard, freestanding, self contained eyewash units.
2. Hot-and cold-water, water-tempering equipment – EM TMV “A”.

1.6 INFORMATIONAL SUBMITTALS

A. Product Certificates: Submit certificates of performance testing specified in "Source Quality Control" Article.
B. Field quality-control test reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For emergency plumbing fixtures to include in operation and maintenance manuals.

1.8 QUALITY ASSURANCE

A. ANSI Standard: Comply with ANSI/ISEA Z358.1-2009, "Emergency Eyewash and Shower Equipment."
B. ASSE Standard: Comply with ASSE 1071-2009, "Performance Requirements for Temperature Actuated Mixing Valves for Plumbed Emergency Equipment."
C. NSF Standard: Comply with NSF 61, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.

PART 2 - PRODUCTS

2.1 EYEWASH EQUIPMENT

A. Standard, Freestanding, self-contained Eyewash Units:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Bradley Corporation; No. S19-921 or comparable product by one of the following:

a. Acorn Safety; a division of Acorn Engineering Company.
b. Encon Safety Products.
c. Guardian Equipment Co.
d. Haws Corporation.
e. Speakman Company.
f. WaterSaver Faucet Co.

2. Capacity: Not less than 0.4 gpm for at least 15 minutes.

3. Factory Supplied Storage Tank: 7 gallon, impact resistant plastic tank including stainless steel wall bracket.

4. Spray-Head Assembly: Pull down arm made from chemical resistant plastic with gravity feed system.

5. Mounting: Wall mounted.

2.2 WATER-TEMPERING EQUIPMENT

A. Shower Hot- and Cold-Water, Water-Tempering Equipment – **EM TMV "A"**:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Bradley Corporation; No. S19-2100 or comparable product by one of the following:

a. Armstrong International, Inc.

b. Haws Corporation.
c. Lawler Manufacturing Co., Inc.
d. Speakman Company.

2. Description: Factory-fabricated equipment with thermostatic mixing valve.

a. Thermostatic Mixing Valve: Designed to provide 85 deg F tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus3 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping.

3. Pressure Rating: 125 psig.

4. Type: Exposed-mounted, compact body design, thermostatically controlled, emergency fixture thermostatic 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. Valve Finish: Rough bronze.

9. Piping Finish: Copper.

2.3 TESTING EQUIPMENT

A. Eyewash Test Gauge:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Bradley Corporation; No. 269-1444 or comparable product by one of the following:

a. Acorn Safety; a division of Acorn Engineering Company.
b. Encon Safety Products.
c. Guardian Equipment Co.
d. Haws Corporation.
e. Speakman Company.
f. WaterSaver Faucet Co.

2. Transparent compliance gauge with testing instructions printed on the test gauge and integral 8-inch scale to assist in evaluation of spray pattern height.

3. Illustrations compliant with American National Standard Z358.1-2009.

B. Drench Shower Tester:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Bradley Corporation; No. S19-330ST or comparable product by one of the following:

a. Acorn Safety; a division of Acorn Engineering Company.
b. Encon Safety Products.
c. Guardian Equipment Co.
d. Haws Corporation.
e. Speakman Company.
f. WaterSaver Faucet Co.

2. Heavy-duty, watertight and chemical-resistant nylon funnel with weighted bottom and telescoping aluminum handle.

3. Funnel characteristics:

a. Overall length: 84 inches.
b. Funnel diameter at the top: 15 inches.
c. Funnel diameter at the bottom: 5 inches.

4. 5 gallon plastic bucket not included.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.
B. Proceed with installation only after unsatisfactory conditions have been corrected.
C. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 EMERGENCY PLUMBING FIXTURE INSTALLATION

A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.

B. Install fixtures level and plumb.

C. Fasten fixtures to substrate.

D. Install shutoff valves in water-supply piping to fixtures. Use ball valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping."

E. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Section 22 11 16 "Domestic Water Piping."

F. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."

G. Install trap and waste piping on drain outlet of emergency equipment receptors that are indicated to be directly connected to drainage system. Comply with requirements for waste piping specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

H. Install indirect waste piping on drain outlet of emergency equipment receptors that are indicated to be indirectly connected to drainage system. Comply with requirements for waste piping specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

I. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

3.3 CONNECTIONS

A. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Section 22 11 16 "Domestic Water Piping."

B. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary waste and vent piping. Comply with requirements for waste piping specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

C. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary waste or storm drainage piping.

D. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.4 IDENTIFICATION

A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

B. Install valve function signage on isolation valves serving emergency fixtures. Comply with requirements for identification materials specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.

B. 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. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

E. Testing equipment: Furnish to Owner one (1) emergency eyewash test gauge and one (1) drench shower tester. Obtain signed receipt from Owner and include in Project Manual.

3.6 ADJUSTING

A. Adjust or replace fixture flow regulators for proper flow in accordance ANSI Z358.1 requirements.
B. Adjust equipment temperature settings.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, test and maintain emergency plumbing fixtures in accordance with ANSI Z358.1 requirements.

END OF SECTION 22 45 00

SECTION 22 66 00 - CHEMICAL-WASTE SYSTEMS FOR LABORATORY FACILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Lab waste piping.
2. Piping specialties.

1.3 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.
B. FPM: Vinylidene fluoride-hexafluoro propylene copolymer rubber.

1.4 PERFORMANCE REQUIREMENTS

A. Single-Wall Piping Pressure Rating: 10 feet head of water.

1.5 ACTION SUBMITTALS

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

1. PP drainage pipe and fittings
2. Adapters and transition fittings
3. Corrosion-resistant traps
4. Plastic floor drains
5. Stainless-steel cleanouts
6. PP sink outlets
7. Air admittance valves.

1.6 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

1.7 QUALITY ASSURANCE

A. NFPA Compliance: Comply with NFPA 70, "National Electrical Code."

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store piping and specialties with sealing plugs in ends or with end protection.
B. Do not store plastic pipe or fittings in direct sunlight.
C. Protect pipe, fittings, and seals from dirt and damage.

1.9 PROJECT CONDITIONS

A. Interruption of Existing Chemical-Waste Service: Refer toSection 01 12 00 “Multiple Contract Summary-Project Schedule” for interruption of existing chemical-waste service requirements.

PART 2 - PRODUCTS

2.1 SINGLE-WALL PIPE AND FITTINGS

A. PP Drainage Pipe and Fittings: ASTM F 1412, pipe extruded and drainage-pattern fittings molded, with Schedule 40 dimensions, from PP resin with fire-retardant additive complying with ASTM D 4101; with fusion- and mechanical-joint ends. Refer to

1. Exception: Pipe and fittings made from PP resin without fire-retardant additive may be used for underground installation.

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

a. IPEX Inc.
b. Orion Fittings, Inc.; a division of Watts Water Technologies, Inc.
c. Sloane, George Fischer Inc.
d. Town & Country Plastics, Inc.
e. Watts Industries (Canada) Inc.
f. Zurn Plumbing Products Group; Chemical Drainage Systems.

B. Adapters and Transition Fittings: Assemblies with combination of clamps, couplings, adapters, and gaskets; compatible with piping and system liquid; made for joining different piping materials.

2.2 JOINING MATERIALS

A. Couplings: Assemblies with combination of clamps, gaskets, sleeves, and threaded or flanged parts; compatible with piping and system liquid; and made by piping manufacturer for joining system piping.

B. Adapters and Transition Fittings: Assemblies with combination of clamps, couplings, adapters, gaskets, and threaded or flanged parts; compatible with piping and system liquid; and made for joining different piping materials.

C. Flanges: Assemblies of companion flanges and gaskets complying with ASME B16.21 and compatible with system liquid, and bolts and nuts.

D. Solvent Cement for Joining CPVC Piping: ASTM F 493. Solvent Cement must be "LOW VOC" type complying with section 1.6 (B) of this specification.

2.3 PIPING SPECIALTIES

A. Corrosion-Resistant Traps:

1. Type: P-trap or jar trap.
2. Size: NPS 1-1/2 or NPS 2, as required to match connected piping.
3. High-Silicon Iron: ASTM A 861, with horizontal outlet and hub-and-plain or plain ends to match connecting piping.
4. PP: ASTM D 4101, with mechanical-joint pipe connections.
5. Glass: ASTM C 1053, with coupling pipe connections.
6. CPVC: ASTM F2618, with mechanical-joint pipe connection to sink tailpiece and solvent cement connection to drainpipe.

B. Plastic Floor Drains – LAB FD:

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. IPEX Inc.
    b. Orion Fittings, Inc.; a division of Watts Water Technologies, Inc.
    c. Schier Products Company.
    d. Sloane, George Fischer Inc.
    e. Town & Country Plastics, Inc.
    f. Watts Industries (Canada) Inc.

2. Body: With 7- to 9-inch top diameter, with flashing flange, weep holes; and with basket strainer and trap-primer connection. Drain body shall be same material as the piping system.

3. Outlet: Bottom, to match connecting pipe, with NPS 2, NPS 3 or NPS 4 outlet as indicated.

C. PP Sink Outlets:

1. Description: NPS 1-1/2, with clamping device, stopper, and 7-inch-high overflow fitting.

D. Chemical Resistant Air-Admittance 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. Studor, Inc.; Chem-Vent.

2. Standard: ASSE 1049.

3. Housing: Flame retardant polypropylene.

4. Operation: Mechanical sealing diaphragm.

5. Size: Same as connected fixture or branch vent piping.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Chemical-Waste Piping Inside the Building:

1. Install piping next to equipment, accessories, and specialties to allow service and maintenance.

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

3. Flanges may be used on aboveground piping unless otherwise indicated.

4. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

5. 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.

6. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

7. Install piping at indicated slopes.

8. Install piping free of sags and bends.

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

10. Verify final equipment locations for roughing-in.

11. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

12. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

13. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

3.2 PIPING SPECIALTY INSTALLATION

A. Embed floor drains in 4-inch minimum depth of concrete around bottom and sides. Comply with requirements in Section 03 30 53 "Miscellaneous Cast-in-Place Concrete" for concrete.

B. Fasten grates to drains if indicated.

C. Set floor drains with tops flush with pavement surface.

D. Install cleanouts and riser extension from sewer pipe to cleanout at grade. Use fittings of same material as sewer pipe at branches for cleanouts and riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in pipe.

1. Set cleanout bodies in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade. Set cleanout plugs in concrete pavement with tops flush with pavement surface. Comply with requirements in Section 033000 "Cast-in-Place Concrete" for formwork, reinforcement, and concrete requirements.

3.3 JOINT CONSTRUCTION

A. Chemical-Waste Piping Inside the Building:

1. Plastic-Piping, Electrofusion Joints: Make polyolefin drainage-piping joints according to ASTM F 1290.
2. Plastic-Piping, Mechanical Joints: Make polyolefin drainage-piping joints according to ASTM F 1290.
3. Join dissimilar pipe materials with adapters compatible with pipe materials being joined.

3.4 HANGER AND SUPPORT INSTALLATION

A. Pipe sizes in this article refer to aboveground, single-wall piping.

B. Comply with requirements in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices. Install the following:

1. Vertical Piping: MSS Type 8 or MSS Type 42, riser clamps.

2. Individual, Straight, Horizontal Piping Runs:

a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.

3. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Comply with requirements in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment" for installation of supports.

D. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

E. Support vertical piping and tubing at base and at each floor.

F. Rod diameter may be reduced 1 size for double-rod hangers, to minimum of 3/8 inch.

G. Install vinyl-coated hangers for PP piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2: 33 inches with 3/8-inch rod.
2. NPS 2-1/2 and NPS 3: 42 inches with 1/2-inch rod.
3. NPS 4: 48 inches with 5/8-inch rod.

H. Install supports for vertical PP piping every 72 inches.

I. Support piping and tubing not listed above according to MSS SP-69.

3.5 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Make connections to existing piping so finished Work complies as nearly as practical with requirements specified for new Work.

C. Use commercially manufactured wye fittings for sewerage piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.

D. Protect existing piping to prevent concrete or debris from entering while making connections. Remove debris or other extraneous material that may accumulate.

E. Install piping adjacent to equipment to allow service and maintenance.

3.6 LABELING AND IDENTIFICATION

A. Comply with requirements in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for labeling of equipment and piping.

1. Use detectable warning tape over ferrous piping.

2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.7 FIELD QUALITY CONTROL

A. Inspect interior of sewerage 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 inspection points.

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. Crushed, broken, cracked, or otherwise damaged piping.

d. Hydrostatic Tests for Drainage Piping:

1) Close openings in system and fill with water.
2) Purge air and refill with water.
3) Disconnect water supply.
4) Test and inspect joints for leaks.

e. Air Tests for Drainage Piping: Comply with UNI-B-6.

2. Leaks and loss in test pressure constitute defects that must be repaired.

3. Submit separate reports for each test.

B. Replace leaking sewerage piping using new materials, and repeat testing until leakage is within allowances specified.

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

D. 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.

E. Tests and Inspections:

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect assembled neutralization systems and their installation, including piping and electrical connections, and to assist in testing.

2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

F. Chemical-waste piping will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

3.8 CLEANING

A. Use procedures prescribed by authorities having jurisdiction or, if not prescribed, use procedures described below:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Clean piping by flushing with potable water.

3.9 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used in applications below unless otherwise indicated.

B. Exposed Chemical-Waste Piping in Casework: Use the following piping materials for each size range:

1. NPS 1-1/2 to NPS 2: PP drainage piping and mechanical joints.

C. Aboveground Chemical-Waste Piping: Use the following piping materials for each size range:

1. NPS 1-1/2 to NPS 6: PP drainage piping and electrofusion joints.

D. Under Slab-on-Grade, Indoor, Chemical-Waste Piping: Use the following piping materials for each size range:

1. NPS 1-1/2 to NPS 6: PP drainage piping and electrofusion joints.

END OF SECTION 22 66 00

SECTION 23 01 20 – HYDRONIC SYSTEMS CLEANING AND WATER TREATMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Flushing, cleaning, filling, venting and treatment of hydronic piping distribution systems (heating and /or cooling systems with and without glycol).

B. Flushing, cleaning, venting, and filling of hydronic systems includes but is not limited to flushing and cleaning of all new piping distribution systems and all existing piping distribution systems that are extended or connected to as part of this project, unless noted otherwise on drawings. Perform all work under the direction of a qualified Water Treatment Services Company (WTSC).

C. Initial water analysis and chemical treatment of hydronic systems as described below, provided complete by an approved WTSC.

D. After systems have been proven clean, final filled, initial chemical treatment of system has been performed, and system is turned over in proper condition and accepted as such by Owner, then, subsequent chemical treatment of hydronic systems will be provided by Owner.

1.3 SUBMITTALS

A. Qualification Data: Submit name, qualifications, and references of WTSC.

B. Closeout Submittals for inclusion in Operations and Maintenance Manual:

1. System Cleaning Report: Provide report on initial system cleaning and treatment including copies of strainer cleaning log books, system fill volume, makeup water and system water test results, chemicals used (type and volume/mass), recommended and final chemical concentrations, and other pertinent water quality data as required to maintain system in optimum condition.

2. Operation and Maintenance Data: Include all instructions for maintenance, cleaning, and ongoing chemical treatment of hydronic systems in project maintenance manuals.

1.4 QUALITY ASSURANCE

A. Water Treatment Services Company (WTSC) Qualifications: A company with minimum 5 years documented successful experience specializing in cleaning and chemical treatment of HVAC piping systems of comparable or greater size and complexity as required on this project, that is capable of analyzing water qualities, installing water-treatment equipment, and applying chemicals and other water treatment as specified in this Section.

PART 2 - PRODUCTS

2.1 TREATMENT CHEMICALS

A. Provide approved system treatment chemicals as directed by water treatment services company.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping distribution systems, both new piping installed in this project and existing piping on the affected systems.

1. Look for automatic and manual vents at end of all horizontal piping runs before elevation drop. Provide additional vents as required for proper air elimination.

2. Look for system connection ports to provide for filling, draining, and circulation of piping. Provide additional valves and connections as required.

3. Look for isolation valves as required to isolate those portions of the system not needing cleaning and treatment. Provide additional valves as required and isolate those portions of the system not being cleaned.

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

C. Beginning cleaning constitutes Contractor’s acceptance of systems and conditions.

3.2 PREPARATION AND PROTECTION OF SYSTEMS

A. At all times from beginning of cleaning of water systems until final acceptance by Owner, provide free oxygen removal and chemical treatment of hydronic systems to protect system components against internal corrosion (or additional corrosion in the case of existing piping and boilers).

1. Do not fill hydronic-heating systems until firing equipment is operable and all aspects of installation are prepared for startup. Do not subject any system to water that has not been de-oxygenated for periods longer than 4 hours. Provide approved de-oxygenation strategy as required to remove free oxygen and prevent corrosion of existing boilers, pumps, other system components, and piping.

a. Heating water to provide for de-oxygenation of heating systems will be an acceptable procedure. Provide heated water to remove free oxygen and prevent corrosion and premature failure of existing boilers and piping. Coordinate with Owner to start boilers and pumps immediately upon filling and proceed to heat system water to at least 190 deg. F while circulating entire system at temperature for at least two hours and actively venting air.

2. Provide services of approved WTSC to perform the following:

a. Obtain and coordinate with hydronic equipment manufacturers' published water quality guidelines as required to maintain equipment warrantees. Include copy of this data in report.

b. Test existing system water and make-up water prior to and during system flushing, cleaning, and venting and prescribe proper water treatment to clean system and maintain boiler, piping, controls, and all other hydronic specialties' warrantees and prevent corrosion or deterioration (further corrosion or deterioration in the case of existing systems) of entire hydronic system due to oxygen, acid, scaling, or other water related problems. Consider and report on the following characteristics at a minimum, and recommend acceptable range of values for this project's systems individually, using specified values as a starting point only:

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 100 ppm.

5) Soluble Copper: Maximum 0.20 ppm.

6) Tolyiriazole Copper, Yellow Metal Corrosion Inhibitor: Minimum 10 ppm.

7) Total Suspended Solids: Maximum 10 ppm.

8) Ammonia: Maximum 20 ppm.

9) Free Caustic Alkalinity: Maximum 20 ppm.

10) Reserve Alkalinity:

11) Corrosion Inhibitor, any of the below or as recommended by WTSC:

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.

12) Microbiological Limits:

a) Total Aerobic Plate Count: Maximum 1000 organisms/ml.
b) Total Anaerobic Plate Count: Maximum 100 organisms/ml.
c) Nitrate Reducers: 100 organisms/ml.
d) Sulfate Reducers: Maximum 0 organisms/ml.
e) Iron Bacteria: Maximum 0 organisms/ml.

c. Provide prescribed ingredients and maintain proper water conditions until acceptance of system. Turn over in Manufacturers' approved condition.

d. Provide certified portion of system cleaning and treatment report including manufacturer's requirements, water quality test data and recommendations, prescription chemical recommendations and data sheets, treatment schedule, and proposal for continued treatment contract for first year following system acceptance.

3.3 DRAINING, FILLING, FLUSHING, VENTING, AND CLEANING

A. Draining:

1. Drain systems completely so as to avoid cross contamination of one process fluid with the next.
2. Install additional drains if necessary to completely drain system. Note that drain valves are required on all new piping low points.
3. Legally dispose of all drainage.

B. Filling and Venting:

1. Fill and vent each entire system, including portions of existing systems connected to but not modified by this Project, as required leaving entire system in a properly filled, chemically treated, air-free condition.

2. Fill slowly with appropriate fluid for process planned (clean water for initial flushing, system cleaning solution for system cleaning, chemically treated water for final fill, etc.) while operating manual and automatic vents to purge air from system.

3. Vent all air from hydronic systems. Open all manual vents repeatedly to relieve air and test operation of all main and branch automatic air eliminators and vents. Repair and/or replace all malfunctioning vents.

4. Purge systems section by section to remove residual air. Isolate piping sections and purge fluid through each section slowly in direction of normal flow to force air to vent connections without forcing air down risers.

5. Install additional air vents as required to fully vent system. Note that air vents are required at all new piping high points and before drops. Note locations where residual air pockets tend to remain in pre-project existing piping and install additional air vents as necessary to remove remaining air.

6. Repeat purging and venting as necessary to remove all air from each system.

7. When final venting is complete, close manual valves serving automatic air vents to prolong automatic vent service life.

C. Flushing:

1. Flush each entire system, including portions of existing systems connected to, but not modified by, this Project.

2. Flush all piping with clean water at flow rate required to produce local pipe velocity of not less than 10 feet per second. Section by section flushing as required to achieve this velocity is required.

3. Note existing strainers will likely become clogged repeatedly during this phase of system operation. Repeatedly clean strainers as described below as required to maintain unobstructed flow. Strainer Cleaning:

a. Remove, clean, and reinstall all strainer screens during and after flushing and venting (including screens of existing system strainers). Record strainer screen contents in log book. Repeat after a 2-week operating period connected to main system pumps.

b. Insure all pump suction diffusers, if present, have fine mesh start-up screens prior to filling system. Remove and clean all pump suction diffuser screens whenever the pressure drop across screen is double the pressure drop of a clean screen and after 2-week operating period. Record strainer screen contents in log book.

c. Reinstall strainer screens after cleaning. Reinstall fine mesh suction diffuser start-up screens each time they contain significant debris upon removal.

d. Purge and vent all air from the systems introduced as a result of strainer cleaning.

e. Submit strainer-cleaning report as detailed for cleaning report submittal.

4. Provide approved de-oxygenation strategy.

5. Test for and repair all leaks.

6. After each system has operated at full temperature for 2-week period and all leaks have been repaired, vent each system as specified above. Purge each system as specified above if necessary.

D. Cleaning: After each hydronic system has been leak-tested, flushed, and vented, clean system as specified below. Do not use system for temporary heat or submit for acceptance and use by Owner prior to cleaning. Do not operate pumps continuously or unattended until system is flushed and strainers cleaned. Notify Owner's Project Representative before starting cleaning.

1. Cleaning Procedures:

a. Clean all air vents, gauge glasses, control valves, etc. and ensure free operation.

b. Provide cleaning compound of sodium carbonate and trisodium phosphate, in proportions of 1lb of chemical per 50 gallons of water or as recommended specifically by WTSC and system equipment manufacturers. Mix chemicals with water and introduce into the system per equipment manufacturer's and water treatment service companies instructions, filling entire system with cleaning solution. Provide temporary meter or other means (calculated volume acceptable) of determining amount of water in system. Provide all necessary valves, fill pipe, and similar components.

c. Operate existing pumps and control system with control valves open. Circulate solution for heating system at 180 Deg. F. for at least 24 hours. Flush and vent system as required during cleaning. Remove and clean air vents, strainers, filters, and check valves, and replace improperly functioning components. Blow down solids separators, sumps, and all system low points where sediment might accumulate.

d. After cleaning and blow down, circulate for additional 8 hours, then clean strainers, filters, and low point blow down locations again; repeat until strainers and filters are found clean, and initial solution taken from any blow down location is clean.

e. Drain, flush cleaning solution with clean water, and legally dispose of drainage.

f. Refill with clean deoxygenated water.

2. Test for Cleanliness:

a. Circulate for additional 24 hours and take water sample to test for cleanliness from any system low point drain or blow down valve selected by Architect or Owner by filling quart sample bottle with initial drainage included and allowing sample to settle for 12 hours. Check for floating and settled impurities. Water is considered clean if no impurities can be observed in drawn samples, and 5-micron side stream filter bag remains nominally clean after 24 hours full flow circulation. Draw samples in presence of Architect and turn over to Owner to confirm cleanliness.

b. Drain and repeat the starting up procedure and cleanliness test as often as required to pass "Test for Cleanliness".

3.4 FINAL FILLING OF WATER PIPING SYSTEMS

A. Water Hydronic Systems: Thoroughly purge and vent approved cleaned system. Provide prescribed chemical treatment and turn over in manufacturers' approved condition.

END OF SECTION 23 01 20

SECTION 23 05 00 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Definitions, references, and abbreviations.
2. General regulatory requirements.
3. General requirements regarding site/field conditions including existing conditions and field measurements.
4. Sequencing and scheduling including coordination.
5. Definition of design equipment and procedures for consideration of specified equivalents, proposed equivalents, or substitutions.
6. HVAC demolition.
7. Equipment installation requirements common to equipment sections.
8. Minimum material requirements and equipment verification.
9. Electrical components for HVAC Work
10. Concrete bases and grout.
11. Mechanical penetrations, waterproofing, and sealants.
12. Fire-stopping
13. Access doors
14. Painting and finishing.
15. General requirements for demonstration of completed systems

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. "Design Equipment", "Design Make", "Basis of Design", and similar terms: Equipment, specified in Technical Specification Section or on Contract Drawings using applicable manufacturer's designation, that forms the basis for performance requirements, physical dimensions, configuration, and similar aspects used in the design of this Project including (but not limited to) physical configuration of surrounding construction and location of connections to other components.

G. Specified Equivalents: Products identified in Technical Specification Section that may provide performance complying with specified requirements but may not have the same arrangement, configuration, size, construction, or other aspects as the specified Design Equipment. Refer to Section 00 21 13 - Instructions to Bidders, and Section 01 25 00 – Substitution Procedures for additional information and requirements regarding equivalents and substitutions.

H. "Equivalents", "Proposed Equivalents", "Proposed Products" and similar terms: These terms may be used interchangeably and mean the same thing: Products NOT identified in Technical Specification Section that the Contractor proposes in accordance with Section 00 21 13 - Instructions to Bidders and Section 01 25 00 – Substitution Procedures.

I. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor, all in accordance with Section 01 25 00 – Substitution Procedures.

J. Heating Work: Refers to Heating, Ventilating and Air Conditioning Systems and Equipment where used in technical specification sections of Division 23.

K. Plumbing Work: Refers to Plumbing and Gas Fitting Work where used in technical specification sections of Division 22.

1.4 ABBREVIATIONS

A. Abbreviations: Reference to technical society, organization, body or section made in Division 23 in accordance with the following abbreviations:

1.	AIA	American Institute of Architects
2.	ADA	Americans with Disabilities Act.
3.	AMCA	Air Movement and Control Association International, Inc.
4.	ANSI	American National Standards Institute
5.	ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
6.	ASME	American Society of Mechanical Engineers International
7.	ASTM	American Society for Testing and Materials International
8.	AWS	American Welding Society
9.	IBC	International Building Code, New Jersey Edition
10.	IEEE	Institute of Electrical and Electronics Engineers, Inc.
11.	NEC	National Electric Code
12.	NEMA	National Electrical Manufacturers Association
13.	NFPA	National Fire Protection Association

14. NYBFU New York Board of Fire Underwriters
15. SMACNA Sheet Metal and Air Conditioning Contractors National Association
16. UL Underwriters Laboratories Inc.

1.5 SYSTEM DESCRIPTION

A. Provide complete systems, properly connected, tested, balanced, adjusted, and ready for operation, including all necessary and required controls, safeties, details and accessories, including (but not limited to):

1. Demolition and removals required for equipment and system installation.
2. Piping systems and related equipment.
3. Refrigeration systems and related equipment.
4. Ventilation systems and related equipment.
5. Support Systems and related equipment.
6. Insulation Systems and related equipment.
7. Miscellaneous items required for equipment and system installation.
8. Controls and electrical control wiring to equipment furnished in this contract.
9. Electrical power wiring to equipment furnished in this contract, where not covered elsewhere.

B. HEATING WORK DRAWINGS ARE DIAGRAMMATIC. Do not infer that Drawings show level of detail indicating every offset, elbow, union, fitting, elevation or aspect ratio changes, or other details required for complete installation.

1. Provide all required fittings, offsets, elevation changes, dampers, controls, components, and similar items not indicated on Drawings, as required for a complete properly operational system.

1.6 SUBMITTALS

A. General Division 23 submittal requirements:

1. Procedural Requirements: Comply with requirements of SECTION 01 33 00 - Submittals and as modified below.

a. Specified Products: If product to be incorporated into Project is specified by name and product designation in Part 2 of product specification, and will be installed as specified in Part 3, and only where allowed as such in submittal portion of product specification, then submit “As-Specified Verification Form” (attached to SECTION 01 33 00 - Submittals) in lieu of “Product Data” identified.

b. Do not use “As Specified Verification Form” unless specifically indicated in detailed product specification.

c. Equivalent Products or Substitutions: If product to be incorporated into Project is <u>not</u> specified by name and product designation in Part 2 below, comply with all Product Data requirements specified.

2. Product Data: Submit Product Data for items listed in individual technical section. Clearly identify manufacturer, pertinent design, function, materials, construction, and performance data specifically addressing specification description and Contract Document requirements of item. Strike out products that are not applicable to item being submitted, where more than one product is indicated on manufacturer product literature.

    a. Cover Sheet: Attach cover sheet, identified in Section 01 33 00, to Product Data of each item submitted. Provide cover sheet for only one type of item with related accessories, equipment with related components. Do not combine unrelated items under same cover sheet.

    b. Specified Equivalent Product Data: Submit manufacturer's product information including product literature, technical specifications and descriptions, performance data, and similar items to demonstrate compatibility with Basis-of-Design Equipment as specified in "Manufacturers" in Part 2 - Products below.

3. Coordination Drawings: Prepare Coordination Drawings in timely manner to comply with overall construction schedule. Refer to Sections 01 31 00 and 01 33 00 for more details.

    a. Prepare drawings coordinating HVAC systems, lighting fixtures, ceiling mounted devices, ceiling heights, materials, structural work, maintenance clearances, electric code clearance, building systems, existing construction, etc. Provide additional details and sections, as required for clarity, at all places of potential conflict.

    b. Deliver Coordination Drawings in accordance with requirements specified in Section 01 31 00. Indicate areas of conflicts between HVAC systems and other building components by highlighting locations on drawings and separately listing.

    c. Reposition proposed locations of HVAC systems as required to work within project constraints. Adjust exact size, aspect ratio, location and offsets of ducts and pipes as required. Achieve as specified and other reasonable appearance objectives in open areas without ceilings without increase in Contract Sum.

    d. Review of Coordination Drawings in accordance with Section 01 31 00 does not relieve Contractor from responsibility for coordinating HVAC systems with Project work, nor does it authorize extra cost, omission or deviation from Contract Document requirements. Costs arising from errors or omissions in Coordination Drawings shall be borne by Contractor.

    e. Review Coordination Drawings and compare them with all other drawings to verify that all Work can be installed without interference. Notify Owner's Project Representative in case of unresolved interferences prior to installation of any work. Revise Coordination Drawings as required to eliminate installation interferences upon direction of Architect.

4. Do not proceed with installation of systems in each area until agreement is reached with all concerned on exact arrangements for each room or area, unless otherwise directed by Architect. If Contractor proceeds prior to resolving conflicts, Contractor shall modify installed Work as required to permit other systems to proceed with a coordinated installation.

5. Specified Equivalent Drawings: Submit detailed drawings of proposed Specified Equivalents, indicating proposed installation of equipment and showing maintenance clearances, required service removal space, and other pertinent revisions to arrangement and configuration shown in Contract Documents.

6. Closeout Information, for inclusion in Operations and Maintenance Manual:

   a. Approved submittals.

      1) If "As-Specified Verification Form" submittal is approved, also include product data as specified in technical section for all components used.

   b. Include all information required in SECTION 01 78 23 – Operation and Maintenance Data.

   c. Include all other closeout information required by the individual technical specification sections.

B. Shop Drawings: Include dimensioned plans, sections, and attachments to other work for concrete bases.

C. Welding Quality Control Submittals

1. When welded or brazed work is required or proposed as a part of this project, submit following for approval before beginning any welding or brazing work:

   a. Welding and Brazing Procedure Qualification: Prepare and submit for approval welding and brazing procedure qualification specification qualifying all proposed procedures as specified in Quality Assurance below with copies of all back-up data.

   b. Welders' and Brazers' Certification: Submit for approval certification that each proposed welder, welding operator, brazer, or brazing operator has been qualified in all procedures proposed for that worker as specified in Quality Assurance below with copies of all back-up data.

D. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

1. Power Train Accessories
2. Concrete Bases, Grout
3. Sealants
4. Fire-stopping.
5. Access doors.
6. Painting and finishing.

E. Samples:

1. Submit color chart with paint manufacturer's color samples for final color selections prior to beginning painting. Comply with additional requirements for color selection samples specified in Division 09.

F. Closeout Information, for inclusion in Operations and Maintenance Manual:

1. Approved submittals.

a. If "As-Specified Verification Form" submittal is approved, also include product data for all components used.

2. Include all information required in SECTION 01 78 23 – Operation and Maintenance Data.

3. Letters on manufacturer's letterhead from equipment manufacturers certifying that their equipment and systems have been installed in strict accordance with manufacturer's recommendations, properly aligned and adjusted, tested, lubricated, wired, balanced, etc.

4. Lubrication, Filter, and Belt / Drive charts as described below.

1.7 QUALITY ASSURANCE

A. Regulatory Requirements

1. Comply with applicable requirements of all Federal, New York State, and Local Building, Health, Mechanical, Plumbing and Electrical Codes, Laws, Ordinances and Regulations, including (but not limited to):

a. Building Code of New York State
b. Mechanical Code of New York State
c. Fire Code of New York State
d. Energy Conservation Construction Code of New York State
e. New York State Education Department Manual of Planning Standards
f. In event of a conflict between the Codes identified above and Contract Documents, comply with more stringent requirement.

2. Comply with applicable requirements of NFPA, utility company regulations, and following standards:

a. Provide Underwriters Laboratories (UL) labels on all electrical materials carrying 50 volts or more.
b. Provide refrigeration equipment complying with Safety Code for Mechanical Refrigeration (ASHRAE Standard 15 - and ANSI Refrigeration Safety Code B9.1).

B. Certifications: Obtain and pay for all necessary inspections and certificates from all applicable agencies. Perform all required tests in accordance with regulation of agency having jurisdiction. Submit certificates of approval prior to Final Completion as defined in Section 01 77 00 – Closeout Procedures. Submit certificates of approval prior to request for final acceptance of Contract.

C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

D. Welding Quality Control for General Construction and Support Work:

1. This paragraph refers to qualifications for General Construction and Support Work welding only. Qualify welders, brazers, and any welding or brazing procedure to be used on piping for this Project in accordance with ASME "Boiler and Pressure Vessel Code", Section IX, as specified and detailed in Section 23 21 13 - HYDRONIC PIPING.

2. Welding and Brazing Procedure Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel." Qualification may by made by technically competent group or agency (subject to approval) meeting the following conditions:

   a. Group or agency qualifying the procedure meets all procedure qualification requirements of AWS D1.1/D1.1M, "Structural Welding Code - Steel.".

   b. Contractor accepts full responsibility for procedure qualified.

   c. Contractor has qualified at least one welder or welding operator using procedure qualified and provides record of qualification.

   d. Contractor accepts full responsibility for qualified procedures by signing related qualification records with procedure and performance qualifications including all dates, results, and associated data.

3. Welders' and Brazers' Qualifications: Ensure that all welders, welding operators, brazers, or brazing operators employed for this project are qualified for all welding and brazing procedures, proposed as part of this Project, in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel.". Qualification by previous employer or technically competent group or agency (subject to approval) may be acceptable if following information is included:

   a. Documentation that the previous qualification was for essentially the same procedures proposed and was in full accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel.".

   b. Copy of performance qualification testing record showing who qualified the worker, date of qualification, and work history record showing continuous performance to maintain qualification.

4. Weld and Braze Qualification Records: Maintain and sign certified records of approved procedures used and approved qualified workers employed for welded and brazed joints performed as a part of Prime Contract. Ensure all welding and brazing work can be traced to a specific procedure and welder.

5. Inspection and Examination by Owner, Remedy by Contractor: Owner reserves right to examine, inspect, and test all piping using visual, radiographic, or other recognized testing methods to determine compliance with specified quality control requirements and requirements of applicable regulatory agencies.

   a. Cost of Owner's testing of acceptable installation provided at Owner's expense.

b. Repair piping installations not passing Owner's quality inspection testing using approved method or replace at no additional cost.
c. Cost of initial testing of piping not conforming to specified requirements and any retesting of repairs or replacement work shall be deducted from Contract Sum.

E. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: Ship materials in manufacturer's containers, fully identified with manufacture's name, trade name, type, class, style, model, grade, size and color.

B. Storage and Protection

1. Store materials, equipment, fixtures, pipe, fittings, attachments, under cover, off ground in original containers as applicable, and protect from physical and weather damage while in storage and during construction.

2. Furnish extra materials identified in technical sections, in original manufacturer's containers and packaging, to Owner at location identified during Preconstruction Conference. Obtain receipt from Owner upon delivery of extra materials and send copy of receipt to Architect.

3. Replace or repair damaged, rusted, corroded or otherwise unusable materials physically damaged or weather damaged equipment as determined by Architect, at no change in Contract Sum.

1.9 PROJECT/SITE CONDITIONS

A. Field Measurements

1. DO NOT SCALE DRAWINGS: Refer to Architectural and Structural drawings for dimensions and details, and verify measurements in field before proceeding.

2. Install all items with proper provision for removal and access to coil bundles, boiler tubes, belts, valves, traps, and similar components.

3. Layout of equipment, piping, and similar components in Drawings is diagrammatic. Review Drawings in the field, identify interference with other construction and verify dimensions at Site prior to beginning installation.

a. Obtain exact size and location of all items and openings and confirm all existing conditions in field. Review Shop Drawings of all Contracts.
b. Coordinate all Heating Work that interferes with other construction with other responsible Contractor.

4. Report any conflicts to Architect in writing before beginning installation.

1.10 SEQUENCING AND SCHEDULING

A. Perform all Heating Work in cooperation with Owner, Architect, Construction Manager, and all Contractors on this Project, and other separate Contractors at the Site.

1. Coordinate all Heating Work with construction schedule requirements in Division 01
2. Coordinate all submittals with the construction schedule and with requirements and schedules contained in Section 01 33 00 – Submittals Procedures.
3. Immediately report any delays in receipt of materials required for Heating Work including circumstances causing delays.

B. Existing Construction: Provide openings, chases, recesses, lintels and bucks required for admission of Heating Work, unless otherwise noted. Do not cut waterproofed floors or walls for admission of equipment or materials without written permission. Do not pierce structural members without written permission.

C. New Construction:

1. Obtain and furnish necessary information, such as locations and sizes of heating construction, fixtures and equipment, to all Contractors in ample time for installation of openings, chases, recesses, lintels and bucks required for admission of project construction, fixtures and equipment.

2. Provide sleeves, inserts, panels, raceways, boxes, and similar components, ahead of schedule required for Heating Work installation and ahead of associated General Work. Provide Heating Work representative during installation of General Work responsible for maintaining items in position.

D. Supports for Heating Work: Provide anchor bolts required supporting or securing Heating Work. Locate settings and check locations as construction progresses. Provide templates or holding fixtures as required to maintain proper accuracy.

E. Cutting and Patching: Bear expense of cutting, patching, repairing or replacing of work of all Contracts required due to fault, error or damage by contractor responsible for Heating Work, unless otherwise specified in Contract Documents. Employ and pay Prime Contractor involved, or if there is no associated Prime Contractor, employ and pay qualified subcontractor as required for corrective work.

F. Refer to Division 01 for cooperation between Contractors. Prior to start of construction:

1. Obtain from Contract Drawings or Architect, exact location of items and openings in construction. Conform to existing conditions in field.
2. Review Shop Drawings of all Contracts.
3. If conflict occurs between Contract Drawings, advise Architect in writing before beginning installation and comply with Architect's directions.

1.11 COORDINATION

A. Pre-Installation Conference:

1. Attend pre-installation conference. Arrange for all subcontractors to be in attendance.

B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

C. Coordinate Heating Work with plumbing systems, lighting fixtures, ceiling mounted devices, ceiling heights, materials, structural work, maintenance clearances, electric code clearance, and building systems. Verify that Work of all Contractors can be installed without interference with Heating Work.

D. Notify Architect in case of unresolved interferences prior to installation of Heating Work.

E. Adjust exact size, location and offsets of exposed HVAC components to achieve reasonable appearance objectives without increase in Contract Sum.

F. Testing and Balancing: Cooperate with contractor responsible for Testing and Balancing work as required ensuring complete and proper testing, balancing and adjustment of air and water systems. Refer to section 23 05 93 – Testing, Adjusting, and Balancing for HVAC, for details.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Equipment – Provide as specified and scheduled with all options as required for full compliance.

B. Specified Equivalents - If Specified Equivalents (refer to “Definitions” in Part 1 above) are proposed, comply with following requirements:

1. Submit “Specified Equivalent Drawings” as specified in “Submittals” in Part 1 above.

a. Provide required changes in design and adjacent construction or equipment at no increase in Contract Sum.

1) Where required, provide larger motors, equipment, additional control devices, valves, fittings, and other miscellaneous equipment necessary for proper operation and provide proper location of roughing and connections to other Contractors.

2) Provide additional motors, starters, power, wiring, and control wiring required.

3) Provide revisions to equipment, wiring, support structure, controls, valves, fittings, and other miscellaneous equipment.

4) Additional Architectural and Engineering work, coordination, and documentation.

b. If proposed arrangement for Specified Equivalent is rejected, revise to be compliant and resubmit or submit Basis-of-Design Equipment.

2. Submit "Specified Equivalent Product Data" as specified in "Submittals" in Part 1 above to demonstrate that proposed Specified Equivalent is equal to or better than Basis-of-Design Equipment with respect to all performance characteristics, including but not limited to durability, individual equipment operating costs, entire interrelated system operating costs, service access, noise levels, vibration levels, compatibility with Owner's other existing equipment to minimize parts inventory, aesthetics where applicable, and similar characteristics.

3. Do not assume that approval of a specified equivalent submittal implies approval of the installed product. Correct all deviations uncovered during construction and warrantee period that result in or are caused by any lower performance characteristic than the specified Basis of Design equipment.

C. Proposed Equivalents and Substitutions: In addition to requirements described elsewhere in these Contract Documents, all proposed equivalent and substitution products being considered shall be subject to the Specified Equivalent requirements listed above.

2.2 MATERIALS

A. Minimum Material Requirements:

1. Construct potable water systems and equipment according to AWWA standards.

2. Provide electrical equipment and systems meeting UL standards and requirements of NEC.

3. Provide UL label on all equipment and material with listing service.

4. Material Flammability:

a. Flame spread rating of 25 or less.
b. Smoke developed rating of 50 or less.

5. Equipment Verification: Carefully check manufacturer's drawings and specifications as they affect their particular equipment; follow factory instructions for roughing, installation, connection, filling, lubrication, testing, balancing, adjusting, alignment, wiring, and start-up operation.

2.3 SEALANTS

A. Comply with requirements for sealants in non-fire rated penetrations specified in Section 07 92 00 "Joint Sealants", and also with requirements for Air Duct sealants in Section 23 31 00 – Ductwork.

B. Provide premium products specified for each application as appropriate.

2.4 PENETRATION FIRESTOPPING

A. Comply with requirements for sealants in fire rated penetrations specified in Section 07 84 13 “Penetration Firestopping”.

B. Submit Manufacturers Product Data Sheets for each type of product selected. Certify that Firestop Material is free of asbestos and lead paint, and complies with local regulations.

1. Certification by firestopping manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs) and are nontoxic to building occupants.

C. Submit system design listings, including illustrations from qualified testing and inspection agency that is applicable to each firestop configuration.

D. Submit a project specific Penetration Firestopping Schedule indicating where each firestop configuration will be used.

2.5 PAINT AND FINISHES

A. Refer to Division 09 for paint and finish product specifications.

PART 3 - EXECUTION

3.1 HVAC DEMOLITION

A. Refer to Division 01 Section "Execution" and Division 02 Section "Selective Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material at point of continued use or as otherwise specifically indicated.

2. Ducts to Be Removed: Remove portion of ducts indicated to be removed and cap remaining ducts with same or compatible ductwork material.

3. Equipment to Be Removed: Disconnect and remove equipment and all associated accessories. Plug, cap, seal, and otherwise patch to match as required.

4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, protect, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational. Document any existing damage before removals.

5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. Disposition of Removed Components:

1. All material and equipment shown on the drawings to be removed during project Work that is not indicated on the drawings as being either reused or turned over to the Owner becomes the Contractor's property as a part of the project including salvage value and legal disposal cost complete.

2. For components indicated on the drawings to be reused: carefully remove, protect, and store until appropriate time for re-installation. Document any pre-existing damage prior to removals.

3. For pipe and tubing indicated to be reused, reuse only those portions of pipe, tubing, and associated fitting assemblies where they are direct replacements of the as specified and as shown new piping assemblies. Valves, strainers, other piping specialties, and insulation shall not be re-used unless specifically indicated on drawings.

3.2 EXISTING CONDITIONS

A. Reuse materials and equipment only as indicated on Drawings. Furnish new equipment and materials in conformance with Contract Documents for all Heating Work, including any material, operation, method or device mentioned, listed or noted within Division 23 Sections, unless reuse is specifically indicated, or unless specified as furnished or installed by Owner, all Contractors, or others.

B. If pipe, insulation, or equipment to remain is damaged in appearance or is otherwise made unserviceable by adjacent or associated work or error, remove damaged or unserviceable portions and replace with new products of equal capacity and quality. Verify, document, and confirm pre-existing damage with Owner and Architect before beginning work.

3.3 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

E. Ensure each equipment manufacturer:

1. Carefully checks Contract Drawings and Specifications applicable to manufacturer's equipment before roughing.

2. Reports to Architect, before or when Shop Drawings are submitted, any discrepancies or conditions applied to manufacturer's equipment that prevents proper functioning, servicing, and other aspects of equipment operation.

3. Provides manufacturer's printed installation instructions for each piece of equipment.

4. Thoroughly instructs Contractor exactly how equipment should be installed, connected, lubricated, started, operated, and similar aspects to ensure all factory instructions are rigidly followed during installation of equipment.

F. Install, test, start, and operate equipment as instructed by manufacturer.

G. Submit written evidence from equipment manufacturer that manufacturer's equipment and systems have been:

1. Installed in strict accordance with manufacturer's recommendations.
2. Properly aligned and adjusted, tested, lubricated, wired, balanced, and similar operations

H. Equipment Connections

1. Provide final water, vent, and refrigerant to all equipment as required.

2. Provide isolation valves and flanges or unions on the supply and return piping connections to all equipment arranged as required for reasonable service isolation and access.

3. Provide equipment waste, drip, overflow, bleed water, condensate, and drain connections extended to floor or roof drains or other approved points of discharge. Provide integral condensate pumps and appropriate piping for units where gravity condensate drain is not practical or possible.

4. Connect equipment complete and ready-to-use, including all valves, piping, piping accessories, traps, gauges, vents, drains, insulation, sheet metal work, controls, dampers, and similar components required.

I. Precautions Against Freezing: In addition to applicable requirements in Division 01 and individual technical sections, take all necessary precautions with equipment and systems to prevent damage to building, piping, equipment, and other components due to freezing and water leakage until final acceptance. Before freezing weather occurs, make certain all:

1. Safety features are properly functioning.
2. Freeze protection is tested and sensing elements are properly located.
3. Openings around outside grilles, louvers, and similar items are properly sealed; notify Architect in writing if openings are not adequately sealed.
4. Outside air dampers are tight fitting and operational, and damper motors are properly winterized.
5. Air systems are properly balanced.
6. Proper insulation is installed where required.

J. Concealment: Conceal all Work not specifically shown on the Drawings as exposed. Note piping risers may be shown outside of walls due to scale of drawing symbols – the general intent is for these pipes to be concealed within the general construction if possible or if not possible, to be within riser chases. If for any reason concealment is impossible, notify the Architect and obtain written approval before starting that part of the Work.

K. Exposed Items: Install exposed items as shown on Drawings or as approved by Architect. Obtain Architect's approval for final arrangement and appearance before installing items in areas without ceilings.

L. Damaged Components and Replacement: If pipe, duct, insulation, or any HVAC component or equipment is damaged in appearance or is otherwise unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.4 ERECTION OF SUPPORTS AND ANCHORAGES

A. Provide a complete system of support and anchorage for all Contract work.
B. Refer to Section 23 05 29 - Hangers and Supports for HVAC Components, Section 23 05 43 – Mechanical Vibration and Movement Control for detailed additional requirements.

3.5 MECHANICAL PENETRATIONS, WATERPROOFING, AND SEALING

A. Openings Through Roofs: Curbs are required for rooftop air handling equipment, ventilators, fans, piping penetrations, etc. Roofing, flashing, and general waterproofing are the responsibility of the Contractor unless specifically indicated otherwise elsewhere in the Contract Documents. Refer to Architectural Drawings for related work by others.

1. Use factory pre-fabricated units as specified and noted on Drawings.

2. Caulk and waterproof neatly with additional material as required.

3. Employ the services of an approved roofing sub-contractor for all patching and/or new work indicated as part of the Heating Work.

4. Any roofing work performed under this Contract shall be performed in such a way as to not void any existing roofing warrantee. Additionally, whether there is a roofing warrantee currently in force or not for roof in area of new penetrations, all new penetration work shall be warranted leak free for a period not less than one year from final acceptance of project.

5. Provide structural support for roof deck around all roof curbs and roof deck penetrations larger than 12 inch x 12 inch, unless specifically indicated otherwise elsewhere on the Contract Documents.

B. Opening Through Outside Walls:

1. Guarantee all penetrations to be thoroughly air and watertight. Caulk and flash duct penetrations in accordance with specifications, details on Drawings, and as required.

2. Install louvers in accordance with specifications, manufacturer's recommendations, and details, as required to achieve guaranteed air and watertight penetrations. Direct drainage to drip away from building surface.

3. Use special waterproof construction as directed.

4. Provide mechanical sleeve seals for piping penetrations.

5. Provide structural support for wall above all penetrations wider than 12 inches, unless otherwise indicated elsewhere on the Contract Documents.

C. Openings Through Floors and Inside Walls: Provide through penetration systems for all mechanical work floor and wall penetrations which do not compromise the integrity of the floor or wall with regards to fire rating, smoke passage rating, acoustical noise reduction rating, or seismic rating. Insure through penetration system does not transmit mechanical vibrations to building walls or floors. Seal all floor penetrations to effectively block the passage of smoke and fumes.

1. Provide structural support for floor deck around all penetrations larger than 12 inches in any dimension, unless specifically indicated otherwise elsewhere on the contract documents.

3.6 FIRESTOPPING

A. Provide Through-Penetration Firestopping Systems and Devices listed in UL Fire Resistance Directory under categories XHCR and XHEZ and conforming to construction type, penetrant type, annular space requirements and fire rating indicated or required for each application.

B. Provide systems that withstand passage of cold smoke either as inherent property of system or by use of separate product included as part of UL system or device designed to perform this function.

C. Applied Fireproofing:

1. Coordinate the installation of hangers, supports and accessories from the structural steel with the Contractor responsible for fireproofing. Install all hangers and supports prior to fireproofing.

2. Repair and/or replacement of any fireproofing removed or damaged as a consequence of the installation work of the Heating Work Contract shall be the responsibility of the Heating Work Contractor.

a. Employ the services of an approved fireproofing contractor to repair or replace the fireproofing by patching any areas that have been removed or damaged due to the installation of work after the completion of the fireproofing.

b. Repaired or replacement fireproofing shall match the fireproofing adjacent to the repaired area. All warranties shall be maintained.

c. Remove all excess applied fireproofing from surfaces adjacent to those requiring it, leaving area clean and neat.

3.7 ACCESS DOORS

A. Provide all access doors shown on Drawings and as required for access to motors, dampers, valves, controls and all other devices requiring periodic inspection, adjustment or maintenance where located above or within inaccessible walls or ceilings except where access doors are indicated to be provided by others.

B. Engage skilled tradesman experienced in installation of access doors in applicable types of adjacent construction to install access doors. Install in accordance with requirements of Division 08 Section on access doors.

C. New Construction: Coordinate size and locations of openings required for access panels in walls, floors and ceiling construction with General Work Contractor in ample time for installation of access panels.

D. Existing Walls, Floors, and Ceilings: Cut and patch to install access doors in conformance with Section 01 73 00 - Execution.

E. Ductwork: Provide all access doors as required by section 23 31 00 – Ductwork and 23 33 00 – Air Duct Accessories.

3.8 PAINTING

A. Painting of HVAC systems, equipment, and components is additionally specified in Division 09 Sections on Painting.

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

C. Vary initial and final coat colors slightly as required to provide positive identification between coats. Do not proceed with final coat until initial coat is properly cured per manufacturer's instructions, and has been approved as complete by Owner's Project Representative. Final coat shall completely conceal initial coat(s).

1. Color Code Identification: Provide color code identification of mechanical piping in Mechanical Rooms and Fan Rooms by painting the following services as listed below.

	Item	Color
a.	Heating hot water supply	Dark Red
b.	Heating water return	Light Red
c.	Refrigerant	Dark Green
d.	Hangers, supports, base rails, etc.	Black
e.	Condensate (AC drain)	White (ASJ without paint OK)

3.9 PROTECTION

A. Maintain systems during construction, temporary use, and until acceptance by Owner.

1. Properly lubricate all HVAC systems bearings during use.

2. Maintain limit controls, overload devices, and safety controls in operating condition during use

3.10 ALTERATIONS

A. Provide protection of existing facilities, demolition and removals, replacement and restoration, including patch-to-match requirements, and hazardous materials procedures to install Heating Work in conformance with Division 01 requirements.

B. Provide cutting and patching required to install Heating Work in accordance with the requirements of Division 01 covering cutting and patching.

3.11 ADJUSTING AND CLEANING

A. Adjust all work as required to insure systems perform as designed and as intended, including but not limited to the following:

1. Adjust all registers and diffusers to insure even air distribution free of objectionable drafts. Include all new and all existing to remain registers and diffusers on systems where HVAC modifications are made.

2. Adjust all hangers and supports to insure proper piping slope, alignment of flexible connections, even loadings, proper venting and draining, proper control over thermal expansion, etc.

3. Adjust all mechanical equipment insuring it runs properly as intended, providing the performance specified and required, and as required to maintain all warrantees.

B. Clean work furnished or provided as part of Heating Work, including but not limited to equipment, control panels and devices.

1. Refer to and comply with Section 01 50 00 - Temporary Facilities and Controls for additional requirements for cleaning during construction and Section 01 77 00 – Closeout Procedures for additional requirements for final cleaning.

2. Remove debris, leftover piping, tubing, metal, insulation, cartons, papers, etc., resulting from Heating Work.

C. Final Cleaning: In addition to requirements specified in Section 01 77 00 – Closeout Procedures and other sections in Division 23, provide following measures.

1. Where heating units have been used to provide temporary heat, clean all permanent filters, replace all disposable filters, and clean all ducts, blowers, and coils.
2. Provide written notification to Architect upon completion of all final cleaning procedures and request inspection of final cleaning.

3.12 DEMONSTRATION OF COMPLETED SYSTEMS:

A. Prior to Final Completion, thoroughly demonstrate and instruct Owner's designated representatives in care and operation of all heating and ventilating systems and equipment provided in Heating Work. Provide necessary skilled labor to operate all systems for not less than 5 days and provide required instruction.

1. In addition to Contractor's instruction, arrange for technically qualified factory representatives to train Owner's designated representatives in care, maintenance, and operation of following manufacturer's equipment and systems.

a. Temperature controls.
b. Central station air handling equipment and units.
c. Energy recovery equipment.
d. Air conditioning units and equipment.

2. Coordinate and schedule time and place of all training through Architect at Owner's convenience.

3. Submit letters verifying satisfactory completion of all instruction including date of instruction, names of persons in attendance and countersigned by authorized representative of Owner.

4. Until final acceptance, Contractor retains full responsibility for systems operations and maintenance, even though operated by Owner's personnel during instruction, unless otherwise agreed to in writing.

5. During instruction, provide list, sealed in clear plastic, outlining operating, maintenance, and starting precautions and procedures to be followed by Owner for operating systems and equipment.

B. Lubrication Chart: Provide minimum 8-1/2 inch x 11 inch lubrication chart for all Work in Heating Work Contract, typed in capital letters, mounted under clear laminated plastic, and secured to wall where directed by Architect.

1. List all motors and equipment including following information:

a. Name and location of equipment.
b. Type of lubrication recommended by manufacturer.
c. Lubrication period recommended by manufacturer.

2. Lubricate all motors immediately after installation and perform lubrication maintenance until final acceptance by Owner.

C. Air Filter Chart: Provide an air filter chart for all equipment installed in contract.

1. Chart shall be 8-1/2 inch x 11 inch minimum size, typed in capital letters, mounted under clear laminated plastic; secure to wall where directed.

2. List all equipment that includes filters in Contract. Obtain necessary information containing the following:

    a. Name and location of equipment
    b. Type of filters recommended by the manufacturer.
    c. Size of filters for each piece of equipment.
    d. Recommended replacement schedule from unit manufacturer.

D. Belt / Drive Chart: Provide a Belt / Drive chart for all motorized equipment installed in contract. May be combined with lubrication chart above.

1. Chart shall be 8-1/2" x 11" minimum size, typed in capital letters, mounted under clear laminated plastic; secure to wall where directed or turned over in binder.

2. List all motor driven equipment in contract. Obtain necessary information containing the following:

    a. Name and location of equipment.

    b. Type of drive – belt, direct, flex coupling, etc.

    c. Drive data as applicable:

        1) Size and number of belts with replacement belt mfgr., model, part numbers.
        2) Size of drive and driven pulleys, mfgr., model, part numbers.
        3) Flexible coupling mfgr, model, part numbers.

END OF SECTION 23 05 00

SECTION 23 05 13 - COMMON ELECTRICAL REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes:

1. General requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

2. Starters and drive train accessories for electric motors.

a. Refer to associated mechanical equipment sections for factory installed variable frequency motor controllers.

1.3 SUBMITTALS

A. General: Submit all action submittals required by this Section concurrently.

B. Action Submittals:

1. Product Data: For each type of product indicated, demonstrating compliance with all specified performance and construction characteristics.

C. Closeout Submittals:

1. Installation, Operation, and Maintenance Data: For motors, drives, electrical power components, and heat trace - include in operation and maintenance manuals.

a. Wiring Diagrams: Employ competent technical aid to prepare composite wiring diagrams for field wiring of power, signal, and control wiring for all equipment and systems installed as part of the HVAC Work. Deliver diagrams to proper parties in time for roughing of conduit and equipment connections. Clearly indicate all items to be mounted or wired as part of DIVISION 26. Include as built wiring diagrams in O&M manual.

1.4 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Manufacturers: Provide products by one of following manufacturers or equal, except where unusual configurations involving frame, hermetic seals, shaft, bearing, or starting characteristics are peculiar to particular item of equipment as specified by Architect:

1. National Resource Management (NRM).
2. Baldor.
3. General Electric.
4. U. S. Motors.

B. Provide all motors required for the work of Division 23 specifications. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or individual technical specification sections.

1. Provide motors wound specifically for voltages as scheduled and available, with 1.15-service factor at rated voltage and frequency complying with all applicable NEMA standards.

C. Provide all motors suitable for operation at the frequency, voltage, and phasing of the building power.

D. Provide motors 1/2 HP and larger and motors indicated as driven by variable speed drives, designed for operation on 3-phase power, voltage as shown on electrical plans, +/- 10 percent, unless specifically indicated otherwise on drawings.

E. Provide constant speed motors 1/3 HP and smaller designed for operation on single phase, 120 volts +/- 10 percent.

F. Comply with NEMA MG 1 unless otherwise indicated.

G. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS AND APPLICATIONS

A. Provide each motor suitable for continuous duty operation at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level, and suitable for speed, enclosure, rating, type and horsepower not less than as scheduled or specified in Contract Documents. Provide motor enclosure and maximum allowable temperature rise in degrees Centigrade over 40 deg. C ambient as follows, unless otherwise specified:

1. General Purpose: Drip-proof 40 deg. C or encapsulated design 60 deg. C.
2. Roof-top unit, damp, high humidity, or condensing applications: Totally enclosed fan-cooled 50 deg. C or drip-proof encapsulated design 60 deg. C.
3. Motors, wiring, and disconnects installed in potentially flammable atmosphere: UL listed, NEC rated explosion proof construction, fan-cooled 50 deg. C rise.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

C. Each equipment manufacturer is responsible for ensuring motors supplied with manufacturer's equipment are fully compatible with the application and capable of starting and running driven equipment without undue noise, heating, or distress.

2.3 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.
5. Electronically Commutated Motor (ECM)

B. Motors 1/20 HP and Smaller: Shaded-pole type.

C. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

D. Variable Speed Motors: electronically commutated motor (ECM) as manufactured by General Electric. Motor shall be of permanent magnet, brushless DC premium efficiency design with variable speed electronic controller capable of maintaining constant speed, torque, and/or cfm as required by service, capable of accepting 0-10vdc or 4-20mA speed control signal from building management system. Adjustable slow start and gradual speed changes, permanently lubricated ball bearings, and extra quiet operation are all included.

E. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

F. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.4 POLYPHASE MOTORS

A. Single Speed General Application Motors:

1. NEMA MG 1, Design B, medium induction motor.
2. Efficiency: Premium efficiency, as defined in NEMA MG 1.
3. Service Factor: 1.15.
4. Random-wound, squirrel cage rotor.
5. Re-greasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
6. Insulation: Class F.
7. Temperature Rise: One class below insulation rating.
8. Motors 15 HP and Larger: NEMA starting Code F or Code G.
9. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
10. Enclosure Material: Manufacturer's standard rolled steel or cast iron enclosures corresponding to NEMA rating and application requirements.

B. Multi-Speed General Application Motors:

1. Similar to single speed motor requirements above, with separate winding for each speed.

2. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

C. Motors Used with Variable Frequency Controllers:

1. Motors shall meet all other requirements of this document, the driven equipment manufacturer, and the Variable Frequency Controller manufacturer, and be rated for this service with the drive and voltage intended. Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

2. All three phase motors for use with variable frequency controllers shall be special application, inverter duty premium efficiency motors of cast iron construction.

3. Ratings shall be in accordance with NEMA MG-1, Part 31 requirements for the specific application.

4. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.

5. Class B temperature rise; Class F insulation.

6. Thermal protection via one Class F thermostat per phase, NEMA MG 1 compliant with requirements for thermally protected motors.

D. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 MOTOR ACCESSORIES

A. For all new motor installations, whether in new equipment or installed as replacement motors, provide accessories listed below as required for a complete new drive system.

B. V-Belt Connected Motors: Provided with adjustable slide rail bases, motor sheaves, driven pulleys, and belts sized and applied such that total overhung load on motor shaft extension due to belt tension and motor torque does not exceed maximum overhung load allowed by motor design and construction.

1. Size and apply pulleys so that total overhung load on motor shaft extension due to belt tension and motor torque will not exceed maximum overhung load allowed by motor design and construction, with minimum 150% safety factor.

2. Motor and driven pulleys/sheaves to be premium quality, machined cast iron balanced to MPTA standards, tapered bushing bolted shaft connections, variable pitch diameter motor sheave through 10 hp motors (fixed sheaves 15 hp and above), multiple belt grooves and belts 5 hp and above and as required to maintain safety factor.

3. V-belts to be premium quality oil and heat resistant notched cog type belts with precision molded raw edges in matched lengths as required for application. Provide one extra set belts minimum for each belt drive system, secured adjacent to drive or turned over loose to Owner if so requested.

4. Provide slide rail base to fit new motor for all new equipment motors, whenever replacement motor has different NEMA frame size from existing, or where specifically called for:

a. Slide rail bases to be heavy gauge formed steel, adjustable with single adjusting bolt for belt tensioning, sized to fit motor.

C. Direct connected motors: provide with flexible couplings if required by application and OSHA approved belt guards surrounding rotating machinery.

2.6 STARTERS

A. Manufacturers: Provide all starting equipment and control devices manufactured by same manufacturer and furnished through single responsible supplier unless otherwise specified in Contract Documents. Factory-wired or assembled packaged equipment may be provided with starting equipment of any acceptable manufacturer. 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. Cutler-Hammer

2. General Electric
3. Square D

B. Provide starters, contactors, and controllers complying with applicable NEMA standards, minimum size 0, and enclosed in enclosures of type appropriate for environment where installed including general purpose, explosion proof, weather resistant, or weather-tight construction as required.

C. Ensure all parts subject to wear, arcing, and similar use are easily removable.

1. Provide necessary auxiliary contacts for each starter subject to electrical interlock or automatic control.

2. Equip magnetic starters for motors operating 208 volts and over, line-to-line, equipped with self-contained light loads imposed thereon with a control transformer having a 120-volt grounded secondary winding, and having 120-volt starter operating coils.

D. Provide combination-type magnetic starters with fused disconnect switches. Fuse with class R fuses. Protect all starters with manual reset, solid state overload relay equal to (Square "D" motor logic) in one leg of single phase line to neutral circuits, in two legs of single phase line-to-line circuits, and in three legs of 3-phase circuits.

E. Provide 6-volt, red pilot light, integral transformer and long life bulb for all starters and contactors.

F. Manual Starters: Toggle operated, single pole for line to neutral circuits, two pole for line-to-line circuits, with thermal overload devices and neon pilot light; flush mounted unless shown otherwise, ganged with selector switch for multispeed applications. Provide manual starters similar to one of the following:

1. General Electric CR-101
2. Cutler-Hammer 9101
3. Square D Class 2510

G. Combination Magnetic Starters: Single speed, across the line, HAND-OFF-AUTO selector switch in cover. Provide combination magnetic starters similar to one of the following:

1. Cutler-Hammer 9589
2. General Electric CR-107
3. Square D Class 8538

H. Magnetic Contactors: With control coil in series with temperature controls as required.

2.7 COMPONENTS

A. Electrical Wiring: Provide all materials conforming to NEMA Standards and UL approved for intended service. Refer to appropriate sections in Division 26.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which materials and methods are to be installed and notify Architect in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in acceptable manner.

1. Installation indicates conditions are acceptable to Contractor as required to ensure requirements for applicable warranty or guarantee can be satisfied.

2. Motors and Starters: Confirm electrical characteristics for all equipment.

3. Electrical Wiring: Check all electrical wiring associated with equipment for compliance with specifications and correctness of connections. Correct wiring in event equipment or devices fail to function in specified manner, whether due to incorrect connections or improper information and wiring diagrams.

B. Inspect and perform tests on project electrical wiring, including infrared scans (thermography), resistance testing, or other industry standard testing as required to demonstrate acceptable wiring. Owner reserves the right to provide their own additional similar testing:

1. Cost of Contractor's testing included in bid price. Cost of Owner's testing of acceptable installations provided at Owner's expense.
2. Repair installations not passing Contractor's or Owner's quality inspection testing using approved method or replace at no additional cost.
3. Cost of initial testing of wiring not conforming to specified requirements and any retesting of repairs or replacement work deducted from Contract Sum.

3.2 INSTALLATION

A. Motors and Starters

1. Correct, at no additional cost, any misapplied motor or starter combination and improper thermal overload devices for motor starters provided as part of HVAC systems or components, along with damage to other equipment or construction.

2. Motors: Provide motors furnished by equipment manufacturer, specifically manufactured or selected for equipment served; mounted, and installed to provide complete installation that is substantially noiseless in performance under intended use. Replace motors unsatisfactory to Architect with new motor.

3. Starters and Accessories

a. Furnish properly tagged and identified devices specifically indicated on "Electric Equipment and Control Schedule" as supplied by HVAC systems suppliers and determine coordinated location and time for delivery of devices.

b. Provide auxiliary contacts required for temperature controls, interlock with other equipment, alarms, and similar components and applications.

B. Motor Accessories

1. Pulleys and Sheaves: Install on shaft with anti-seize compound and new locking drive keys and setscrews as applicable. Align drive and driven pulleys to within +/- 0.03 inches axially and to within +/- 2 degrees angular misalignment. Install locking devices with anti-vibration locking compound.

2. Belts: Install belts and adjust to the manufacturer's recommended tension.

3. Personnel Guards: secure to equipment such that belts and pulleys / sheaves are free to rotate and personnel are protected from moving parts.

C. Miscellaneous Electrical Wiring included in HVAC systems installations:

1. Provide all control wiring and power wiring for all equipment and associated control devices (including automatic control system) required for HVAC systems and components.

2. Comply with all applicable NEC requirements. Install all electric wiring in accordance with all local and state codes and regulations having jurisdiction.

3. Wiring for Controls: Provide wiring specified in Section 23 09 00 – Instrumentation and Control for HVAC, for all control devices required for temperature control system and other miscellaneous controls not included in "Electrical Equipment and Control Schedule".

4. Allow sufficient headroom under equipment as directed for each location (unit heater, etc.). Verify space available for each equipment item. Refer to Architect for any correction, discrepancy or suggested change in size of location.

5. Secure all equipment and fixture mountings, wiring devices, and accessories (clips, supports, etc.) to structure with screws, bolts, or similar items; nailing not acceptable.

END OF SECTION 23 05 13

SECTION 23 05 19 - METERS AND GAUGES FOR HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Liquid-in-glass thermometers.
2. Thermowells.
3. Test plugs.

1.3 SUBMITTALS

A. Action Submittals:

1. Submit all action submittals required by this Section concurrently.
2. Product Data: For each type of product indicated, demonstrating compliance with specifications. Include schedules of locations and ranges proposed.

B. Closeout Submittals:

1. Approved submittal.

   a. If "**As-Specified Verification Form**" submittal is approved, also include product data for all valves used.

2. Include all information required in SECTION 01 78 23 – Operation and Maintenance Data for all meters and gauges used. Include wiring diagrams for meter power, signal, and control wiring.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

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. Trerice, H. O. Co.
b. Weiss Instruments, Inc.
c. WIKA Instrument Corporation - USA.
d. Winters Instruments - U.S.

2. Standard: ASME B40.200.

3. Case: Cast aluminum; exterior grade powder coated finish, 9-inch nominal size unless otherwise indicated.

4. Case Form: Adjustable angle unless otherwise indicated.

5. Tube: Glass with magnifying lens and non-mercury blue or red organic liquid.

6. Tube Background: Non-reflective with permanently etched scale markings graduated in deg F.

7. Window: plastic.

8. Stem: Bare aluminum of length to suit installation.

9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.

B. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 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 or Steel Piping: solid machined de-zincification resistant brass or stainless steel.
4. Type: Stepped shank unless straight or tapered shank is indicated.
5. External Threads: ASME B1.20.1 pipe threads, size as required for sensors.
6. Internal Threads: ASME B1.1 screw threads, size as required for sensors.
7. Bore: Diameter required to match temperature sensor bulb or stem.
8. Insertion Length: Length required to match temperature sensor bulb or stem.
9. Lagging Extension: Include on thermowells for insulated piping and tubing.
10. Bushings: For converting size of thermowell's internal screw thread to size of temperature sensor connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin unless otherwise required by sensor manufacturer.

2.3 TEST PLUGS AND ACCESSORIES

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. 3D instruments Inc.
2. Flow Design, Inc.
3. Peterson Products Co
4. Trerice, H. O. Co.
5. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
6. Weiss Instruments, Inc.

B. Test Plugs:

1. Description: Test-station fitting made for insertion into piping tee fitting.

2. Brass or stainless steel body, NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread with Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber core inserts and gasketed and threaded cap with retainer. Include extended stem on units to be installed in insulated piping.

3. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.
C. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 INSTALLATION

A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.

B. Install thermowells of sizes required to match temperature sensor connectors. Include bushings if required to match sizes. For pipe sizes 1 inch and smaller, increase pipe size by one size at location of thermowell to minimize obstruction.

C. Install thermowells with extension on insulated piping. Insulate fitting past piping well and neatly terminate insulation at temperature sensor body minimizing heat loss while allowing for adjustment.

D. Fill thermowells with heat-transfer medium.

E. Install test plugs in piping tees in location that allows for ease of insertion of standard test kit probes.

3.3 LOCATIONS

A. Install temperature sensor and thermometer in the following locations, and as additionally shown on drawings:

1. Inlet and outlet of each air handler heating coil.

END OF SECTION 23 05 19

SECTION 23 05 23 – GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Brass and bronze ball valves.
2. Check Valves.
3. Manual Balancing valves
4. Automatic Flow Control Balancing valves.
5. Air vent valves

1.3 DEFINITIONS

A. CWP: Cold working pressure.
B. EPDM: Ethylene propylene copolymer rubber.
C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.4 SUBMITTALS

A. Procedural Requirements: Comply with requirements of SECTION 01 33 00 - Submittals and as modified below.

1. Specified Products: If product to be incorporated into Project is specified by name and product designation in Part 2 below, submit "**As-Specified Verification Form**" (attached to SECTION 01 33 00 - Submittals) in lieu of "Product Data" identified below in this Article.

2. Equivalent Products or Substitutions: If product to be incorporated into Project is not specified by name and product designation in Part 2 below, comply with all Action Submittal requirements specified below.

B. Action Submittals:

1. Product Data: Submit concurrently for each type of valve proposed, demonstrating compliance with requirements.

C. Closeout Information, for inclusion in Operations and Maintenance Manual:

1. Approved submittal.

a. If "**As-Specified Verification Form**" submittal is approved, also include product data for all valves used.

2. Include all information required in SECTION 01 78 23 – Operation and Maintenance Data.

3. Receipt: For spare automatic flow control valve cartridges.

4. Valve Chart: Refer to Section 23 05 00 – Common Work Results for HVAC, for details.

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 B31.9 for building services piping valves.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set ball and plug valves open to minimize exposure of functional surfaces.

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 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. Handlever: For quarter-turn valves NPS 5 and smaller.

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

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

F. Valve-End Connections:

1. Solder Joint: With sockets according to ASME B16.18.
2. Threaded: With threads according to ASME B1.20.1.

2.2 BRONZE AND BRASS BALL VALVES

A. Two-Piece Ball Valves with Stainless-Steel Trim:

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

a. Conbraco Industries, Inc.; Apollo Valves.
b. Milwaukee Valve Company.
c. NIBCO INC.

2. Description:

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

2.3 CHECK VALVES

A. 1/2-inch to 2-inch Lines: Y-pattern swing-type manufactured in accordance with MSS-SP80, Class 125, bronze ASTM B-62 body with TFE seat disc; similar to "T413-Y (threaded) S413-Y (solder)" by Nibco.

B. Provide silent type where indicated and when check valves are installed in vertical lines.

1. 1/2-Inch To 2-Inch Lines: Bronze body, ball-cone check, straight through design, 1/2 PSI opening pressure or other opening pressure if so indicated on drawings, bubble tight shut-off with liquid media, 125 PSIG steam rating; similar to "Apollo 61-100" by Conbraco.

2.4 MANUAL BALANCING VALVES

A. Provide combination globe-type calibrated flow measuring balance, shutoff, and throttling valve with provision for attaching portable differential pressure meter with each meter connection having positive shutoff access valves equipped with removable insulating cover providing minimum R of 4.5. Rated for 250 PSI at 250 deg. F and provided with calibrated nameplate, 1/4-inch drain/purge port, and drip-tight shut off. Similar to "CBV" by Armstrong, "3D" by B & G, or similar products by Tour & Anderson.

B. Threaded, grooved, or flanged ends as required to fit system piping with bronze, A-metal, or dezincification resistant brass body for pipe sizes 1/2-inch to 2-inches inclusive.

1. Valves designed to allow for presetting of balance points for proportional system balance prior to system start up.

C. Valve Size: As required to meet the Cv indicated on the Drawings, or if not indicated on Drawings, provide the larger of pipeline size or size required to provide maximum 5 ft. water gauge pressure drop at design flow.

D. Read-Out Ports: Include internal EPT inserts and check valves.

E. Adjustment Knob: Includes minimum of four full turns (1440 degrees) from bubble tight shutoff to full open position and includes pre-set feature indicating degree of valve opening including memory position stop and indicator.

2.5 AUTOMATIC BALANCING VALVES

A. Provide each valve with an identification tag attached by chain, factory marked with the zone identification, valve number and flow rate. Valve to be line size.

B. The GPM for the automatic flow control valves shall be factory set and shall automatically limit the rate of flow to within 5 percent of the specified GPM over at least 95 percent of the control range.

C. For 1/2 inch – 2 inch, the flow cartridge shall be removable from the Y- body housing without the use of special tools to provide access for regulator change-out, inspection and cleaning without breaking the main piping.

D. Pump head requirement: The permanent pressure loss added to the pump head shall not exceed seven feet.

E. Each valve shall have two P/T test plugs.

F. Construction:

1. For 1/2" through 2" pipe sizes: Assembly consisting of a de-zincification resistant (DZR) brass, bronze, or A-metal Y-type body, integral full port SS ball and stem ball valve and 'O' ring type union. For all insulated pipe services, provide manufacturer's pre-formed insulation cover to fit each valve, with extended, insulated, non-condensing handle on ball valves.

2. Stainless steel internal flow cartridge body and wear surfaces, with machined threads for spring free height adjustment, permanently marked with the GPM and spring range.

3. Factory leak tested at 100 psi. air under water.

G. Flow Verification:

1. Differential pressure measured across the valve shall be measured for flow verification and to determine the amount of system over heading or under pumping.

H. Acceptable Manufacturers:

1. IMI Flow Design Inc.
2. Griswold Controls
3. Engineer approved equal.

2.6 AIR VENTS

A. Manual Air Vents:

1. For All Pipe Sizes In Accessible Locations Only: Bronze body, quarter turn ball valve with minimum 1/4-inch discharge and inlet connections. Provide collection chamber at inlet and 1/4-inch tube with return bend on outlet, piped to point of collection.

2. For Terminal Units In Accessible Locations: Bronze or brass body and non-ferrous internal parts, 150 PSIG working pressure, 225 deg. F operating temperature. 1/8-inch MNPT inlet connection. Coin or key operated, supply three keys minimum to owner. Similar to "Model 4V" by Bell & Gossett.

B. Automatic Air Vents:

1. High Capacity Type: Cast iron body with internal working parts of stainless steel, brass, bronze, and EPDM and float-operated sealing valve designed to purge free air from the system and provide positive shut off at pressures to 125 PSIG and temperatures to 250 deg. F. Vent prevents air from entering the system if system pressure drops below atmospheric. Vent readily serviceable by disassembly to access the internal working parts. Similar to "Model "107A" by Bell & Gossett or "720" by Amtrol.

2. Standard Capacity Type: Cast bronze body with internal working parts of stainless steel, brass, bronze and EPDM and float operated sealing valve designed to purge free air from the system and provide positive shut off at pressures to 150 PSIG and temperatures to 230 deg. F. Vent prevents air from entering the system if system pressure drops below atmospheric. Vent readily serviceable by disassembly to access the internal working parts. Similar to "No. 700-C" or "701-C" by Amtrol.

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

3.2 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

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

B. Install isolation valves at each new branch connection serving three or more pieces of terminal equipment, and as additionally shown on drawings.

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

D. If valves with specified CWP ratings are not available, the same types of valves with higher CWP ratings may be substituted.

E. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 inch and Smaller: Threaded or solder joint ends.

3.3 GENERAL DUTY VALVE SCHEDULE

A. Unless otherwise specifically indicated elsewhere, use the following:

B. Hydronic Flow Shutoff Service:

1. 2 inch and smaller: Full Port Ball Valves

C. Pressure Gage Shutoff Service: Standard or Full Port Ball valves.

D. Flow Adjustment and Balancing:

1. Provide line size manual adjustment balancing valves for service on branch main lines serving multiple terminal loads, where shown on drawings.

2. Provide line size automatic flow control balancing valves for all individual terminal loads. Size valve flow cartridges based on approved equipment submittal flow rates where different from that scheduled. Include in contract changing cartridges on 10% of automatic flow control valves to some different flow as required during TAB and system commissioning work.

E. Pump Service:

1. Suction: Provide full line size isolation valve at pump inlet before reducers, flex connections, and suction diffuser.

2. Discharge:

a. Constant speed pumps: Provide Pump Discharge Valves by pump manufacturer, full line size of system piping (typically larger than pump discharge size), after flex connections.

b. Install with sufficient length of straight pipe before and after valve as recommended by manufacturer to obtain good and stable measurements.

F. Hydronic System Drain Service: Provide drain valves at all system local or global low points as required for complete system drainage.

1. 2 inch and smaller service: Provide ¾ inch full port ball or globe valves, with ¾ inch hose thread end and chained cap.

G. Hydronic System Air Venting:

1. Manual vents: provide standard or full port ball valve, minimum 1/4” NPT.

2. Provide Standard Capacity Type Automatic Air Vent at accessible points in piping system where air may collect, including all local high points and at the end of each horizontal run before a drop in elevation.

a. If any such point will be inaccessible after construction is complete, provide only Manual Air Vent in lieu of automatic, installed as described below.

3. Equipment Air Vents:

a. Equipment Above Mains: Connect run outs or risers to upper quadrant or top of mains. Install vent assembly at branch high point, concealed within enclosure if possible, consisting of 1 in. diameter by 6 in. long air collection chamber with 1/4 in. soft copper tube to manual valve. Mount securely near bottom of enclosure, but not fastened to enclosure. For individual units, radiators, fan convectors and units with return grilles: Provide coin air vent valve, operated from discharge grille or access door. Positioning of valve shall not interfere with removal of enclosure.

b. Equipment Below Mains: Connect piping run outs or risers to bottom or lower quadrant of mains. Vent assembly not required in unit. Provide means of purging and draining each unit. Use tees instead of ells at low point of run outs.

3.4 VALVE INSTALLATION

A. When installing solder-joint end valves, protect valve body from soldering heat using water soaked rags or other heat sink method as required to avoid valve damage. Leaking stems or seats on solder-joint end valves shall be subject to immediate replacement with new valve.

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 and handle movement.

E. Install all Automatic Air Vents above manual vent assembly described below, with discharge piped to point of collection - for glycol venting, pipe discharge to glycol feed station as shown, or if not shown to minimum 1 quart clear plastic container, secured and removable for service.

F. Install all Manual Air Vents with air collection chamber above flow piping (minimum line size diameter x 6 inches long), and minimum ¼" tube extended to accessible location, terminating with ball valve located so liquid discharged during venting may easily be collected in minimum 1 quart container.

1. Coin vents may be connected directly to equipment served.

3.5 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.

END OF SECTION 23 05 23

SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC COMPONENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes

1. Hangers and supports for (but not limited to) following components:

   a. Piping hangers and supports
   b. Duct hangers and supports
   c. Equipment hangers and supports

2. Roof mounted supports and equipment penetrations including (but not limited to):

   a. Combination equipment / pipe penetration curbs
   b. Pipe curb assembly
   c. Equipment support rails
   d. Pipe and duct supports

3. Miscellaneous components and accessories including (but not limited to):

   a. Anchors
   b. Guides
   c. Fasteners
   d. Custom supports
   e. Insulation protection systems

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

A. Provide corrosion resistant construction as described below for hangers, hanger rods, supports, fittings, hardware, etc, unless otherwise noted or approved. Note that not all products described below are available in corrosion resistance as required for all applications listed – select appropriate corrosion resistant products as required. Multiple conditions may apply, in which case the more corrosion resistant construction is required:

1. General purpose indoor: ASTM B-633 Fe/Zn 25 minimum zinc plated fasteners, ASTM B-653 G90 minimum sheet steel, factory baked enamel paint, or anodized.

2. In contact with copper: Copper plated for size identification and felt lined or plastic coated.

3. In contact with aluminum: Same aluminum alloy as equipment or 300 series stainless steel. 300 series stainless steel fasteners.

4. Outdoors, in crawl spaces, manholes, pits, and below grade: 300 series stainless steel or post-fabrication (after forming, welding, drilling, etc.) ASTM A-153 hot dipped galvanized steel, minimum coating thickness 3 mils.

5. Miscellaneous fabricated custom supports, anchor bases, etc..: painted in accordance with Section 23 05 00 – COMMON WORK RESULTS FOR HVAC.

6. Other special conditions: where noted on drawings, provide materials of special temperature, corrosion resistance, or other properties, as required for durable and safe performance.

B. Allowable Working Loads:

1. Use only manufacturer's load rated hangers, supports, and fasteners designed and rated for the intended service.

2. Do not load connectors, hangers, or supports to more than the manufacturers′ recommended working load or the following:

   a. Use a safety factor of 5:1 minimum with respect to manufacturers′ published ultimate shear strength.
   b. Use a safety factor of 10:1 minimum with respect to manufacturers′ published ultimate tension or pull-out strength.

C. 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, service loads, 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 SUBMITTALS

A. Product Data: Submit manufacturer's product literature, technical specifications, and other data required to demonstrate compliance with specified requirements for following components:

1. Hangers and supports

2. Roof mounted supports
3. Miscellaneous components

B. Roofing Work:

1. Submit qualifications of proposed roofing and structural subcontractor(s)

2. Submit copy of any existing roofing warrantee and certification by existing warrantee holder that proposed roofing subcontractor is certified to provide compliant roofing warrantee work and that this project's roofing work will not (before construction) and has not (after construction) voided any warrantee.

3. Submit copy of new warrantee for roofing performed on existing out-of-warrantee roofing.

C. Shop Drawings: Submit intended custom support construction for approval.

D. All supports, etc., shall meet the approval of the Architects / Engineers. Submit shop drawings showing fabrication and installation details including calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.

1.6 QUALITY ASSURANCE

A. Comply with applicable requirements of following standards for all hangers and supports:

1. MSS-SP-58 Pipe Hangers and Supports – Materials, Design, and Manufacture.
2. MSS-SP-69 Pipe Hangers and Supports – Selection and Application.
3. ANSI / ASME Code for Pressure Piping B 31.1
4. ASTM standards for corrosion resistant Zinc coatings.
5. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
6. UL 203 Standard for Pipe Hanger Equipment and Fire Protection Service
7. Metal Framing Association MFMA-2
8. ANSI/ NFoPA NDS - National Design Specification for Wood Construction
9. SMACNA – Sheet Metal and Air Conditioning Contractor's National Association, Inc.

B. All welding shall be approved procedures performed by approved welders. Refer to Division 05 Section for "STRUCTURAL STEEL FRAMING", and Section 23 05 00 – COMMON WORK RESULTS FOR HVAC, for details on welder's qualification requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. For convenience, details and specifications have been based on product types as defined in MSS SP-58 and 69 where applicable, and, where not applicable, catalog numbers shown have been based on products by the listed manufacturers.

2.2 PIPING ATTACHMENTS

A. Individually Suspended Horizontal Rigid Piping or Tube Attachments:

1. Band type:

a. 1-1/4 inch diameter pipe size and less only.
b. Formed steel loop overlapped at top with rod sized hole or insert nut. With or without side insert closure.
c. MSS SP-58 type 5, 6, or 10.

2. Clevis type:

a. Any size pipe or tubing.
b. Formed steel bands top and bottom connected by sheer bolt.
c. MSS SP-58 type 1.

3. Provide products by one of the following manufacturers:

a. B-Line Systems, Inc., Highland Illinois, or equal
b. ERICO/Michigan Hanger Co.; Solon, Ohio, or equal
c. Grinnell Corporation; Pipe Support Division, Cranston, Rhode Island, or equal.

B. Supported from below Horizontal Rigid Piping or Tube Attachments:

1. Split Ring type:

a. 1-1/4 inch diameter pipe size and less only.

b. Cast malleable iron split ring with steel pivot and bolt, cast boss on one side threaded for standard rod or pipe attachment. Designed to accommodate minimal longitudinal movement only.

c. MSS SP-58 type 12.

2. Provide products by one of the following manufacturers:

a. B-Line Systems, Inc., Highland Illinois, or equal
b. ERICO/Michigan Hanger Co.; Solon, Ohio, or equal
c. Grinnell Corporation; Pipe Support Division, Cranston, Rhode Island, or equal.

C. Group Supported or Suspended (Trapeze) Horizontal Rigid Piping or Tube Attachments (Common Support Beam):

1. Support frame or trapeze beam of load rated brackets or channel strut product.

2. U-Bolt type:

a. Any size pipe or tubing.

b. Insulation support system rests directly on beam or shim, with U-bolt or split strut clamp upper restraint. Designed to accommodate minimal longitudinal movement only.

c. U-bolt MSS SP-58 type 24, Strut clamp similar to B-Line "B-2000" series.

3. Provide products by one of the following manufacturers:

a. B-Line Systems, Inc., Highland Illinois, or equal
b. ERICO/Michigan Hanger Co.; Solon, Ohio, or equal
c. Grinnell Corporation; Pipe Support Division, Cranston, Rhode Island, or equal.

D. Individual Vertical Rigid Piping and Tube Attachments:

1. Split Ring type:

a. 1-1/4 inch diameter pipe size and less only.

b. Cast malleable iron split ring with steel pivot and bolt, cast boss on one side threaded for standard rod or pipe attachment. Designed to accommodate minimal longitudinal movement only.

c. MSS SP-58 type 12.

2. Riser clamp type:

a. 1-1/2 inch diameter pipe size and larger.

b. Twin formed steel bands with formed radius to fit pipe and extension wings drilled for clamping bolts, space between extension wings designed to accept various connections to building structure.

c. MSS SP-58 type 8.

3. Provide products by one of the following manufacturers:

a. B-Line Systems, Inc., Highland Illinois, or equal
b. ERICO/Michigan Hanger Co.; Solon, Ohio, or equal
c. Grinnell Corporation; Pipe Support Division, Cranston, Rhode Island, or equal.

E. Piping Insulation Protection Systems:

1. Pipe Insulation Shields:

a. One Piece:

1) Formed steel, minimum 18 gauge thickness, longer of 2 times diameter or 12-inch long minimum, and 180 degree circumference, sized for insulation thickness.

2) MSS SP-58/69 type 40.

2. Type “A” Insulation Protection System:

   a. 1” piping and smaller only.
   b. Provide one piece or two piece sliding shield as required.

3. Type “B” Insulation Protection System:

   a. 1¼” through 8” heating piping only.

   b. Provide one piece or two piece sliding shield as required.

   c. Pipe Support Insulation: High density (20 pcf). molded fiberglass blocks consisting of fiberglass wool and urea-phenolic resin cured binder. Provide number and size of support blocks as required to limit deflection to 1% and avoid long-term damage to vapor barrier, and as required for pipe size and insulation thickness, in accordance with manufacturer’s written guidelines and project details. Seal cut in piping insulation vapor barrier using manufacturer’s recommended matching tape. Similar to AHAMFAB H-Block" by ICA

4. Type “C” Insulation Protection System:

   a. Acceptable for any size heating or cooling piping.

   b. Manufacturer’s assembly consisting of insulation shield, high compressive strength insulation, and vapor barrier covering. May include hanger also.

   c. Hanger: As required above, secured to shield and support insulation.

   d. Insulation Shield: Provide one piece or two piece sliding shield as required by distance from piping anchors.

   e. High Compressive Strength Insulation: 180 or 360-degree circumference insulation insert formed of water resistance treated hydrous calcium silicate (untreated cal-sil not acceptable) or cellular glass insulation, same thickness as adjacent insulation.

   f. Vapor Barrier Covering: White kraft outer surface bonded to aluminum foil, sandwiching reinforcing fiberglass skrim yarn, permanently treated for fire and smoke safety and to prevent corrosion of the foil, with a vapor transmission perm rating of 0.02 or less. Seal to piping insulation vapor barrier using manufacturer’s recommended matching tape.

   g. Similar to Models “123”, “124", “1031”, and “4031” by ERICO/Michigan Hanger.

5. Provide products by one of the following manufacturers:

   a. B-Line Systems, Inc., Highland Illinois, or equal
   b. ERICO/Michigan Hanger Co.; Solon, Ohio, or equal
   c. ICA Inc.; Lehighton, Pennsylvania, or equal.
   d. Buckaroos, Inc.

2.3 DUCT ATTACHMENTS

A. Per SMACNA Duct Manual standards for size, height, and location of ductwork, and as noted below.

1. Materials and corrosion resistance as listed above.

2. SMACNA load tables allow for no external loads on duct: provide for 200 lb external load on all duct hangers and supports. Increase hanger and support sizes from SMACNA tables accordingly:

   a. Minimum band size 20ga. x 1 inch.
   b. Duct 48" wide and larger; provide trapeze style support of metal channel framing or angle iron, suspended from threaded rods.

3. Hanger bands to extend down sides and turn under bottom 1 inch minimum for all duct sizes. Minimum (2) #10 sheet metal screws per hanger (one each on side and bottom), (2) screws minimum on sides for duct over 12 inches tall, 12 inches on center max.

4. Round exposed duct: hang from twin half round bands and rods, or as otherwise detailed.

2.4 BUILDING ATTACHMENTS

A. Structural Steel Connectors:

1. C-Clamp style:

   a. FM approved, U.L. listed, steel or malleable iron C-clamp with hardened set screw and lock nut, tapped for rod size, typically eccentrically loads structure.
   b. Hanger rod bypasses structure: MSS SP-58 type 19.
   c. Hanger rod in line with set screw: MSS SP-58 type 23.

2. Center Loading Beam and Channel Clamp Style:

   a. Forged or formed steel or malleable iron construction, beam clamps with connection for concentrically loading structure, of types as required by loading and configuration.

   b. MSS SP-58 types 21, 27, 28, 29, and 30.

3. Pivoting or Adjustable Connection Style:

   a. Structural welding lug with forged steel clevis, side beam bracket, or other appropriate pivoting beam clamps as required for sloped steel.
   b. Use for sloped steel, where thermal movement requires pivot, where seismic controls requires non-moment building connection, and elsewhere as required.
   c. MSS SP-58 types, 21 or 22 with 16 or 17, 34, 57 with 14, etc...

4. Provide products by one of the following manufacturers:

   a. B-Line Systems, Inc., Highland Illinois, or equal

b. ERICO/Michigan Hanger Co.; Solon, Ohio, or equal
c. Grinnell Corporation; Pipe Support Division, Cranston, Rhode Island, or equal.

B. Existing Concrete Connectors

1. Self-energizing tapered expansion bolt/sleeve: GSA specification FF-S-325, Group II, Type 3, Class 3, UL Listed, FM approved, complete with split expansion sleeve, washer, and hex head nut; similar to "Rawl Lok/Bolt" by Rawlplug.

2. Dual-Interlocking Expansion Wedge Stud: GSA specification FF-S-325, Group II, Type 4, Class 1, UL Listed, FM approved, complete with split expansion sleeve, washer, and hex head nut; similar to "Rawl-Stud" by Rawlplug.

3. Dual-Interlocking Expansion Wedge Threaded Rod Anchors: UL Listed, FM approved, complete with split expansion sleeve; similar to "Rod Hanger Wedge Anchor" by Rawlplug.

4. Provide products by one of the following manufacturers:

a. Hilti, Inc.; Tulsa, Oklahoma, or equal
b. Ramset/Red Head; Michigan City, Indiana, or equal
c. Rawlplug Co. Inc.; New Rochelle, New York, or equal.

C. Hollow Masonry, Hollow Concrete, Pre-cast Plank Connectors

1. Toggle Bolt Type: GSA specification FF-B-588C, Type 1, Class A with ultimate load capacities meeting or exceeding load capacities for hollow concrete block in conformance with ASTM C-90; similar to "Rawl Toggle Bolt" by Rawlplug.

2. Epoxy/Screen tube type: Manufacturer's load rated epoxy resistant to the chemical exposure of the application and capable of developing the ultimate strength of the threaded rod used, with stainless steel screen tube designed specifically for use with epoxy anchors in hollow masonry. Use manufacturer's recommended mixing/injection device. Similar to the "Foil-Fast", "Chem-Fast", and "Chem-Stud" systems by Rawlplug.

3. Through bolt, nuts, square plate steel washer (thickness equal to half bolt diameter, width equal to six diameters minimum).

4. Provide products by one of the following manufacturers:

a. Hilti, Inc.; Tulsa, Oklahoma, or equal
b. Ramset/Red Head; Michigan City, Indiana, or equal
c. Rawlplug Co. Inc.; New Rochelle, New York, or equal.

D. Flanged Connectors:

1. Applicable for attachment to building steel, concrete, or wood.

2. Malleable iron flange base, with central threaded hole for connection to threaded rod and symmetrical side hole for securing to structure with appropriate fasteners, typically used with split rings, similar to “Model No. 365M" by ERICO/Michigan Hanger.

3. Pipe Stanchion Flanged Support Plate and Floor Stand: ASTM A-536 ductile iron support plate with 1-inch rolled thread adjustment stud and nut, or 1/4-inch carbon steel base plate welded to schedule 80 threaded steel pipe, designed for use with Stanchion Saddle style supports described above; similar to “PS1236 Redi-Jack Pipe Support” by Red Hed.

4. Provide products by one of the following manufacturers:

   a. B-Line Systems, Inc., Highland Illinois, or equal
   b. ERICO/Michigan Hanger Co.; Solon, Ohio, or equal
   c. Red Hed; Lincoln, Rhode Island. or equal.

E. Wood Construction Fasteners:

1. Apply NDS criteria to all structural wood connections.

2. Use load rated through bolts, lag screws, coach screws, side beam brackets, and wood screws (nails not acceptable). Tighten connections between members. Install fasteners without splitting wood members.

   a. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials.

2.5 ROOF MOUNTED SUPPORTS

A. Roof Curbs: Double shell, galvanized steel, welded and painted, 1-1/2 inch minimum thickness, with pressure treated wood blocking, braced and fully insulated with rigid fiberglass insulation (3 PCF). Includes gasket at top of curb for airtight seal between curb and ventilator or fan. Provide raised cant, recessed, or flanged curb bottom to suit roof construction and insulation, with custom profile to match sloped, metal or profiled roofing as required.

1. Steel Thickness: 20 gauge up to 36 inches, 18 gauge 38 to 72 inches, and 16 gauge over 72 inches. Provided with reinforcing and heavier gauge as required to adequately support weight load on curb; coordinate exact size with specified equipment.

2. Minimum height of curbs above finished roof:

   a. 12 inches for curbs supporting exhaust and relief air equipment.
   b. 24 inches for curbs supporting outside air intakes.
   c. For sloped roof curbs, curb of height sufficient to maintain bottom edge of supported equipment at above specified height.

3. Provide with pressure treated blocking, through bolted to structure with stainless steel fasteners, as required bringing base of curb into proper plane for installation. Blocking minimum width to be no less than blocking height. Refer to Division 6 section “Rough Carpentry” for additional details.

4. Provide products by one of the following:

    a. Pate or equal
    b. Con-Fab or equal
    c. Thy-Curb or equal

B. Curb Adapters: Where necessary, provide curb adapters to transition in size from existing curb to equipment provided as a part of this contract. Curb adapters of fully welded aluminum (12ga) or stainless steel (16ga) construction designed for continuous exposure to the elements. Provide with integral curb counter flashing and drip edge with minimum 2 inch downturn and quarter inch clearance to existing curb exterior on all sides and minimum two screws per side, sized for proper wind resistance, #12 ss screws minimum. Upper portion similar to Roof Curb above.

C. Pipe Curb Assembly: Similar to Roof Curb specified above, equipped with fully welded curb cap top cover of heavy gauge aluminum (12ga), galvalume (16ga), or stainless steel (16ga) construction with integral curb counter flashing, raised flashing collars with replaceable neoprene pipe boot counter flashing secured with stainless steel clamps, size and number of pipe and conduit openings as required. Similar to Pate PCA curb with PCC-C custom curb cap package.

1. Provide products by one of the following:

    a. Pate or equal
    b. Con-Fab or equal
    c. Thy-Curb or equal

D. Equipment Support Rails: Double shell galvanized steel, 14 gauge minimum, fully welded with solid bottom and ends. 2 inch x 8 inch treated wood top blocking, minimum 12 inches high above finished roof, minimum 2 inch turned out flange at bottom, C-channel top cap counter-flashing over blocking. Length to be the longer of 12 inches longer than equipment served or extended past equipment to next building structural support member, factory certified for weight of intended equipment at spacing of structure below, with reinforcement and heavier gauge as required. Units longer than eight feet may be field spliced with bolts and splice plates. Provide galvanizing paint at welds and field splices. Include top cap and integral base with raised cant where required. Provide raised cant, recessed cant, or flanged curb bottom to suit roof construction and insulation.

E. Similar to custom "ES-5A" by Pate.

1. Provide products by one of the following:

    a. Pate or equal
    b. Con-Fab or equal
    c. Thy-Curb or equal

F. Non roofing penetration exterior duct supports:

1. Install per manufacturers recommendations, and as required to maintain roofing warranty. In general, assume installation on loose laid pad of PVC or EPDM reinforcement compatible with roofing, at least one half inch thick and 4 inches larger than support stand base. Provide base sizes load rated for distributing the supported weight at less than two pounds per square foot. Include snow load as shown on code compliance drawings. Provide detailed duct support layout drawings and support size / weight / roof loading calculations in submittal for all non roofing penetration exterior duct supports.

2. Provide loose laid support stands with structural UV stabilized plastic (polypropylene, polycarbonate, FRP) or stainless steel deck base, with socket securing Hot Dipped galvanized or Stainless Steel channel duct support superstructure. Include mechanically bolted support angle clips, and cross member channels for both gravity support and uplift resistance. All fasteners to be stainless steel. Provide with radiused edges to protect roofing, drainage holes, and bolt down holes as required by seismic restraint system.

3. Sliding clamped height adjustment supports, adjustable as required to achieve duct slope and roof clearance required.

4. Similar to "PPH-D Enclosed" by PHP. Provide products by one of the following:

   a. B-Line Systems, Inc., Highland Illinois, or equal
   b. RTS by Eberl Iron Works, Buffalo, NY, or equal
   c. Miro Industries, Inc., Murray, Utah, or equal
   d. Portable Pipe Hangers (PHP) Systems and Design, Houston, Texas, or equal

G. Non roofing penetration pipe supports:

1. Install per manufacturers recommendations, and as required to maintain roofing warranty. In general, assume installation on loose laid pad of PVC or EPDM reinforcement compatible with roofing, at least one half inch thick and 4 inches larger than support stand base. Provide base sizes load rated for distributing the supported weight at less than two pounds per square inch. Provide detailed piping support layout drawings and support size / weight / roof loading calculations in submittal for all non roofing penetration pipe supports.

2. 2 inch nominal and smaller pipe:

   a. Loose laid pipe support stand with structural UV stabilized plastic (polypropylene, polycarbonate, FRP) deck base / roller housing, with load rated roller saddle running on nylon or SS bearing shaft. Provide with drainage holes, and bolt down holes as required by seismic restraint system.

   b. Provide matching height adjustment spacers to achieve pipe slope required.

   c. Manufacturer load rated as required.

   d. Similar to "Pillow Block Pipestand Model 3-R" by Miro Industries, SS8-R by PHP.

3. Provide products by one of the following:

    a. B-Line Systems, Inc., Highland Illinois, or equal
    b. RTS by Eberl Iron Works, Buffalo, NY, or equal
    c. Miro Industries, Inc., Murray, Utah, or equal
    d. Portable Pipe Hangers (PHP) Systems and Design, Houston, Texas, or equal

H. Roofing Penetration Pipe and Duct Supports: Same construction as “Equipment Support Rails” specified above, minimum 12 inches high. Include full-length steel bracket, pipe rolls, adjustable upright supports, and accessories as required to secure piping or duct to support. Similar to “RAS” with "PRS-1 or 5" by Pate.

1. Provide products by one of the following:

    a. Pate or equal
    b. Con-Fab or equal
    c. Thy-Curb or equal

2.6 MANUFACTURED METAL FRAMING 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. Allied Tube & Conduit.
2. Cooper B-Line, Inc.
3. Flex-Strut Inc.
4. Unistrut Corporation; Tyco International, Ltd.

B. Description: Factory, shop, or field-fabricated support assembly made of steel channels, accessories, fittings, and other components, factory stock or custom designed and assembled for supporting diverse mechanical components.

C. Standard: MFMA-4.

D. Channels: Load rated continuous slotted steel channel with in-turned lips.

E. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

F. Corrosion resistance as described above.

2.7 EQUIPMENT SUPPORTS

A. Provide custom designed hangers and supports to properly and resiliently support all contract equipment as required by special circumstances encountered. Suspend from above or support from below as shown on drawings and as required.

B. Use structural carbon steel plate and shapes, secured by welding or bolts as required.

C. Use load rated fasteners full size of the component attachment points unless specifically requested and approved otherwise.

D. Provide lateral bracing as required minimizing potential for sway.

E. Fabricate as required to transmit loads and reaction forces to structure, in accordance with applicable details and layouts shown on Drawings, and as approved by Architect. Submit load calculations and fabrication details for approval for all such supports including verified coordinated dimensions, weights, etc., of mechanical component, support component, and building structure proposed.

2.8 MISCELLANEOUS COMPONENTS AND ACCESSORIES

A. Threaded Rods, Bolts, Nuts, Washers, Metals, Hardware, and Miscellaneous Assembly Components:

1. Provide manufacturer's load rated fasteners with size, strength and corrosion resistance as required for the application.

2. Rods, bolts, machine screws: rolled forged ANSI B1 Class 2A or better thread, bolts and screws with heads as required by the application.

3. Nuts: heavy pattern where space permits and where subject to repeated operation, ANSI B1 Class 2B or better thread.

4. Washers: US pattern where space permits, SAE pattern otherwise, with toothed or split lock washer when attached to equipment with moving or vibrating parts.

5. Sheet metal screws: self drilling, thread forming, hardened steel (hardened SS as required), load rated screws with hex heads designed for power driving

6. Structural Steel: ASTM A 36/A 36M, carbon-steel, black and galvanized, and/or series 300 Stainless Steel plates, bars, angles, channels, and other shapes in thickness and size as required for load.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which hangers and supports are to be installed and notify Architect in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in an acceptable manner.

1. When Contractor confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to Architect written confirmation. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Contractor.

2. Identify any discrepancies between specifications and field conditions or changes required due to specific equipment selection, prior to installation. Corrective work required by discrepancies after installation at Contractor's expense.

3.2 GENERAL INSTALLATION

A. Provide complete hanger and support systems for piping and ductwork systems and equipment, including all necessary attachments, fasteners, threaded rods, bolts, miscellaneous hardware, and associated work as required.

B. Provide specified products, installed in accordance with applicable sections of this specification, in accordance with the manufacturer's recommended installation instructions, and as detailed on the Drawings.

C. Support pipe, duct, and equipment from the building structure.

1. Provide approved miscellaneous support structure as required to attach hangers and supports to building structure in conformance with all applicable standards and related specification sections.

2. Do not use chain, perforated hanger strapping or band, wire hangers, or kinked, bent, or otherwise damaged hangers and supports.

3. Do not support one pipe from another, one duct from another, pipe from duct or equipment, or any similar combination.

4. Install lateral bracing with pipe hangers and supports as required to prevent swaying.

5. Provide special hangers and supports as shown on the drawings, as required to suit existing conditions, and as required for proper installation of equipment.

D. Coordinate the installation with applied fireproofing and where possible install attachments to structure prior to fireproofing. Where prior installation is not possible, repair fireproofing as required.

1. Repair or replace any fireproofing removed or damaged during installation of components.
2. Ensure repaired or replacement fireproofing continuously matches or exceeds rating of adjacent fireproofing and ensure that all warranties are maintained.

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

3.3 PIPE HANGER AND SUPPORT INSTALLATION

A. Comply with MSS SP-58 and MSS SP-89 and as specified below. Install hangers, supports, clamps, and attachments as required properly supporting piping from the building structure.

B. Trapeze Pipe-Hanger Installation: 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 manufactured slotted channel system or structural shapes selected for loads being supported.

C. Size piping attachments for insulated piping to fit outside insulation. Size piping attachments for un-insulated piping to fit outside diameter of pipe.

D. 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. Provide for slope of trapeze supported piping systems with adjustable individual piping attachments.

E. Accommodate thermal movement of piping systems.

1. Install hangers and supports to allow controlled thermal 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.

2. Provide rods of sufficient length for ample swing. Hang rods from high points to allow maximum swing.

3. Hang piping so that rods are vertical at the design temperature.

4. Where length of rod and thermal expansion combine to cause more than 4 degrees angular movement of rod (or 1 inch lateral movement in a 12 inch rod), provide suitable linkage to permit swing and limit rods to tensile loading only, or, provide pipe roll.

5. Where length of rod and thermal expansion would combine to cause more than 10 degrees angular movement of rod (or 2 inch lateral movement in a 12 inch rod), provide pipe roll.

6. More thermal movement is expected as the straight line distance from piping anchor points increases. Unless unusually long hanging rod length allows swing as indicated above, provide pipe roll hangers and supports at or above the following distances from piping anchor points indicated on drawing or installed in field. Deviations from below values subject to pre-approval:

Piping Service		Distance from Anchorage
a.	Individual Copper Heating Service.	35 ft.
b.	Trapeze Copper Heating Service.	20 ft
c.	Individual Steel Heating Service.	60 ft.
d.	Trapeze Steel Heating Service.	50 ft

F. Pipe Hangers and Supports Spacing (Maximum):

1. Provide hanger or support as close as possible to and within 24 inches of any elbow.

2. Provide hanger or support on branch pipe within 24 inches of main at takeoff / tee.

3. All Horizontal / Sloped Heating and Cooling Piping Systems:

Piping Material		Maximum spacing of hangers
a.	Flexible piping or hose	Continuous
b.	Copper ¾ in. and smaller	5 ft.
c.	Copper 1 in. and 1-¼ in.	6 ft.
d.	Copper 1½ in. and larger	8 ft.
e.	Steel 1¼ in. and smaller.	7 ft
f.	Steel 1½ in.	9 ft.
g.	Steel 2 in. and larger	10 ft.

G. Insulated Piping

1. Center insulation shields at piping attachments and secure shield from lateral movements by wrapping PVC tape around circumference of piping insulation and shield at both ends of shield.

2. At all piping attachments, provide piping insulation protection system of strength and configuration required to guarantee integrity of pipe insulation and associated vapor barrier. Refer also to SECTION 23 07 00 INSULATION.

3.4 BUILDING ATTACHEMENTS INSTALLATION

A. Threaded Rod for Hangers:

1. Double nut each end of each rod. Threaded clamp, turnbuckle, etc. counts as one nut.

2. Rod size for individual pipe hangers and two rod / two pipe or duct trapeze style supports:

Rod size:	for Pipe size:	for Duct size:
3/8”	2” and smaller.	48” wide to 72”
1/2”	2-1/2" and 3".	Over 72” wide
5/8”	4" and 5".	
3/4”	6".	

3. For multiple pipe or duct trapeze style supports with two rods for more than two pipes or two or more ducts, size rods according to manufacturers recommended safe working loads taking into account total hung weight, 200 pound live load, as well as capacity of structure; each rod not smaller than size shown above for largest pipe or the sum of the duct width in the trapeze. Submit details of all such supports and connectors for approval before construction, including schedule of proposed sizes and capacities.

B. Fastener Systems: Provide screws, bolts, approved anchors, etc., to secure piping, duct, equipment, supports, and miscellaneous components and accessories to structure. Nailing not permitted.

1. Install all fastener systems and anchorage in strict accordance with fastener manufacturer’s instructions and as otherwise indicated below.

2. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 3" 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.

3. Minimize eccentric loading of structure as follows:

   a. For paired point loads eccentrically suspended (C-clamp attached supply and return pipes, etc), suspend from opposite edges of structural member.

   b. For point loads over 400 pounds, use center loading beam clamps or other structurally concentric building attachment, and confirm proposed configuration with Engineer by submittal.

4. For connections cast in place to new concrete, assume concrete strength as specified. Do not apply loads to freshly cured concrete until written approval is received from contractor responsible for concrete strength.

5. For connection to existing concrete:

   a. Connect only to sound concrete free of evidence of deterioration.

   b. Do not install connections or apply loads to recently cast curing concrete until written approval is received from contractor responsible for concrete strength. Use compressive strength certified by ASTM approved test results.

   c. For older existing concrete and in the absence of ASTM approved tests certifying otherwise, assume a concrete compressive strength of $f'c$ = 3000 psi.

   d. 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. Do not use powder-actuated fasteners in precast concrete or in pull-out tension.

6. For connection to wooden structures: Apply NDS criteria to all structural wood connections. Unless grade stamped better, use #2 SPF / white wood strengths for fastener loading calculations.

3.5 DUCT HANGERS AND SUPPORTS

A. Install per SMACNA duct manual and as modified by the requirements of this section.
B. Provide support spacing per building structural system but not greater than 8 feet. Provide extra support structure as required.

3.6 ELECTRICAL WORK HANGER AND SUPPORT INSTALLATION

A. Refer to Division 26 complete.

3.7 ROOFTOP SUPPORT INSTALLATION

A. Rooftop Supports for Piping, Duct, and Service Access:

1. Non-roofing penetration supports:

a. Install per manufacturers recommendations, and as required to maintain roofing warranty. In general, assume that cleaning area of roofing at each support is required with installation on loose laid pad of pvc or epdm reinforcement compatible with roofing, at least one half inch thick and minimum 4 inches larger than support stand base.

b. Center supports beneath duct. Align platform supports adjacent to equipment requiring service access as required provided optimized access.

c. Adjust to desired height insuring level platforms, level horizontal bars, proper longitudinal pitch for pipe and duct, and even load distribution among all supports.

d. Set equipment in support without dropping or causing undue impact. Assemble platform grating and secure to superstructure.

e. Assemble duct restraints and make final adjustments to alignment and level.

B. Roof Curbs, Pipe Curbs, and Equipment Support Rails:

1. Maintain existing roof warranties. Contractor is responsible for the installation of all Roof Curbs, Pipe Curbs, and Equipment Support Rails for their equipment complete. Employ the services of a qualified subcontractor specializing in roofing work and certified by the carrier of all new or existing roofing warrantees to perform warrantee compliant roofing work as required for this project. Employ the services of a qualified subcontractor specializing in structural work to perform structural roof support work as required for this project. Use their services to cut roof openings, provide structural support and installation of Roof Curbs, Pipe Curbs, and Equipment Support Rails, and to patch roofing cuts complete. Refer to SECTION 01 73 00 - EXECUTION for additional requirements and procedures for cutting openings in existing roofs and roof decks.

a. If existing roofing is out of warrantee, provide minimum two year warrantee for roofing work of this contract.

2. Provide larger of curb height scheduled on Drawings or as recommended by equipment manufacturer, but not less than 12 in. above finished roof. Refer to required installation details and provide additional curb height where finished roof surface is above curb mounting flange.

3. Provide all roof curbs required for all rooftop-mounted equipment in Contract.

a. Provide structural support for roof deck around all roof curbs and roof deck penetrations 12 inch x 12 inch and larger, unless specifically indicated otherwise elsewhere on the Contract Documents. Refer to drawings for additional support details around roof openings.

b. Refer to section 06 10 00 –ROUGH CARPENTRY, for additional wood blocking requirements.

c. Verify exact size and location and set and secure unit to roof.

d. Set and secure curb or support level as required by manufacturer of equipment served and as required by the installation details of the seismic restraint system. Provide tapered shims as required up to 3-1/2 inch thick. If structure slopes more than 3-1/2 inch over length of curb, provide sloped curb to match structure so as to minimize shims. Provide corrosion-resistant fasteners as required to secure curbs to deck or structure, coordinate with subsequent roofing requirements.

e. Coordinate roof openings and set and secure curbs in ample time so as to avoid delay in construction schedule.

f. Coordinate in curb access and rooftop equipment sound transmission mitigation:

1) Coordinate roof deck removal within curbs in all cases with Architect, Owner, Construction Manager and all affected trades as required to optimize access and sound transmission prevention.

2) In general, for exhaust fan, roof top hood, pipe, and combination equipment / pipe penetration curbs, provide for below curb service access by complete removal of roof deck internal to curb throat free area.

3) In general, for Roof Top Air Handling Units, provide in curb sound attenuation and acoustically rated roof deck penetrations as specified in Section 23 05 48 – MECHANICAL, VIBRATION, AND MOVEMENT CONTROL.

4) Coordinate special circumstances requiring exceptions to above with Architect and equipment manufacturers.

g. Prevent water entry into building. Provide roofing work as required to flash curbs. Provide counter flashing and gaskets with curb mounted equipment as required to keep water from entering curb. Provide temporary caps as required until permanent installation is made.

h. Install Curb Adapters in manner similar to how supported equipment is secured to curb. Provide complete with closed cell gaskets, minimum two stainless steel fasteners per side and additionally as required for equipment support.

3.8 METAL FRAMING AND EQUIPMENT SUPPORT INSTALLATION

A. Provide miscellaneous metal, beams, angles pipe bars, structural steel shapes, bases, braces, etc. accessories required to attach hangers and supports to walls, floors, structural members, etc. in conformance with Section 05 12 00 – “STRUCTURAL STEEL FRAMING”.

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

C. Custom Hangers and Supports: Install as required by special circumstances encountered, in accordance with applicable details and layouts shown on Drawings, and as approved by Architect.

D. Provide lateral bracing to prevent swaying for equipment supports.

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

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

G. 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.

3.9 ADJUSTING

A. Adjust all hangers and supports after installation of piping and associated equipment to distribute loads equally on attachments and to achieve proper pitch for the applicable piping system.

B. Trim excess length of continuous-thread hanger and support rods as required - avoid hazardous protrusion.

3.10 PAINTING AND TOUCHUP

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

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

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09.

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

END OF SECTION 23 05 29

SECTION 23 05 43 – MECHANICAL VIBRATION AND MOVEMENT CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes mechanical movement controls for all mechanical equipment and components, piping, and duct work provided or modified as a part of this Project and as noted on the drawings, whether movement is from sound, vibration, thermal, or other sources including (but not limited to):

1. Vibration isolation hangers and mounts for equipment, piping, and ductwork.
2. Equipment isolation bases.
3. Flexible piping and flexible piping connections.
4. Restrained vibration isolation roof-curb rails.

1.3 DEFINITIONS

A. IBC: International Building Code.
B. ICC-ES: ICC-Evaluation Service.

1.4 PERFORMANCE REQUIREMENTS

A. Provide mechanical sound, vibration, and movement control for all mechanical equipment, piping, duct work, and other components provided or modified as a part of this Project, and as shown on the Drawings. Mount on or suspend from vibration isolators to reduce transmission of vibration and mechanically transmitted sound to building structure. Select vibration isolators in accordance with weight distribution to produce reasonably uniform deflections.

1. Correct any variance or non-compliance with specified requirements in manner directed by Architect.

1.5 SUBMITTALS

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

B. Action Submittals:

1. Product Data for the following:

a. Catalog cuts and data sheets on vibration isolators, isolation bases, and isolation curbs. Indicate rated load, rated deflection, and overload capacity for each device. Annotate to indicate application of each product submitted and compliance with requirements.

b. Catalog cuts and data sheets on sound attenuation components used. Indicate style, material, and attenuation characteristics for each device or product.

c. Schedule of flexibly mounted equipment, referencing drawings by number. Include number, type, and loading of all isolation components.

2. Shop Drawings

a. Submit details of following items

1) Equipment bases including dimensions, structural member sizes and support point locations. Equipment bases shall include all curbs for rooftop air handling units.

2) Isolation hangers and systems for ceiling hung equipment, piping and ductwork.

3) Mountings for floor supported equipment, piping and ductwork.

4) Complete flexible connector details.

b. Indicate deflections and model numbers on all hanger, mounting or pad drawings including any other specified requirements.

c. Provide in tabular form spring diameters, rated loads and deflections, heights at rated load and closed height for all springs shown in submittals.

C. Closeout Submittals:

1. Field quality-control test reports.

2. Contract Closeout Submittals: Comply with requirements of Section 01 73 00, including submission of operating and maintenance instructions as item in "General Construction Instructions" manual described in that section.

1.6 COORDINATION

A. Coordinate layout and installation of vibration isolation and movement control devices with other construction that penetrates ceilings or is supported by, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

C. Coordinate design of vibration isolation design with expansion compensation systems.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

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:

1. Amber/Booth Company, Inc.
2. Kinetics Noise Control.
3. Mason Industries.

B. Factory Finishes: Provide manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanized metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation devices to indicate capacity range.

C. Where neoprene is referred to and used in vibration isolation components, it shall be bridge-bearing grade premium neoprene of the durometer hardness grade and size specifically recommended by the design make manufacturer for both maximum vibration isolation and load rated for the specific application.

D. Hangers

1. Neoprene Hangers: Rigid steel frames containing neoprene element.

a. Minimum 1-1/4-inch thick neoprene element on bottom with projecting bushing preventing steel-to-steel contact.
b. Minimum static deflection of 0.20-inch.
c. Boxes not articulated, clearance hole in neoprene element to allow non-moment bearing connection at structural support.
d. Configured for threaded rod, eye bolt, or strap connections as required.
e. Basis-of-Design Product: Mason Industries, Inc.; Type HD.

2. Vibration Hangers: Similar to Type A Hangers specified above with following modifications.

a. Provided with weldless eyebolts top and bottom to facilitate attachment to flat duct straps.
b. Basis-of-Design Product: Mason Industries, Inc.; Type W30N.

E. Piping Vibration Isolation and Movement Control

1. Flexible Hose: Factory assembled lengths sufficient to handle the anticipated flexing required due to either installation or thermal movement and rated for minimum 150 psig working pressure at 210 deg F operating temperature.

a. Provide one of following two styles of flexible hose. Pipe size listed on Drawings are for smooth bore hose; provide corrugated style hose one pipe size larger:

1) Stainless steel or bronze annular or helically corrugated closed pitch bellows with braided stainless steel or bronze wire reinforcing protective jacket, continuously TIG welded or silbrazed to end fittings.

a) Basis-of-Design Product: Flex-Hose Co., Inc.; Corrugated Metal Hose.

2) Smooth bore polymer liner with braided stainless steel or bronze wire reinforcing protective jacket, mechanically swaged to the end fittings.

a) Basis-of-Design Product: Flex-Hose Co., Inc.; Polyflex.

b. Provide connectors with threaded end connections meeting requirements specified for fittings and including external pipe thread one end and internal pipe thread adapter swivel or union other end for sizes through 2-inch, with flanges on both ends for sizes over 2-inch.

c. Rated for static and intermittent flexing radii no greater than that of the design make (approximately 3 diameters static and 8 diameters dynamic).

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

1) Flex-Hose Co., Inc.; Corrugated Metal Hose or Polyflex.
2) Mason Industries, Inc.; Type BSS or BFF.
3) Southeastern Hose, Inc.; SECM or SECC.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and movement control devices for compliance with requirements for installation tolerances and other conditions affecting performance. Notify affected Prime Contractors and Architect in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in an acceptable manner.

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

2. Identify any discrepancies between specifications and field conditions or changes required due to specific equipment selection, prior to installation. Corrective work required by discrepancies after installation at Contractor's expense.

B. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

3.2 VIBRATION, SOUND, AND THERMAL MOVEMENT CONTROL INSTALLATIONS

A. Install all vibration isolators in strict accordance with manufacturers written instructions and all submittal data. Coordinate installation to avoid rigid contact with building.

1. Install without any change of position of equipment, piping or ductwork resulting in stresses or misalignment.

2. Do not make rigid connections between equipment and building structure that degrade noise and vibration control system specified.

3. Do not install any equipment, piping, duct, or conduit with rigid connections to building or other support structure unless no isolation is specifically called for. "Building" includes, but is not limited to, roof deck, floor/ceiling/roof slabs, beams, joists, columns, studs and walls.

4. Identify any conflicts which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions to Architect / Engineer prior to installation. Corrective work required by conflicts after installation at Contractor's expense.

5. Correct, at no additional cost, all installations deemed defective in workmanship and materials at Contractor's expense.

3.3 PIPED EQUIPMENT INSTALLATIONS

A. Condensing Units, other Base Mounted Compressor-driven Equipment:

1. Isolate equipment from structure using vibration isolation system specifically designed for the installation and having deflection tuned to the mass and frequency of the rotating or vibrating machinery to minimize the propagation of the vibrations.

a. Unless specifically detailed otherwise, isolate equipment having 1 KW motors and larger and/or having a rotating speed of any component under 1800 rpm using restrained spring isolators with minimum 2” deflection, on inverted saddles as required to lower height, all mounted on elastomeric pads.

b. Unless specifically detailed otherwise, isolate equipment having under 1 KW motors and having a rotating speed of all components 1800 rpm or over using restrained elastomeric isolators with minimum 0.3” deflection, on inverted saddles as required to lower height.

3.4 AIRSIDE INSTALLATIONS

A. Vibration Isolation of Air Handling Equipment:

1. Isolate all interior and exterior mounted air handling units and dunnage-mounted rooftop units using vibration isolation bases specifically designed for the particular installation and having deflection tuned to the mass and frequency of the rotating or vibrating machinery so as to minimize the propagation of the vibrations or use manufacturer's structural base rails attached to Inverted Saddles.

2. Protect air handling equipment and centrifugal fans against excessive displacement resulting from high air thrust in relation to equipment weight. Provide horizontal thrust restraint specified in Part 2 above when thrust forces exceed 10 percent of equipment weight.

3. For all roof top air handling equipment including DOAS unit(s) above occupied spaces unless otherwise noted or scheduled on drawings, provide acoustical attenuation within curb below rooftop air handlers as follows:

   a. Coat deck within curb with damping compound.

   b. Seal around duct, pipe, conduit, fastener, etc., penetrations air-tight to maintain air and vapor barrier, typically with 60mil EPDM roofing membrane sealed to deck and cut for a tight stretch fit to pipe or duct. Caulk holes. Fill deck corrugation flutes at edges with fire rated expanding urethane foam and set / seal EPDM into wet foam.

   c. For air handlers with total motor power less than 5KW unless specified otherwise on the drawings:

      1) Fill entire area within curb with fire rated expanding urethane foam to a minimum depth of 5 inches from the top of the deck flutes.

   d. For air handlers with total motor power 5KW and above and/or as specifically called for on the drawings:

      1) Overlay sealed deck with 3" flexible fiberglass batt insulation.

      2) Overlay insulation with one layer of ⅝" thick moisture and mold resistant gypsum board (GWB) fitted 1" from curb perimeter and duct/piping penetrations with annulus filled with fiberglass batt, sealed and taped at all joints with damping compound and skrim joint tape.

      3) Overlay GWB with acoustical duct/pipe lagging fitted closely to duct, pipe, and curb perimeter and seal to each in accordance with manufacturer's directions.

      4) Provide acoustical duct and piping penetrations both through unit bottom and roof deck.

B. Vibration Isolation of Ductwork:

1. Isolate all ducts from mechanical air handling equipment using flexible connectors.

2. Isolate all discharge runs for distance of 50 ft. from connected equipment from building structure using Type A or Type B hangers. Provide minimum of 0.75-inch spring deflection.

3. Isolate all rectangular duct runs having average air velocity of 1200 fpm or more from building structure using Type A or Type B hangers. Provide minimum of 0.75-inch spring deflection.

3.5 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.

C. Adjust active height of spring isolators.

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

END OF SECTION 23 05 43

SECTION 23 05 53 - IDENTIFICATION FOR HVAC COMPONENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.
5. Stencils.
6. Valve tags.
7. Warning tags.
8. Equipment Location Ceiling Markers

1.3 SUBMITTALS

A. Procedural Requirements: Comply with requirements of SECTION 01 33 00 - Submittals and as modified below.

1. Specified Products: If product to be incorporated into Project is specified by name and product designation in Part 2 below, submit "**As-Specified Verification Form**" (attached to SECTION 01 33 00 - Submittals) in lieu of "Product Data" identified below in this Article.

2. Equivalent Products or Substitutions: If product to be incorporated into Project is not specified by name and product designation in Part 2 below, comply with all Action Submittal requirements specified below.

B. Action submittals:

1. Submit manufacturer's data sheets for all proposed products demonstrating compliance with specifications.

C. Closeout Information, for inclusion in Operations and Maintenance Manual:

1. Approved submittal.

a. If "**As-Specified Verification Form**" submittal is approved, also include product data for all identification components used.

2. Include all information required in SECTION 01 78 23 – Operation and Maintenance Data.

3. Valve Chart - Refer to SECTION 23 05 00 – Common Work Results for HVAC, for details.

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 MANUFACTURERS

A. Paint: Refer to DIVISION 09.

B. 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. Brimar Industries, Inc. or equal.
2. Campbell International (Ltd.), or equal.
3. Craftmark Identification Systems, Fort Worth, Texas, or equal
4. EMED Company, Inc., Buffalo, New York , or equal
5. Seton Name Plate Company, New Haven, Connecticut, or equal

2.2 LABELS

A. Warning Signs and Equipment Labels:

1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware, or multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware

2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

3. Colors:

   a. Brass Labels: black in-filled letters on brass background
   b. Plastic Labels: white letters on black plastic background
   c. Warning Signs: yellow letters on black background.

4. Able to withstand temperatures up to 160 deg F. continuously.

5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

6. Fasteners: Stainless-steel rivets or self-tapping screws.

7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Equipment Label Content: Include equipment's Drawing designation or unique equipment number and equipment function.

C. Warning Sign Content: Include caution and warning information, plus emergency notification instructions.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Include Equipment Schedule in Operation and Maintenance Manual.

2.3 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 [**partially cover**] [**cover full**] circumference of pipe and to attach to pipe without fasteners or adhesive. Secure in place with full circumference tape wrap.

C. Pipe Label Contents: Include identification of piping service using abbreviations indicated below, 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 (flow direction arrow circumference tape preferred).

2. Lettering Size: In accordance with ANSI 13.1 and as follows:

Outside diameter:	Letter Height:
a. 2” or less	¾”

3. Pipes too small to be directly labeled: provide hanging equipment tag with ½” lettering. Outside diameter indicated is to outside of pipe insulation on insulated piping.

D. Piping Systems: Identify the following systems as indicated:

1. Refrigerant Liquid (RL)
2. Refrigerant Suction (RS)

3. Refrigerant Hot Gas (HG)
4. Heating Hot Water Supply (HWS)
5. Condensate Drain (CD)

2.4 DUCT LABELS

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

B. Colors: Letter color, black; background color, white.

C. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

E. Minimum Letter Size: One inch for viewing distances up to 60 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

F. Fasteners: Stainless-steel rivets or self-tapping screws.

G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

H. Duct Label Contents: Include identification of duct service, duct size (inches x inches clear inside dimensions, side labeled first), and an arrow indicating flow direction.

1. Unless specifically indicated otherwise on Drawings, use duct service designations below, where (SYSTEM) is the equipment served:

    a. (SYSTEM) SUPPLY AIR
    b. (SYSTEM) RETURN AIR
    c. (SYSTEM) RELIEF AIR
    d. (SYSTEM) OUTSIDE AIR
    e. (SYSTEM) MIXED AIR
    f. (SYSTEM) MIXED EXHAUST
    g. (SYSTEM) TOILET EXHAUST

2. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.

2.5 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts (1 inch for each five feet viewing distance).

1. Stencil Material: Durable, thin, as required to make crisp stenciled pattern.
2. Stencil Paint: Exterior, gloss, acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.

3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.
4. Stenciled Label Contents: as described in pipe and duct labels above.

2.6 VALVE TAGS

A. Valve and Hydronic Specialty Identification: Provide **[1-1/2 inch]**[40-mm]inch diameter brass tags, 0.032-inchminimum thickness, with predrilled or stamped holes for attachment with #16 brass jack chain, factory engraved or stamped with 1/2-inch letters for piping system abbreviation and 1/2-inch numbers, with black in fill, legend as described below.

1. Stamp "H" and valve number for each main, riser, zone, and branch heating valve.

B. Provide manufacturer's tags for all balancing fittings.

C. 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. Include valve-tag schedule in Operation and Maintenance Manual.

2.7 WARNING TAGS

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

1. Size: 3 by 5-1/4 inches minimum.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

2.8 EQUIPMENT LOCATION CEILING MARKERS

A. 5/8-inch diameter celluloid covered or vinyl PSA backed stickers, suitable for ink notation on a colored face; color coded as follows:

1. Yellow: Volume Dampers
2. Blue: Isolation Valves
3. Green: Controls Devices (valves, automatic dampers, controllers)
4. Orange: Equipment (VAV boxes, fan coils, blower coils, fans, pumps, etc.)
5. Red: Fire Dampers

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.

B. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.
B. Locate equipment labels where accessible and visible.

3.3 PIPE IDENTIFICATION

A. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles and flow direction arrows, complying with ASME A13.1, on each piping system. Stencils shall be crisp and neat with no overspray, drips, runs, or other imperfections visible from normal viewing distance.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

B. 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 15 feet along each run.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Piping Painting Requirements:

1. Refer to Section 23 05 00 – "Common Work Results for HVAC" and Division 09 sections covering painting for pipe painting requirements and Pipe Color Code Identification Schedule.

3.4 PIPE LABEL INSTALLATION

A. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels complying with ASME A13.1**,** on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

B. 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 **15 feet** along each run.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Pipe Label Color Schedule:

	Item	Color
1.	Refrigerant……..	Dark Green
2.	Hot water supply & return……..	Brown
3.	Condensate (drain)……..	Rust Brown
4.	Refrigerant……..	Dark Green

3.5 DUCT LABEL INSTALLATION

A. Install plastic-laminated duct labels with permanent adhesive on air ducts.

B. Stenciled Duct Label Option: Stenciled labels, showing service, size, and flow direction as indicated above, may be provided instead of plastic-laminated duct labels, at Installer's option, for concealed ductwork or if lettering larger than 1 inch high is needed for proper identification because of distance (over ten feet) from normal location of required identification. Stencils shall be crisp and neat with no overspray, drips, runs, or other imperfections visible from normal viewing distance. Refer to Division 09 sections on painting for more information.

C. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.6 VALVE-TAG INSTALLATION

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

1. Valve Numbering System: Extension of and compatible with existing valve numbering system, where valves are installed in existing building or in addition to existing building. Do not duplicate existing numbers; verify existing numbers in the field

2. Verification: Verify existing valve numbers in field and provide valve numbering avoiding duplication of existing numbers.

B. Valve Identification For New Construction:

1. Provide 1-1/2 inch diameter brass tag with brass jack chain (#16).
2. Stamp "H" and valve number for each main, riser, zone, and branch heating valve and at all other valves whose function is not readily apparent.

3.7 WARNING-TAG INSTALLATION

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

3.8 EQUIPMENT LOCATION CEILING MARKERS

A. Provide markers in the metal grid of lay-in tile, in metal panel ceilings, at access doors in hard ceilings, and other locations as appropriate, indicating the location of dampers, valves, controls, equipment, fire dampers, and other devices as required. Write on markers with sharply contrasting permanent ink in neat handwriting clearly identifying equipment located beyond mark with abbreviation used in valve chart, equipment schedule, etc.

END OF SECTION 23 05 53

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

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Testing, Adjusting, and Balancing (TAB) Work shall be a joint effort of the Contractor and the TAB Agency, performed with the intention of leaving the systems involved in a properly functioning and balanced flow condition as designed and indicated in the Construction Documents, similar to the "Total System Balance" condition described in the AABC Standard.

1. The division of responsibility for the TAB Work is outlined below. Contractor to perform preparation and ancillary work described below, with the option of subcontracting a portion of their work to the TAB Agency, but the TAB Agency must take sole responsibility for any portion of the preparation or TAB Work defined as the TAB Agency's Work.

2. TAB Agency Work to be performed by a fully qualified independent TAB Agency as described in quality assurance below and as approved by the Architects and Engineers.

B. Section includes preparation for, and Testing, Adjusting, and Balancing (TAB Work) of HVAC components, equipment, and systems:

1. Contractor Preparation and Participation:

a. Place systems in satisfactory operating condition as detailed below prior to the arrival of the TAB Agency for the specified TAB Work, and notify the TAB agency, Construction Manager, and Engineer in writing when systems are ready for TAB Work.

b. Attend and actively participate in coordination and TAB meetings.

c. Keep TAB Agency apprised of construction schedule as required facilitating TAB agency job site visits prior to concealment of work. Provide overall construction schedule to TAB agency at coordination meetings and TAB meetings, update schedule regularly noting milestones and dates affecting TAB review and work schedule, and provide at minimum 7 calendar days notice prior to concealment.

d. Coordinate and provide mechanical and controls systems operation, revisions, and other ancillary work as required during TAB Work, as detailed below.

e. Make changes as required to create a testable, balanceable system, as recommended by TAB agency but only as approved by the Engineer.

2. TAB Agency Preparation:

a. Review Construction Documents and Coordination Drawings with Engineer, and Contractor and assist in preparation of submittals, particularly Coordination Drawings, dampers, and balancing valves, by preparing recommendations to Contractor and Engineer on locations of balancing valves, dampers, access doors, test connections, etc., as well as any other special considerations affecting the TAB Work and/or the fabrication or engineering of the systems. Documentation of assistance shall be both by mutually agreed upon notations on the submittals / sheet metal Shop Drawings prior to submittal, and by TAB Agency's letter accompanying submittal, verifying review and TAB Agency approval of the specific submittal.

b. Visit job prior to concealment of work, repeatedly if necessary due to construction scheduling, check work, and advise the Contractor and Engineer on correctness of locations of dampers, access doors, test connections, etc., as well as any other special considerations affecting the TAB work. Advise in writing, copied to the Contractor and the Engineer within 3 days of the site visit but in any event before concealment.

C. TAB Work includes:

1. *Testing* of all mechanical components for performance, calibration, capacity, and other characteristics as outlined below and as required, demonstrating conformance with contract documents and submittals.

2. *Adjusting and Balancing* of all mechanical components of this project as described in the contract documents, achieving specified air and water flow at all terminal equipment, distribution at lowest noise levels and energy use, and achieving specified thermometer, gauge, and sensor instrument accuracy and calibration, all as outlined below.

3. Documentation, correspondence, data recording, reporting, and demonstration all as outlined below and elsewhere in the contract documents.

4. *Coordination* with other Contractors, subcontractors, Construction Manager, Owner's Representatives, and Architect / Engineer as required achieving specified TAB results.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.
B. ASHRAE: American Society of Heating, Refrigerating, and Air-Conditioning Engineers
C. Contractor: The entity contracted to perform the HVAC Work described in these contract documents.
D. NEBB: National Environmental Balancing Bureau.
E. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
F. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.
G. TAB: Testing, adjusting, and balancing.
H. TABB: Testing, Adjusting, and Balancing Bureau.
I. TAB Agency: An entity engaged to perform TAB Work who is qualified and approved to do so as described below.

1.4 SUBMITTALS, GENERAL

A. Contractor:

1. Prior to submittal of any equipment affecting TAB Agency, review with TAB Agency and obtain commentary and approval as described in “Summary” Article. Include TAB Agency review commentary with affected submittals.

2. Immediately upon approval of other submittals, provide the TAB Agency with copies of approved submittals, including Shop Drawings of all hydronic and air systems and equipment requiring balancing.

1.5 ACTION SUBMITTALS

A. Contractor:

1. Perform no work affecting TAB prior to TAB Agency approval.
2. Within 30 days after award of Contract, submit TAB Agency qualifications proposal for approval

B. TAB Agency:

1. Submit TAB Agency qualifications proposal for approval.

a. Name and contact information of proposed TAB Agency,
b. Documentation that they meet the qualifications specified in "Quality Assurance" Article,
c. Evidence of current TAB Agency and TAB Supervisor Certification,
d. List of instruments to be used in testing and balancing, with current certification of all instruments’ calibration,
e. Examples of data forms proposed for each system type showing input cells for this Project’s required data,
f. 3 regional references for comparable recent jobs.

2. Submit Strategies and Procedures Plan: Within 30 days of Architect’s approval of TAB Agency, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

3. Submit Preliminary Partial TAB Reports.

4. Submit Certified Final TAB Report.

5. Certified Six Month System Check / Design Condition TAB Report.

1.6 INFORMATIONAL SUBMITTAL

A. Contractor and TAB Agency:

1. Systems Readiness Report as described more fully below.

B. TAB Agency:

1. Instrument Calibration Reports: Include the following on calibration agency letterhead:

   a. Instrument type and make.
   b. Serial number.
   c. Application.
   d. Dates of use.
   e. Dates of calibration.
   f. Test data points over range qualified – standards and measured values.

2. Contract Documents Examination Report: Within 15 days of Architect's approval of TAB Agency, submit the Contract Document Examination Report as specified in Part 3.

3. Include commentary with all Contractor submittals affecting TAB work as described above.

4. Pre-Construction Inspection and Testing Report: Prior to removal of any affected construction.

1.7 QUALITY ASSURANCE

A. TAB Agency, Employee, and TAB Work Qualifications:

1. TAB Agency: Fully certified current member of "Associated Air Balance Council" (AABC), "National Environmental Balancing Bureau" (NEBB), or "Testing, Adjusting, and Balancing Bureau" (TABB), specializing in the adjusting and balancing as specified in this Section of systems as specified and as shown on the Contract Documents, with minimum three years documented experience as a fully certified member, and three current regional references for projects of comparable scope.

2. TAB Field Supervisor: Employee of the TAB Agency and currently certified by AABC, NEBB, or TABB as a Testing, Balancing and Adjusting Supervisor.

3. TAB Technician: Employee of the TAB Agency and currently certified by AABC, NEBB, or TABB as a TAB technician.

4. All TAB Work: Performed by direct employees of the TAB Agency, who are either TAB Field Supervisors themselves, or who are TAB Technicians working under the direct supervision of a TAB Field Supervisor.

B. Conform to basic procedures and methods outlined by applicable publications in testing and balancing of air and water systems by the following organizations, and as modified by this document:

1. Associated Air Balance Council (AABC).
2. National Environmental Balancing Bureau (NEBB).
3. Testing, Adjusting, and Balancing Bureau (TABB).
4. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)
5. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)
6. Individual manufacturer requirements and recommendations.

C. TAB Report Data Forms: Follow AABC, NEBB, TABB, or SMACNA format as modified by the data requirements of this Project, subject to submittal approval.

D. 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.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: Instruments as described in ASHRAE 111, Section 5, "Instrumentation.", all currently certified as calibrated by a NRTL or NVLAP in accordance with Division 01 Section “Quality Requirements”.

F. Contractor: maintain qualified personnel at Project for system operation, trouble-shooting, making system changes, and performing mechanical adjustments in conjunction with TAB procedures.

1.8 COORDINATION AND SCHEDULING

A. Refer to Division 00 and Division 01 for overall project sequencing and scheduling requirements. All HVAC work required for, and, approvable balancing in accordance with the requirements of this section is required to be complete before Contract Substantial Completion.

1. Contractor: Assure that all HVAC work required to properly and completely test and balance the various systems, occurs in a timely fashion coordinated with the overall project schedule as required, with final readiness reported at minimum two calendar weeks prior to contract scheduled Substantial Completion Date. For HVAC Work required to be performed simultaneous with TAB Work, coordinate schedule with TAB agency and provide qualified staffing as required keeping pace with TAB agency personnel. Coordinate and report partial systems readiness to TAB agency to allow TAB work to proceed in an orderly fashion.

2. TAB Agency: Assure that all TAB Work and all subsequent reporting on same occurs in a timely fashion coordinated with the overall project schedule prior to contract scheduled Substantial Completion Date. For HVAC Work required to be performed simultaneous with TAB Work, coordinate schedule with Contractor and provide qualified staffing as required to complete TAB work and reporting within two calendar weeks of final HVAC systems readiness for TAB.

B. Tab Agency: Coordinate, schedule, and run a TAB Strategies and Procedures meeting, with Contractor, Owner, Architect, Engineer, Controls Subcontractor, and Commissioning Agent all present. Provide TAB Plan and agenda in advance, and produce and distribute meeting minutes.

C. Contractor and TAB Agency: Perform all examination and preparation work required and submit Systems Readiness Report(s) prior to beginning TAB work.

D. Contractor and TAB Agency: After submission of Systems Readiness Report, coordinate and schedule all preparation and TAB work with each other, Architect/Engineer, and Owner,. Notify O/AE/CM/Cx team of all scheduled TAB work test dates and times in writing with at least seven days' advance notice for each visit.

1. Cooperate with other contractors and affected subcontractors as required to provide complete and proper testing, adjusting, and balancing of HVAC systems.

E. Accomplish TAB Work during construction period as soon as the systems are complete enough to perform TAB work. Coordinate with project phases and before Owner takes possession. TAB work and approval of at least partial pencil copy reports is required before Owner takes possession.

F. Multiple visits will be required for phased construction in cooperation with construction schedule, with multiple “pencil copy” submittals of partial TAB reports required promptly as each phase of TAB work is accomplished.

G. Perform balancing for record at final stage when all previously completed sub-systems are checked and re-balanced to design performance.

H. Contractor and TAB Agency: return to the site approximately six months after initial TAB Work is complete to perform system checkup and design condition rebalancing as defined below.

I. Contractor and TAB Agency are subject to recall to site to verify report information before acceptance of the report by the Architect.

J. Contractor: provide 2 additional copies of Shop Drawings and other submittals for all equipment and systems to be tested and balanced to TAB Agency as soon as possible but no later than 60 days prior to scheduled completion of equipment and systems installation.

K. TAB Agency:

1. Verify that Contractor has placed all systems and equipment in satisfactory operating condition as required allowing TAB Work to be properly performed.

2. Cooperate with Contractor and affected subcontractors as required to provide complete and proper testing, adjusting, and balancing of air and water systems.

3. Visit Project prior to concealment of Work and note location of dampers, test connections, and similar items. Record this information, transmit to Contractor, and incorporate on Record Drawings.

4. Coordinate timing of six month system check and design condition TAB Work with weather, Contractor, and Owner.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. TAB Agency: Provide tools, ladders, recording meters, gauges, thermometers, velometers, anemometers, Pitot tubes, inclined gauge manometers, magnehelic gauges, amprobes, voltmeters, psychrometers, tachometers, ultrasonic or other non-intrusive flowmeters, and all other instrumentation required to perform specified TAB work. Accurately calibrate all instruments.

1. Make instruments available to Architect to facilitate spot checks during testing and back-checking.
2. Provide additional balancing devices as required.

PART 3 - EXECUTION

3.1 EXAMINATION

A. By TAB Agency:

1. 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.

2. Visit Site and examine existing systems before construction and new / re-worked systems prior to concealment of construction to check on and advise regarding location of installed balancing devices, such as test ports, gage cocks, thermometer wells, thermometers and gages, flow-control devices, balancing valves and fittings, volume dampers, test connections, etc. Verify that locations of these balancing devices are accessible. TAB Agency shall advise Contractor and Architect of TAB Agency findings by letter.

3. Examine the submittals for HVAC systems and equipment. Verify that proposed equipment can be balanced as specified and as required. Provide commentary on all submittals advising where additional balancing devices are needed or configuration adjustment is desired to facilitate TAB work.

4. 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.

5. Examine test reports specified in individual system and equipment Sections.

6. Examine manufacturer’s equipment performance data including pump and fan curves.

    a. 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.

B. By Contractor:

1. Examine systems and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections has been performed, and all TAB preparation as described in "Preparation" Article is complete.

3.2 PREPARATION

A. TAB Agency:

1. Prepare a TAB plan that includes site specific strategies and step-by-step procedures with this project's equipment identified.

B. Contractor: Before TAB work commences on any portion of the system, and before new system startup, verify that systems are complete and in proper operating condition. Ensure the following:

1. Equipment is operable, in a safe and normal condition, and is of the size and capacity specified in the Contract Documents, bearings are greased, belts are aligned and properly tight, and equipment with functioning controls is ready for operation. Required modifications to systems shall be made in advance of the TAB Agency's arrival for that portion of the work.

2. Provide proper equipment start-up as specified, complete with manufacturer's filled out standard published start-up forms.

3. Temperature control systems are operable to the extent required for that portion of the TAB Work. Control valves must at least be installed complete and hand operable. Automatic dampers must be operable and under control. Safety interlocks and controls on HVAC equipment must be properly functional.

4. All motors, pumps, and fans have correct rotation.

5. Align belt driven fan drive systems. Align motor and fan shafts into parallel to within ¼ degree. Align drive and driven pulleys into same plane to within 1/32 inch per foot of center to center distance. Adjust belt tension to within drive manufacturer's recommended tolerance, and securely lock all adjustment fasteners.

6. Permanent electrical-power wiring is complete, and proper thermal overload protection is in place for all electrical equipment.

7. All ductwork, air handlers, grilles, registers, and diffusers are installed, complete, and cleaned of dust and debris.

8. All piping, terminal radiation, pumps, valves, required pressure taps, and hydronic specialties are correctly installed, complete, operational, and clean.

9. All ductwork, diffusers and registers have dampers where specified, and all hydronic systems have balancing and isolation valves where specified.

10. Duct system leakage has been tested where required and minimized.

11. Hydronic systems are flushed, vented, cleaned, leak free, and filled with specified heat transfer fluid if required.

12. System pump suction piping is properly vented to ensure absence of entrained air.

13. All manually set dampers (register, grille, diffuser, and manual volume dampers) operate smoothly and are adjusted open. All automatic dampers have actuators and required linkages installed and rough adjusted.

14. All hydronic systems valves are installed with proper direction of flow and operate smoothly, balancing valves are adjusted open, two-way control valves are open, and service valves are open or closed as required for normal flow.

15. Make preliminary adjustments to airflow patterns of all registers, grilles, and diffusers to obtain uniform space temperatures and air movement free from objectionable drafts and noise.

16. Clean new final design filters are installed everywhere called for.

17. Coil fins are clean and straight.

18. Access doors in ducts are closed and duct end caps are in place.

19. Access doors necessary to reach duct volume dampers, balancing valves, and measuring stations are installed in accessible locations and are operable.

20. As-built conditions are accurately recorded on working as-built drawings, including locations of all access points, manual and automatic dampers, isolation, balancing, and control valves, fittings, and all other items affecting TAB work. Provide copies of these annotated as-built drawings for TAB agency's use during TAB work.

C. Contractor:

1. Prepare and submit Systems Readiness Reports to Engineer, Commissioning Agent, and TAB Agency, with itemized checklists of the above items as appropriate for the equipment to receive TAB Work, with a column for Contractor indicated status and another with room for TAB Agency commentary, itemizing any remaining deficiencies discovered and confirming all systems preparation and examination has been properly performed.

    a. Include itemized list of all examination and preparation procedures outlined above and as otherwise required by TAB Agency's procedures, with initialed dated verification of each item by authorized responsible party.

    b. Promptly report abnormal conditions in mechanical systems or conditions that prevent system balance. If, for design reasons, system cannot be properly balanced, report as soon as observed.

2. Report any defects or deficiencies observed during performance of TAB procedures.

D. TAB Agency:

1. Review, edit, and submit annotated Contractors Systems Readiness Reports to Contractor, Engineer, and Commissioning Agent, with itemized TAB Agency concurrence or commentary, itemizing deficiencies discovered and confirming all systems preparation and examination has been properly performed, with initialed dated verification of each item by authorized responsible party.

    a. Report abnormal conditions in mechanical systems or conditions that prevent system balance within 24 hours of discovery. If, for design reasons, system cannot be properly balanced, report as soon as observed.

2. Report any defects or deficiencies observed during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values. Include updates in partial TAB report submittals. Adjust as-built drawings as required to accurately reflect deviations from draft as-built set.

3. Promptly report abnormal conditions in mechanical systems or conditions that prevent system balance. If, for design reasons, system cannot be properly balanced, report as soon as observed.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. In the following TAB procedures portions of Part 3 Execution of this document, the procedures are deemed to be TAB Agency work unless specifically identified as Contractor work.

B. Contractor required assistance and Ancillary Work during TAB Agency Work includes the following general work categories and notes on Contractor Work requirements in subsequent specific procedure descriptions:

1. Maintain mechanically qualified personnel at Site to perform necessary mechanical modifications and adjustments in conjunction with TAB procedures.

2. Operate systems.

3. Provide trouble-shooting.

4. Change and re-align pulleys, sheaves, belts, etc., as required to meet system performance requirements. Provide machined steel or cast iron sheaves of quality equal to OEM equipment, and cogged premium raw edge belts. Properly adjust belt tension. Maintain specified drive safety factor – do not reduce the size of the smaller sheave /pulley without explicit written approval of first manufacturer then engineer.

5. Cut insulation, pipes, ducts, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures. Properly plug all holes. Provide new insulation that matches removed materials, finished in accordance with Division 23 Section "HVAC Insulation."

6. Change air filters as required.

7. Adjust automatic damper linkages so they all operate smoothly and close tightly.

8. Perform necessary controls operations required for TAB procedures.

9. Re-adjust / make final adjustments to registers, grilles, and diffusers in cooperation with Owner and TAB Agency as required to obtain uniform space temperatures and air movement free from objectionable drafts and noise. As this affects system pressure drops, this must be completed before final airflow balancing.

10. Make any required additions or changes in types, locations, etc., of balancing equipment.

11. Provide other mechanical adjustments as required in conjunction with TAB procedures.

12. Leave system in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes and securing cover plates, restoring thermostats to specified settings, restoring systems to automatic operation as required, replacing ceiling tiles, plugging access ports and repairing insulation, cleaning, etc...

3.4 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Pre-Construction Testing of Existing HVAC Systems: Prior to system shut down, demolition and modifications associated with existing HVAC systems, and prior to submittal of any replacement equipment, provide testing and recording of existing system operating data as itemized below. Submit copies of existing system operating data to Architect for review. On completion of system modifications, confirm that new or modified system characteristics conform to original data or new requirements by taking new readings and readjusting systems as required.

B. On systems where there are no HVAC component modifications or work other than possible TAB work shown on the contract drawings, no TAB work is required unless specifically called for on the drawings.

C. On systems that are only partially modified, perform TAB work both before and after modifications as required to demonstrate that modified portions of the system are performing as required and unmodified portions of the system are still operating at least as well as they were prior to modifications. Also perform additional TAB work as specifically called for on the drawings.

D. Perform the following operations:

1. Air Systems:

a. Fans: Perform check and record suction and discharge pressures, total cfm, rpm, drive data, and motor data.

1) (2) Existing Rooftop Units serving the Upper Auditorium.
2) Existing Administration area Air Handling Unit.
3) Existing Lower Auditorium Air Handling Unit.

b. Main branch ducts: Make pitot tube traverse and obtain cfm.

c. Return / outside air / total airflow cfm and associated damper positions in occupied and unoccupied operating modes.

d. Airflow at all inlets and outlets.

3.5 GENERAL PROCEDURES: AIR SYSTEMS TESTING, ADJUSTING, AND BALANCING

A. Visit Site prior to concealment of construction to check and advise regarding location of dampers, test connections, etc. TAB Agency shall advise Contractor and Architect of TAB Agency findings by letter.

B. Review sheet metal shop drawings and mark locations of all required balancing dampers before duct fabrication.

C. Re-check fan belt pulley alignment under properly tensioned condition, and report final tolerances and tension achieved. Direct re-alignment as required to achieve stated tolerances.

D. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct in such a manner that local flow dynamics have a negligible effect on the measurements. Use multiple, bidirectional, traverses if flow measurements cannot be made in a section with at least 8 diameters straight duct upstream and 4 diameters of straight duct downstream from the measuring station. Mark all traverse locations on plans in report.

E. After adjustments, take measurements to verify balance has not been disrupted. Verify that disruptions in balance have been corrected.

F. Permanently mark valve, damper, and other adjustment device settings at devices to simplify restoration of settings. Record settings and include in report. Set and lock memory stops.

G. Procedures:

1. Verify that all systems are complete and operable as scheduled.

2. Verify that registers, grilles, and diffusers are adjusted to obtain uniform space temperatures and air movement free from objectionable drafts and noise. Cooperate with Owner and Contractor and reach agreement on air distribution pattern before proceeding.

3. Align belt driven fan drive systems. Align motor and fan shafts into parallel to within ¼ degree. Align drive and driven pulleys into same plane to within 1/32 inch per foot of center to center distance. Adjust belt tension to within drive manufacturer's recommended tolerance. Re-check alignment under properly tensioned condition, securely lock all adjustment fasteners, and report final tolerances and tension achieved.

4. Provide temporary filter media as follows: with the system fully operational, all dampers open, and the fan running at the scheduled RPM, check submittal values for new, midlife, and final/clogged filter pressure drops, check and record air pressure drop across the new clean final design filters, and provide temporary media to approximate midlife pressure drop across the filters for use during balancing. Record and report both pressure drop values at the final design flowrates. Adjust filter differential pressure switches to trip at correct final/clogged filter pressure drop in cooperation with Energy Management and Control System manufacturer's representative.

5. With the system fully operational, all dampers open, and the fan running at the approved submittal RPM, measure the airflow through all terminal units as well as the total system volume, without making any adjustments, and formulate a plan for preliminary adjustments of dampers and fan speed. Terminal units shall be defined to include all diffusers, registers, grilles, duct entries, louvers, hoods, etc.; i.e., wherever air enters or leaves ductwork whether indoors or outdoors. Record and report all initial values.

6. In cooperation with Energy Management and Control System manufacturer's representative, make mechanical adjustments of automatically operated dampers to operate as specified, indicated, and/or noted. Adjust and set the extreme operating conditions of these dampers and check completed damper control operations for proper calibration, reporting to control installers conflicts with those requiring adjustment. Test leakage of closed dampers. Adjust and set intermediate positions of outside air and return air dampers as required to achieve design outside airflow requirements defined in the sequence of operations, and / or calibrate outside air flow meters at this point. Balance variable volume systems at maximum air flow rate with full cooling and at minimum air flow rate with full heating

7. Adjust terminal units to the proportionally correct cfm, not necessarily the design cfm.

    a. If all the dampers in a branch line’s terminal units must be adjusted to limit cfm, then use the branch line volume damper to limit the pressure drop across the terminal units in that branch so that at least one terminal unit’s damper remains wide open but still has the correct flow. Adjust all branch ducts to proper proportional cfm in this way, leaving the volume dampers in the flow limiting branches wide open.

    b. Provide branch duct volume control by duct internal devices such as dampers and splitters only to the extent that the most open damper or splitter remains wide open and adjustments do not create objectionable air motion or sound levels. Under no circumstances shall total air system volume be throttled back to design flow through the partial closing of all dampers and splitters.

    c. Record and report all initial adjustment positions and proportional flowrates achieved.

8. Vary total air system flowrate by adjustment of fan speeds. Provide drive changes required.

    a. For variable frequency drive fans, perform the following procedure:

b. With the VSD set to bypass mode or set at 60 Hz, adjust the fan belt drive system (if applicable) as described above to achieve the design system cfm, with bypass dampers etc. closed or otherwise in the maximum resistance position.

c. Adjust the VSD to the maximum non- overloading frequency for the system, and measure and report the flowrate at this frequency

d. If other specific air flow rates are required due to the sequence of operations as reported on the drawings or in Section 23 09 00 – Instrumentation and Control for HVAC, coordinate with these requirements and determine the required frequency - flow relationships

9. Verify that all terminal units are at the design cfm to within the balancing tolerance, and if not, repeat steps f. and g. above until design conditions are satisfied.

10. Test and record final motor, drive, air moving equipment, exhaust fan, damper, and terminal unit information at this point.

11. After all air flow rates are tested, adjusted, and balanced, test the performance of all air to air energy recovery equipment. Test the performance of air to air energy recovery equipment only when the outside air and inside air temperatures are close enough to summer or winter design conditions to verify performance. Test under either summer or winter conditions; if design conditions cannot be met during initial TAB work due to timing, provide energy recovery core testing under true design conditions at the six month system check. Include all data as specified above in reports.

12. Test and record air heating and cooling coil information after this point, as follows:

a. Perform this step in conjunction with hydronic system balancing and after cooling and heating systems are operational.

b. Set hydronic control valve to fully open at design flow and temperature as described below. Allow cooling coils to become fully wet with condensation. Test temperatures outside of the line of sight to the coil.

c. Test and adjust coil performance for all data indicated to be on report test sheets.

3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:

    a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.

    b. Measure static pressure directly at the fan outlet or through the flexible connection.

    c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.

    d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

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. Measure static pressures entering and leaving other devices, heat-recovery equipment under final balanced conditions.

5. 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.

6. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

7. 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, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of submain and branch ducts.

    a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.

3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.

2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.7 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Balance variable-air-volume systems the same as described for constant-volume air systems.

2. Set terminal units and supply fan at full-airflow condition.

3. Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.

4. Readjust fan airflow for final maximum readings.

5. Measure operating static pressure at the sensor that controls the supply fan if one is installed, and verify operation of the static-pressure controller.

6. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.

7. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.

8. Measure 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.

3.8 PROCEDURES FOR MULTIZONE SYSTEMS

A. Set unit at maximum airflow through the coil.
B. Adjust each zone's balancing damper to achieve indicated airflow within the zone.

3.9 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. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.

6. Set system controls so automatic valves are wide open.

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.

3.10 PROCEDURES FOR HYDRONIC SYSTEMS

A. Measure water flow at pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump at 60Hz/VSD bypass. 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 Architect and comply with requirements in Division 23 Section "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 and mark pump manufacturer's head-capacity curve with this initial balance point. Note and record pump discharge valve position, then return to wide open (or maximum non-overloading position) for proportional balancing procedure.

   a. Monitor motor performance during procedures and do not operate motors in overload conditions.

3. Verify pump-motor brake horsepower at intended flow rate at run-out. 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.

B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

C. With the system fully operational, all branch and terminal isolation, balancing, and control valves open, and the pump running at 60Hz/VSD bypass, measure the flow through all terminal units as well as the total system volume, without making any adjustments, and formulate a plan for preliminary balancing valve adjustment. Record and report all initial flow and pressure drop values.

D. Adjust all manual balancing valves to the proportionally correct gpm, not necessarily the design gpm.

1. If all the valves in a branch line's terminal units must be adjusted to limit gpm, then use the branch line manual balancing or isolation valve to limit the pressure drop across the terminal units in that branch so that at least one terminal unit's balancing valve remains wide open but still has the correct flow. Adjust all other branch lines to proper proportional gpm in this way, leaving the balancing valves in the flow limiting branches wide open.

2. Provide branch volume control by balancing valves only to the extent that the most open valve remains wide open and adjustments do not create objectionable hydronic sound levels. Under no circumstances shall total system volume be throttled back to design flow through the partial closing of all branch valves.

3. Record and report all initial adjustment positions and proportional flowrates achieved.

E. Vary total system flowrate by adjustments at pump.

1. For constant speed single pump operation systems: throttle the system pump balancing/triple-duty valve until the flow in the system is the design flow rate. If the available flow from the pump is less than the design flow using this procedure, report this to the engineer for advisement immediately. Report the pump, valve, and motor data both with the throttling valve in the wide open and at the final, design flowrate position.

2. For variable frequency drive pumps, Perform the following procedure for each pump circuit running individually:

   a. Ramp the VSD to the minimum frequency required to obtain the design flow, with each pump discharge valve open to the maximum position consistent with accurate reading and VSD bypass/60Hz non-overloading operation.

   b. Repeat this VSD adjustment for each pump circuit of lead / lag pumps driven by one VSD, and set the VSD at the higher of these two frequencies.

   c. At this frequency (the full design frequency - could be more or less than 60Hz), adjust the higher flow rate circuit to the design flow rate by further throttling the pump balancing valve, so that the flow rate from each pump is identical at the design frequency.

   d. Verify that all terminal units are at the design gpm to within the balancing tolerance, and if not, repeat steps above until design conditions are satisfied at all system valves, with no excessive pressure and resultant energy use.

   e. Report this value as the design frequency in the balancing report, and in writing to the Contractor responsible for incorporation into controls work of the Division 23 .

   f. Measure and report the flow-rate at 60Hz, and also at the frequency where the pump motor is running at full load amperage.

   g. Measure and report all other pump flow data at this point.

   h. Check settings and operation of each safety valve. Record settings.

3.11 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 automatic and manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.12 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.
B. Measure entering- and leaving-air temperatures.
C. Record compressor data.

3.13 PROCEDURES FOR HEAT-TRANSFER 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.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:

1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Air pressure drop.
4. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.14 PROCEDURE FOR MISCELLANEOUS DEVICE TESTING

A. Test and adjust all devices on project as required to correctly report the data listed below under paragraph on final report.

3.15 TOLERANCES

A. Adjust system totals to the sum of the connected load (plus leakage for air systems) rather than the scheduled pump or fan capacity.

B. Adjust air handling systems as follows:

1. Main ducts (ie. each fan system) to within minus 5 percent and plus 10 percent of the design values.
2. Outside air flow tolerance shall be at minimum that scheduled, with a tolerance of minus 0 percent and plus 10 percent.
3. Branch ducts and terminal units to within plus or minus10 percent of the design flow.
4. A total maximum variation of 10 percent between terminal units designated as “typical of (#)”.

C. Adjust hydronic systems as follows:

1. Each pump to within 5 percent of the design flow values.
2. Branch lines and radiation to within 10 percent of the design flow values
3. A total maximum variation of 10 percent between terminal units designated as “typical of (#)”

3.16 PRELIMINARY REPORTING

A. Contract Document Examination Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for proper systems' balancing. 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. Pre-Construction Inspection and Testing Report: Prior to removal of any affected construction, prepare and submit report outlining results of Pre-Construction Inspection and Testing as outlined above and on the contract drawings.

C. 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.

3.17 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. Settings for supply-air, static-pressure controller.
    g. 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 Moving Equipment (FCU, AHU, RTU, DOAS, UV, Fan or Blower):

1. Location

2. Manufacturer

3. Model

4. Air flow, specified and actual

5. Return air flow, specified and actual

6. Outside air flow, specified and actual

7. Total static pressure (total external), specified and actual

8. Labeled diagram showing pressure drop across each internal component including dampers, filters, coils, diffusers, and blowers. Provide multiple readings for complex systems with multiple internal dampers affecting system pressure drops, under all specified modes of operation.

9. Inlet pressure

10. Discharge pressure

11. Applicable data as specified elsewhere including coil, motor, damper, and drive data.

12. Fan RPM (for VSD driven fans, under various design conditions including at least full heating, 100% OA economizer, and full cooling loads)

F. Exhaust Fan Data (F):

1. Location
2. Manufacturer
3. Model
4. Air flow, specified and actual
5. Total static pressure (total external), specified and actual
6. Inlet pressure
7. Discharge pressure
8. Fan motor and drive data
9. Fan RPM(for VSD driven fans, under various design conditions including at least full heating, 100% OA economizer, and full cooling loads).

G. Apparatus-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.
   l. Refrigerant expansion valve and refrigerant types.
   m. Refrigerant suction pressure in psig.
   n. Refrigerant suction temperature in deg F.
   o. Inlet steam pressure in psig.

H. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

   a. System and air-handling-unit identification.

b. Location and zone.
c. Room or riser served.
d. Coil make and size.
e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.
b. Entering-water temperature in deg F.
c. Leaving-water temperature in deg F.
d. Water pressure drop in feet of head or psig.
e. Entering-air temperature in deg F.
f. Leaving-air temperature in deg F.

I. Gas-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btu/h.
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and rpm.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches, and bore.
n. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

a. Total air flow rate in cfm.
b. Entering-air temperature in deg F.
c. Leaving-air temperature in deg F.
d. Air temperature differential in deg F.
e. Entering-air static pressure in inches wg .
f. Leaving-air static pressure in inches wg.
g. Air static-pressure differential in inches wg.
h. Low-fire fuel input in Btu/h.
i. High-fire fuel input in Btu/h.
j. Manifold pressure in psig.
k. High-temperature-limit setting in deg F.
l. Operating set point in Btu/h.
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btu/h.

J. Round and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg .
e. Duct size in inches.
f. Duct area in sq. ft..
g. Indicated 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.

K. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft..

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.
b. Air velocity in fpm.
c. Preliminary air flow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final air flow rate in cfm .
f. Final velocity in fpm.
g. Space temperature in deg F.

L. Pump Test Report: 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. Design frequency for VSD pumps.
k. Impeller diameter in inches.
l. Motor make and frame size.
m. Motor horsepower and rpm.
n. Voltage at each connection.
o. Starter size, rating, heater data.
p. Amperage for each phase.
q. Rated efficiency, full-load amperage, and service factor.
r. 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.

M. Electric Motors:

1. Manufacturer
2. HP/BHP
3. Phase, voltage, amperage (nameplate, actual, and no load)
4. RPM
5. Service factor
6. Starter size, rating, heater elements

N. Automatic Air Dampers (AAD, TBAAD, or internal to air moving equipment):

1. Location

2. Manufacturer

3. Model

4. Airflow, specified and actual.

5. Check closed position leakage and report.

6. Damper and/or actuator position at all required positions, along with associated controls signal required to achieve position. Coordinate required positions of return air and outside air ventilation control dampers with positions required by required ventilation rates. Refer to SECTION 23 09 00 – INSTRUMENTATION AND CONTROLS FOR HVAC, and coordinate damper position adjustment with temperature controls and Owner's required occupancy schedule.

7. Total static pressure drop at all required positions.

O. Manual Air Volume Dampers (VD, or shown with no text as: ⊺):

1. Location.
2. Report final damper position as angular deviation of blades from axial, with 0° being fully open and 90° being closed. Mark this position on duct at damper also.
3. Total static pressure drop across damper in as balanced condition.

P. Belt Drives:

1. Identification/location
2. Required driven RPM
3. Driven sheave, diameter and RPM
4. Belt, model, type, size, and quantity
5. Belt tension achieved.
6. Motor sheave, diameter and RPM
7. Alignment tolerances achieved.
8. Center to center distance, maximum, minimum, and actual

Q. Air Distribution Test Sheet (registers, grilles, and diffusers):

1. Air terminal number
2. Room number/location
3. Space Temperature
4. Terminal type
5. Terminal size
6. Area factor
7. Design velocity
8. Design air flow
9. Test (initial, adjusted, and final) velocities
10. Test (initial, adjusted, and final) air flows
11. Percent of design air flow

R. Automatic Balancing Valves Reports:

1. Identification/station
2. Location
3. Size
4. Manufacturer
5. Model
6. Design flow rate

7. Functional pressure drop range.
8. Actual/final pressure drop at system full flow condition.

S. Hydronic Control Valves Reports:

1. Location
2. Manufacturer
3. Model
4. Flowrate, specified and actual.
5. Pressure drop at full flow condition.

T. Gauges and Thermometers Reports:

1. Identification/number
2. Location
3. Service
4. Manufacturer
5. Test all gauges and thermometers for mid range accuracy. Adjust thermometers where applicable; adjust all gauges for best 0 and/or midrange accuracy.
6. Temperature, test reading and actual
7. Pressure, test reading and actual

U. Controls Sensors Reports:

1. Coordinate work with Energy Management and Control System.

2. Test all controls system temperature, pressure, air monitoring (CO_2, CO, combustible gasses, humidity, etc.), and electrical current analog sensors for mid normal operating range accuracy. Adjust where applicable.

3. Test all controls system temperature, pressure, air monitoring (CO_2, CO, combustible gasses, humidity, etc.), and electrical current digital (on/off) sensors/switches for trip point. Adjust where applicable.

4. Verify that locations shown on Operators Work Station are schematically correct.

5. Identification/number

6. Location

7. Service

8. Manufacturer

9. Temperature, test reading and actual

10. Pressure, test reading and actual

11. **A**ir composition, parts per million, test reading and actual. Test and adjust at normal ambient and alarm conditions.

V. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.18 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 water flow of each device.
b. Verify that balancing devices are marked with final balance position.
c. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection by TAB Agency is complete and documentation verifies that testing and balancing are complete and accurately documented in the report, request that a final inspection be made, giving at minimum 7 calendar days' notice. Deliver copies of Draft Final Report to Engineer and Commissioning Authority with final inspection request.

a. Engineer may elect to postpone final inspection upon delivery of written notice to TAB Agency that significant portions of the required TAB results are missing from draft report. If inspection is postponed, TAB Agency shall promptly return to site and provide missing TAB Work, then submit a revised draft and request the Final Inspection again.

2. The TAB Agency and Contractor's qualified technicians are to provide access, tools, and measurements during the inspection in the presence of the TAB Agency Supervisor and the Commissioning Authority.

3. Commissioning Authority will randomly select measurements, documented in the report or as required by contract, to be rechecked. Rechecking will 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." If recheck calls for a measurement that is required but cannot be found in the draft report, the missing measurement will be noted as “MISSING”.

5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the TAB Work will be considered defective and rejected. If the number of "MISSING" measurements is greater than 10 percent of the total measurements checked during the final inspection, the TAB Work will be considered defective and rejected.

C. If TAB Work is considered defective and rejected, 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. Pay all costs associated with second inspection including Commissioning Authority’s reasonable additional fees.

2. If the second final inspection also fails, Owner may require additional inspection similar to second inspection or may contract the services of another TAB agency to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB Agency's final payment.

D. Prepare test and inspection reports.

3.19 ADDITIONAL TESTS

A. Re-check and adjust systems approximately 6 months after final acceptance and submit report:

1. Measure the total flow rate of each of the systems originally covered by this section.

2. For each of the systems that no longer operate at design flow measure the flow at each of the terminals of that system.

3. Measure the flow at any terminals included in the original balancing, reported by the Owner or Architect to have continued or new problems.

4. Adjust system changes back to the design values if possible, and submit reports in writing to the Architect, Contractor, and Owner, noting any changes and/or complaints, and offering an interpretation of the cause and significance of the problems.

5. If the design air temperature criteria as specified cannot be satisfied upon initial balancing, perform this six month stability check at a time when it can be, and repeat water system balancing and chiller / heat exchanger performance testing using air temperature at the design conditions.

END OF SECTION 23 05 93

SECTION 23 07 00 – HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes materials and installation requirements for mechanical component insulation and related accessories.

1. Insulation Materials:

a. Calcium silicate.
b. Cellular glass.
c. Flexible elastomeric.

2. Insulation Accessories:

a. Insulating cements.
b. Adhesives.
c. Mastics.
d. Lagging adhesives.
e. Sealants.
f. Factory-applied jackets.
g. Field-applied fabric-reinforcing mesh.
h. Field-applied cloths.
i. Field-applied jackets.
j. Tapes.
k. Securements.
l. Corner angles.
m. Insulation protection systems

1.3 DEFINITIONS

A. “Concealed”: Work within or behind various construction elements, or in crawl spaces or trenches, that is not exposed to view when Project has been completed. (Areas above ceilings, including above Auditorium or Large Group Instruction partially open “cloud” ceilings and chases are considered a concealed location.)

B. “Exposed”: Anything exposed to view when project has been completed.

1.4 SUBMITTALS

A. Comply with requirements of SECTION 01 33 00 – Submittal Procedures and as modified below.

B. Provide all submittals required by this Section concurrently.

C. Product Data

1. Submit complete manufacturer's product information for each type of insulation and accessory specified in this section demonstrating compliance with specified requirements and including:

    a. Thermal and vapor transmission performance.
    b. MSDS information.
    c. Flame spread / smoke developed data.
    d. Manufacturer's recommended installation methods.

D. Submit insulation schedule indicating each required service with type of insulation, thickness and R value, covering method, finishes, and any applicable notes.

E. Quality Control Submittals

1. Qualifications Certification: Submit written certification of installers signed by applicable certification agency and/or manufacturer (where applicable) indicating compliance with "Installer Qualifications" requirements specified below in "Quality Assurance" article.

2. Installer Experience Listing: Submit list of completed projects using products proposed for this Project, including Owner contact information for each project, demonstrating compliance with applicable "Qualifications" requirements specified below in "Quality Assurance" article.

F. Contract Closeout Submittals: Comply with requirements of DIVISION 1 sections on closeout, including submission of maintenance instructions as item in "Operating and Maintenance Data" manual described there.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Provide insulation system installation by qualified Installers who are trained in installation of each proposed insulation material and product with at least one of the following qualifications:

1. Have successfully completed a mechanical insulation apprenticeship program by the Department of Labor, Bureau of Apprenticeship and Training,
2. Have successfully completed an ASHRAE / NIA 8 hour Mechanical Insulation Training course or equal, or
3. Have five years documented experience as a mechanical insulation specialist with references attesting to successful completion of at least three comparable projects.

B. Condensation Resistance: Provide insulation and vapor barrier systems complete as required to eliminate condensation under any normal operating conditions from surfaces of all cooling equipment and components provided or modified as a part of this contract Work, unless those surfaces are designed to remove moisture by condensation from process air, and to contain and drain the condensate.

C. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per 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 and inspecting 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 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

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

1.7 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.

1.8 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. For convenience, details and specifications have been based on products by the following manufacturers:

1. Armstrong; Lancaster, Pennsylvania
2. Benjamin Foster
3. CertainTeed; Valley Forge, Pennsylvania
4. Fit Tight Covers, Inc.
5. Johns Manville; Defiance, Ohio
6. Kingspan Tarec
7. Knauf; North Carolina
8. No Sweat Valve Wraps, Inc.
9. Owens-Corning; Toledo, Ohio
10. Polyguard Products Inc., Ennis, Texas
11. Thermaxx, LLC.
12. Or Approved Equal.

2.2 MATERIALS

A. Pipe and Fitting Insulation: Provide pipe insulation in compliance with ASTM C 585 Dimensional Standards.

1. Insulation Thickness:

a. Pipe and fitting insulation thicknesses specified assume an insulation conductivity (k) value of 0.27 btu•in/hr•ft2•ºF. For pipe and fitting insulation with conductivity other than 0.27 btu•in/hr•ft2•ºF, insulation must be thicker for higher conductivity and may be thinner for lower conductivity as required to achieve same or higher R value. Adjust insulation thickness from that specified in accordance with the following formula:

T = r[(1+t/r)K/k-1] where:

1) T = Adjusted insulation thickness, inches
2) r = Actual pipe outside radius, inches.
3) t = Insulation thickness specified, inches.
4) K = actual insulation conductivity, btu•in/hr•ft2•ºF.
5) k = specified conductivity, 0.27 btu•in/hr•ft2•ºF.

b. Hydronic Piping for Heating or Heating / Cooling (dual temp):

1) Pipe sizes ½ inch through 1-¼ inches ..... 1-1/2 inch
2) Pipe sizes 1-½ inches and larger ..... 2 inches

c. Condensate Drain Piping

1) All pipe sizes..... ½ inch

d. Refrigerant Suction Piping:

1) All pipe sizes..... 1 inch

e. All Variable Refrigerant Flow and Heat Pump Refrigerant Piping:

1) All pipe sizes..... 1 inch

f. Runout piping in restricted spaces where it is not possible to provide the specified thickness may use reduced thickness insulation as required by space restriction.

2. Interior Above Grade Hydronic Piping Insulation:

a. ASTM C547, cylindrically molded preformed rigid half pipe shell forms, factory one-piece "hinged" construction.

1) Rigid pipe or tube insulation may be of mineral wool, fiberglass, closed cell glass, formed polyisocyanurate, formed phenolic, or extruded polystyrene (chilled service only).

2) Thermal Conductivity ("k"): Measured in accordance with ASTM C 335. For k values greater than 0.27, include calculations and compliant increased thickness proposed. For k values equal or less than 0.27, provide specified insulation thickness or calculations justifying thinner insulation.

3) Jacket: All Purpose (AP) vapor barrier jacket with:

a) White kraft paper outer surface bonded to aluminum foil, reinforced with fiberglass yarn, permanently treated for fire and smoke safety and to prevent corrosion of foil.

b) Self sealing pressure sensitive lap.

c) Water Vapor Permeance: ASTM E96, Procedure A, 0.02 perm maximum.

d) Puncture resistance: ASTM D781, 85 scale units minimum

e) Burst resistance: ASTM D774, 100psi minimum.

f) Similar to "150TL facing" as used in "AP T Plus Jacket" and tape by Johns Manville, or equal.

3. Refrigerant Piping, Flexible Connections Insulation: fire-resistant, closed cell flexible (elastomeric) foam plastic, similar to Armacell Armaflex with manufacturer's white painted mastic protective finish.

4. Condensate Drain Lines: insulation material similar to rigid pipe or refrigerant piping insulation specified above.

5. Fitting and Valve Insulation: Precut fiberglass blanket to match thickness, appearance and insulation value of adjacent pipe insulation; similar to "Hi Lo Temp Fiber Glass Insulation Insert" by Johns Manville, with fitted protective jacket specified for the installation.

B. Pipe and Fitting Protective Jackets:

1. Intended for permanent installation on non-serviceable components only.

2. Interior Pipe and Fitting Insulation Protective Jacket:

a. Plastic: High-impact, UV resistant polyvinyl chloride, white, paintable, covering designed to fit over AP jacketed insulated piping systems, molded to fit various sizes of fittings and piping as required; similar to "Zeston 2000 or Zeston 300 PVC Jacketing" by Johns Manville.

1) 20 mil thickness: Fittings and valves in interior applications eight feet above finished floor and higher.
2) 30 mil thickness: Fittings, valves, and straight pipe in interior applications lower than eight feet above finished floor.

C. Duct Insulation

1. Provide insulation thickness on ducts, plenums, and equipment equal to height of flanges, but not less than thickness required to achieve duct insulation R values specified herein:

a. R=6 deg. F-sq. ft.-h/Btu-in:

1) All interior HVAC duct where insulation is required, unless otherwise noted elsewhere.

b. R=12 deg. F-sq. ft.-h/Btu-in

1) Interior outside air intake duct

c. R=12 deg. F-sq. ft.-h/Btu-in:

1) Exterior Duct with no transverse dimension above 48 inches (R=10 minimum, not average)

d. R=20 deg. F-sq. ft.-h/Btu-in:

1) Exterior Duct with any transverse dimension above 48 inches (R=20 minimum, not average)

2. Rigid Board: 3 PCF minimum density glass fiber board (6PCF when exposed in mechanical or utility spaces) or phenolic, with factory-applied AP vapor barrier; similar to "800 series Spin-Glas" and "AP" facing by Johns Manville, or Kingspan KoolDuct.

3. Semi-Flexible: 2.5 PCF minimum density continuous glass fiber oriented strand sheets, with factory-applied AP vapor barrier. Strand orientation such that material has comparable rigidity to board type insulation above in one direction and comparable compressive strength, but is flexible enough in the other direction to wrap curved surfaces at a factory recommended minimum bend radius of 3T where T is the material thickness. Similar to "CrimpWrap" by CertainTeed.

4. Flexible: Glass fiber blanket, 3/4 PCF minimum density, with factory-applied, flame-resistant, FSK jacket; all joints taped; similar to Owens Corning "Fiberglas All Service Duct Wrap".

5. Exterior Duct Insulation: Rigid closed-cell extruded polystyrene or phenolic board with integral high density skin, foil or poly faced as recommended by insulation covering manufacturer, tongue and groove along long edges; complying with and exceeding requirements of ASTM C 578 for Type IV insulation, with the following properties:

    a. Density: 1.6 pcf minimum.
    b. Thermal resistance (R) at 75 deg. for 1-inch thickness: 5 nominal.
    c. Compressive resistance at 10 percent deformation or yield: 25.0 psi minimum.
    d. Tapered thickness as required to provide ¼" to the foot slope for water shedding.
    e. Flame spread (ASTM E84): less than 75.
    f. Fuel contributed (ASTM E 84): less than 100.
    g. UL listed.

D. Ductwork Insulation Protective Jackets:

1. All Purpose (AP) Vapor Barrier for Duct Insulation: White kraft paper outer surface bonded to aluminum foil and reinforced with fiberglass yarn, permanently treated for fire and smoke safety and to prevent corrosion of foil.

    a. Water Vapor Permeance: ASTM E96, Procedure A, 0.02 perm maximum.
    b. Puncture resistance: ASTM D781, 85 scale units minimum
    c. Burst resistance: ASTM D774, 100psi minimum.
    d. Similar to "150TL facing" as used in "AP T Plus Jacket" and tape by Johns Manville, or equal.

2. Foil-Skrim-Kraft (FSK) Vapor Barrier for Duct Insulation: Foil faced outer surface bonded to kraft paper backing and reinforced with fiberglass yarn, permanently treated for fire and smoke safety and to prevent corrosion of foil.

    a. Water Vapor Permeance: ASTM E96, Procedure A, 0.02 perm maximum.
    b. Similar to "FSK Jacket" and tape by Johns Manville, or equal.

3. Exterior Duct Insulation Covering:

    a. Modified bituminous, aluminum skinned, peal and stick membrane, similar to Polyguard "Alumaguard 60", with the following properties:

        1) Minimum 60 mils thick
        2) Permeance less than 0.01 Perms
        3) Puncture resistance per ASTM E154 >40lbs.

4) Overlap bond peal adhesion per ASTM D1000 never less than 11lb/in.
5) UV stabilized.
6) Self healing when punctured.

b. EPDM membrane as specified in Division 07 section 07 53 23 – EPDM Roofing.

E. Insulation Accessories:

1. Mechanical Pin Fasteners: Provide welded or adhered pins of length based on manufacturer's recommendations for insulation density and thickness, securely holding insulation with insulation manufacturer's recommended compression. Mechanical Pin Fastener types include:

a. Stud style welded pins minimum 12 gauge diameter with matching push-on washers. Welded on with capacitor discharge type pin welder with no burn through or undercutting. Welded on prior to insulation application allowing for inspection prior to insulating.

b. Cup head style welded minimum 12 gauge diameter with integral washers. Welded on with capacitor discharge type pin welder with no burn through or undercutting. Welded on after insulation application dis-allowing inspection of pin welds without insulation removal. Not permitted for any Class A or tighter duct, not permitted for any fire rated duct insulation application.

c. Adhered style with perforated metal back plate (minimum 4 square inches surface area) welded to 12 gauge pins with matching push washers, bonded with full coverage of manufacturer's recommended adhesive. Not permitted for any fire rated duct insulation application.

d. Not permitted: PSA backed "peal and stick" pins, sheet metal fastening screws, or any other penetration of duct by fasteners.

2. Insulation Securement Bands: For larger cylindrical surfaces and fire rated duct insulation, tension securement bands may be used to supplement or replace mechanical pin fasteners. Provide bands of material compatible with insulation and system being insulated, minimum ½ inch wide and as required to avoid compressing insulation at required securement tension (3/4 inch minimum for diameters over 36 inches), 24 gage thick or thicker. End buckles of similar material. Wrapping or securing with wires not permitted.

3. Insulation Tapes: Provide insulation manufacturers' recommended and matching tapes, matching characteristics of exterior jacket of insulation, in widths as required and as specified below to seal all gaps and reinforce vulnerable areas in vapor barrier. Provide tapes with peel off protective coating covering high performance acrylic adhesive unless manufacturer documents superior performance of alternative recommendation.

4. Insulation Adhesives and Mastics: Provide insulation manufacturers' recommended and matching adhesives and mastics, as required and as specified below to seal all gaps and reinforce vulnerable areas in vapor barrier. Provide with water based and low VOC formulations unless manufacturer documents superior performance of alternative recommendation and performance deficiencies of water based low VOC products.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
B. Verify that systems and equipment to be insulated have been tested and are free of defects.
C. Verify that surfaces to be insulated are clean and dry.
D. Proceed with installation only after unsatisfactory conditions have been corrected.
E. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 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 inhibition coating to surfaces to be insulated as follows:

1. All non-galvanized ferrous components with a service temperature below ambient (chilled water and chilled water/glycol systems): Coat with one full coverage coat of specified corrosion inhibition 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.

3.3 INSTALLATION

A. General:

1. Provide thermal and acoustical insulation for components shown on the Drawings as specified in this Section for the following:

a. All heating and air conditioning systems piping including fittings, valves, and accessories.

1) Include removal of existing insulation and replacement insulation as specified for existing piping where called for on the drawings or where existing insulation is damaged as a result of contract work.

2) Include re-insulation where insulation is removed as a part of the abatement work, and not otherwise replaced. Refer to abatement drawings for quantities.

b. All heating and air conditioning ductwork unless noted otherwise.

1) All heating and air conditioning ductwork labeled as exposed shall not be insulated unless noted otherwise.
2) All heating and air conditioning ductwork within a Fan Room, etc., shall be insulated whether exposed or not.
3) Include re-insulation where insulation is removed as a part of the abatement work. Refer to abatement drawings for quantities.

c. All outside air ductwork extending from exterior wall or roof to the equipment which it serves.

d. Exhaust, return, and relief air ductwork not passing through air to air energy recovery devices prior to exiting the building: extending from exterior wall or roof 15 feet into the building envelope in all directions of duct branch take-offs.

e. Exhaust, return, and relief air ductwork that does pass through air to air energy recovery devices prior to exiting the system: insulate complete as described below.

f. All cooling condensate drain lines.

2. Comply with manufacturer's installation instructions and recommendations.

3. Do not begin mechanical insulation until permission is granted to begin mechanical insulation installation, hydronic systems have proved drip free under pressure, duct systems have passed required duct leakage requirements and testing, indoor work areas are weather tight, and outdoor work areas are at appropriate ambient conditions.

4. Below ambient temperature applications:

a. Provide corrosion inhibition coating as specified above.
b. Apply vapor barrier mastic and sealant to all open ends, joints, seams, breaks, and punctures in insulation.

5. Do not use any insulation support system which causes compression of insulation, localized or widespread, to less than 75% of the rated nominal thickness. Wires wrapped around rectangular duct insulation are not permitted as insulation support.

6. Provide for durable and repeated service access as part of insulation system.

a. Do not permanently cover inspection stampings, hand holes, manholes, plugged outlets, or similar features on equipment – provide removable labeled insulated access port with beveled and sealed insulation plug, gasketed if vapor barrier is needed, durably fabricated for repeated access.

7. Install thermal mechanical insulation as follows:

a. Only on clean, dry surfaces and after piping and ductwork has been tested and found to be tight.
b. Continuously through wall or ceiling openings and sleeves.

c. On cold surfaces with continuous unbroken vapor seal.
d. Insulate ducts and pipes individually.

8. Where more than one layer of insulation is required to achieve specified thickness or R value, apply thinner layer first, and stagger joints between insulation layers at least 3 inches.

B. Pipe Insulation

1. Comply with manufacturer's installation instructions and recommendations. Install only when ambient temperatures are within range recommended by manufacturer. STAPLES NOT PERMITTED.

2. Provide high impact plastic wrapper on all exposed, insulated piping from finished floor to 8 ft. above finished floor.

3. Interior Pipe and Fitting Insulation: Install on all heating, cooling, and condensate piping. Seal with factory applied pressure-sealing adhesive strip on the longitudinal lap. Seal butt joints with pressure-sealing adhesive strip at least 2 inches wide. Install valve and fitting covers in all locations.

4. Refrigerant Piping Insulation: Install in full accordance with manufacturers specifications and recommendations on refrigerant and condensate lines, using adhesive specifically intended for flexible foam plastic and provided by insulation supplier. Paint all exposed insulation cut ends with manufacturers (white) finish, similar to “WB Armaflex” or equal. Provide preformed elbows and fittings where available and neatly mitered and fit custom fabrications where manufactured components are not available. Tape and seal all joints vapor tight. For exterior refrigerant piping, install exterior piping protective wrapper water and air tight in accordance with manufacturer’s printed installation directions.

5. Insulation at Pipe Support: Refer to SECTION 23 05 29 - Hangers and Supports for material specifications of insulated piping support assembly and pipe support insulation. Complete insulation installation for the applicable pipe support insulation type to be used.

a. Type “B” Pipe Support Insulation:

1) Install pipe support insulation at hanger and support locations in conformance with manufacturer’s recommendations and as indicated on Drawings.

2) Remove a section of insulation from pipe insulation and replace this section with heavy density molded fiberglass blocks without breaking vapor barrier wrap.

b. Type “C” Pipe Support Insulation:

1) Provide butt connection to high-density insulation sections at pipe hangers as specified in Section 23 05 29 - Hangers and Supports.

2) Provide insulation with vapor barrier on upper half of insulated piping support assembly.

3) Apply wet coat of vapor barrier lap cement on butt joints and finish coat of vapor barrier mastic.

4) Tape edge of insulation section edge and insulation with white, pressure-sensitive PVC tape with tape extending over adjacent pipe insulation by at least 2 inches.

C. Ductwork Insulation: Provide external thermal insulation on ducts as specified or indicated on Drawings; external thermal insulation not required where ducts are shown or specified with internal acoustical insulation. Insulate and seal around duct dampers, damper motors, thermometers, instruments, access doors, and similar component as required without restricting operation or function. Insulate all ducts in all concealed spaces.

1. Use flexible type insulation on concealed ductwork with widths or diameters of 18 inches or less only. Insulate all other ductwork requiring insulation with rigid board type, semi-flexible type, or other type as required by drawings.

2. Duct Insulation Mechanical Fasteners: Provide mechanical fasteners for all duct surfaces over 12” wide. For duct surfaces 18’” wide and less, provide single row of fasteners down duct centerline. For duct surfaces over 18” wide, install minimum of 2 rows per side, applied on maximum 18" centers, starting within 3" of any edge.

   a. Pins with the point facing out accepting push washers: clip points close to washers and cover with vapor barrier adhesive and tape. Not permitted on mechanical room duct unless covered by puncture resistant protective wrapper.

3. Duct Insulation Tape: Apply only to clean dry dust free surfaces as recommended by tape manufacturer and as required for durable adhesion.

   a. Pealing tape, loose insulation, or otherwise broken vapor barrier subject to repeated recall.

4. Rigid Board Type Insulation Installation: Install board with all corners mitered or rabbeted; no butt joints allowed. Secure insulation with mechanical fasteners. Apply corner reinforcement angles (beads) on all corners for exposed ductwork (including in mechanical or storage spaces), with edge tape over beads. Seal all breaks and joints in vapor barrier with 3 to 5 inches wide insulation tape (minimum 1.5” tape past break all around).

5. Semi-flexible Type: Install similar to rigid board type, on round duct, curved elbows, etc.. Wrap curved and round surfaces taught, provide circumference tape band maximum two feet on center (butt joints and center of four foot roll stock).

6. Flexible Type Insulation Installation: Make all joints and seams with 2-inch lap of vapor barrier cemented with Benjamin Foster “BF85-20”. Apply Benjamin Foster “BF-20” adhesive to ducts in 6-inch brush widths at 1 ft. intervals and at each facing edge. Tape all adhered with Benjamin Foster “BF-20”. Tape seal all seams, breaks, and joints in vapor barrier, then continuously coat all tape with manufacturer’s recommended vapor barrier adhesive

7. Exterior Duct Work Insulation: Install insulation and covering in strict compliance with manufacturer's printed instructions and recommendations and as follows:

    a. Mechanically fasten insulation to duct.

    b. Slope top insulation a minimum ¼” per foot for positive drainage using tapered thickness panels, not shims with air gaps below.

    c. Tape joints and ruptures in facing, using adhesive tape of type recommended by insulation manufacturer, and seal each continuous area of insulation to surrounding construction ensuring vapor tight installation.

    d. Seal and protect exterior duct work insulation with Exterior Duct Insulation Covering, making all joints and terminations watertight with any and all special details as required by application.

    e. Mechanically support bottom of duct Exterior Duct Insulation Covering on all exterior duct 24 inches wide and wider such that there is no unsupported dimension over 30 inches. Provide transverse and if required longitudinal strut system compressing Exterior Duct Insulation Covering against bottom of duct. Refer to Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment, for details of corrosion resistance and construction of insulation support system.

    f. Provide for air pressure bleed ports in the bottom of insulation system of exterior positive pressure duct as required to bleed off duct leakage without pressurizing insulation system. Typical bleed port shall be similar to ¼” OD nylon tubing penetrating bottom of insulation full thickness of insulation, extending ½ inch below insulation cover, cut off at 45 degrees both ends, and sealed to insulation and covering with appropriate caulk. On vertical duct, slope down for drainage. Provide one bleed port for every 10 linear feet of exterior duct.

        1) Test and eliminate duct leakage before applying insulation system. If additional bleed ports are needed to prevent insulation covering from bulging out between supports due to internal pressure, remove insulation and reseal duct to control leakage.

END OF SECTION 23 07 00

SECTION 23 08 00 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes commissioning process requirements for the following Building Mechanical Systems, which are described in more detail in the technical specifications of Division 23.

1. Cooling generation systems, including direct-expansion systems.
2. Distribution systems, including supply and return air distribution, heating hot water systems, and exhaust systems.
3. Vehicle exhaust systems and carbon monoxide control.
4. Make-up air handling units, air handling (recirculation) units, and air to air energy recovery units.
5. Terminal and packaged units, including unit ventilators, fan-coil units, finned-tube radiation, unit heaters and packaged units.
6. Vibration, sound, and movement control systems, including vibration isolation devices, sound attenuation, and seismic restraints.
7. Energy Management and Control System.
8. Systems testing, adjusting, and balancing verification, including all of the above mentioned systems.

1.2 DEFINITIONS

A. BAS: Building automation system, also known as Energy Management and Control System (EMCS).

B. Building Mechanical Systems: All Systems, Subsystems, Equipment, and Components of the building systems traditionally known as Heating, Ventilating, Air Conditioning, Refrigeration, Plumbing, and Electrical Works.

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

D. CxA: Commissioning Authority –The Owner or a third party commissioning agent designated by the Owner.

E. DDC: Direct digital controls, a part of the BAS.

F. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.

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

H. TAB: Testing, adjusting, and balancing.

1.3 SUBMITTALS

A. Qualification Data: For BAS and HVAC&R Testing Technician.

B. Construction Checklists: Provide construction pre-functional test checklists filled out by qualified technician for all equipment to be commissioned on this project, including but not limited to all :

1. BAS.
2. Heating-water piping and accessories.
3. Refrigerant piping.
4. Metal ducts and accessories.
5. Fans.
6. Air-handling units.
7. Heat Pumps.
8. Hydronic Pumps.

C. Certificates of readiness and completion of installation.

D. Test and inspection reports and certificates.

E. Corrective action documents.

F. Instrumentation Calibration Information

G. Functional Performance Test Procedures

1.4 QUALITY ASSURANCE

A. BAS Testing Technician Qualifications: Technicians to perform BAS construction checklist verification tests, construction checklist verification test demonstrations, commissioning tests, and commissioning test demonstrations shall have the following minimum qualifications:

1. Journey-level or equivalent skill level with knowledge of BAS, HVAC&R, electrical concepts, and building operations.
2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.
3. International Society of Automation (ISA) Certified Control Systems Technician (CCST) Level I.

B. HVAC&R Testing Technician Qualifications: Technicians to perform HVAC&R construction checklist verification tests, construction checklist verification test demonstrations, commissioning tests, and commissioning test demonstrations shall have the following minimum qualifications:

1. Journey-level or equivalent skill level. Vocational School four-year program graduate or an Associates degree in mechanical systems, air conditioning, or similar field. Degree may be offset by three years' experience in servicing mechanical systems in the HVAC industry. Generally, required knowledge includes HVAC&R systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of HVAC&R equipment, assemblies, and systems.

2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.

3. One of the following:

    a. National Environmental Balancing Bureau (NEBB) Certified Testing, Adjusting, and Balancing Technician.
    b. Associated Air Balance Council (AABC) Certified Test and Balance Technician.
    c. Owner retains the right to waive NEBB or AABC Certification.

C. Testing Equipment and Instrumentation Quality and Calibration: For test equipment and instrumentation required to perform HVAC&R commissioning work, perform the following:

1. Submit test equipment and instrumentation list. For each equipment or instrument, identify the following:

    a. Equipment/instrument identification number.
    b. Planned commissioning application or use.
    c. Manufacturer, make, model, and serial number.
    d. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.

2. Test equipment and instrumentation shall meet the following criteria:

    a. Capable of testing and measuring performance within the specified acceptance criteria.
    b. Be calibrated at the manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
    c. Be maintained in good repair and operating condition throughout the duration of use on this Project.
    d. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

D. Proprietary Test Instrumentation and Tools:

1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the commissioning process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, perform the following:

    a. Submit proprietary instrumentation and tools list. For each instrument or tool, identify the following:

1) Instrument or tool identification number.
2) Equipment schedule designation of equipment for which the instrument or tool is required.
3) Manufacturer, make, model, and serial number.
4) Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.

b. Include a separate list of proprietary test instrumentation and tools in the operation and maintenance manuals.

c. HVAC&R proprietary test instrumentation and tools become the property of Owner at the time of Substantial Completion.

1.5 CONTRACTOR'S RESPONSIBILITIES

A. Provide mechanical work in accordance with contract document requirements.

B. Perform commissioning tests including Materials Checks, Installation Checks, Start-up Checks, Startups, and Functional Testing, all at the direction of the CxA.

C. Attend construction phase controls coordination meetings.

D. Attend and participate in TAB review and coordination meetings

E. Attend and participate in commissioning meetings.

F. Participate in Building Mechanical Systems maintenance orientation and inspection as directed by the CxA.

G. Prepare Construction / Prefunctional Checklists and Functional Performance Test procedures and execute and document results. All Prefunctional Checklists and tests must be documented using specific, procedural forms in Microsoft Word or Excel software developed for that purpose. Prior to testing, Contractor shall submit those forms for review and approval.

H. Submit documentation required for Commissioning work. At minimum, include: Detailed Start-up procedures, Full sequences of operation, Operating and Maintenance data, Performance data, checkout sheet forms used by factory or manufacturer's field technicians, Functional Performance Test Procedures, Control Drawings, and details of Owner-Contracted tests.

I. Review and approve other relative documentation for impact on Functional Performance Tests of the systems:

1. Shop Drawings and product submittal data related to systems or equipment to be commissioned. Review and incorporate comments from the CxA.

2. Incorporate manufacturer's Start-up procedures with Prefunctional checklists.

3. Factory Performance Test Reports: Review and compile all factory performance data to assure that the data is complete prior to executing the Functional Performance Testing.

4. Complete equipment Construction / Prefunctional Checklists, Start-up certification forms, and the manufacturer's field or factory performance and Start-up test documentation: review the documentation prior to commencing with the scheduled Functional Performance Tests.

5. Final Testing Reports: Contractor or Subcontractor performing the test will review the documentation prior to commencing with the scheduled Functional Performance Tests.

6. Operating and Maintenance (O&M) information per requirements of the Technical Specifications and Division 01 requirements: To validate adequacy and completeness of the Functional Performance Tests, the Contractor shall ensure that the O&M manual content, marked-up record Drawings and Specifications, component submittal drawings, and other pertinent documents are available at the Project Site for review.

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

K. Schedule work so that required installations are completed, and systems verification checks and functional performance tests can be carried out on schedule.

L. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

M. Inspect, check and confirm in writing the proper installation and performance of all Work.

N. Provide technicians to assist during system verification and functional performance testing as required by the CxA

1.6 CxA'S AUTHORITY

A. Directing Commissioning.

B. Assign Commissioning Agent for various commissioning tasks to stand in for the CxA.

C. Edit and approve project-specific construction checklists and commissioning process test procedures for actual Building Mechanical Systems, assemblies, equipment, and components to be provided as part of the construction contract.

D. Verify Testing, Adjusting, and Balancing of Work are complete.

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 Building Mechanical Systems 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 Building Mechanical Systems and associated controls are ready for testing.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Certify that Building Mechanical Systems have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that Building Mechanical Systems instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify that Contractor portions of testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing report discrepancies have been corrected, and corrective work approved.

D. 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).

E. Inspect and verify the position of each device and interlock.

F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. Testing Instrumentation: Provide (Furnish and 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 tests at the direction of the CxA.

B. Scope of Building Mechanical Systems testing includes entire HVAC&R installation. Testing includes measuring capacities and effectiveness of operational and control functions, accuracy and precision of sensing equipment, and other functional parameters as required, demonstrating that systems are performing as specified and intended. Commissioning testing includes verification of up to 30 percent of the control points, Testing and Balancing data, and other system requirements indicated in the individual technical sections, and on the drawings and schedules of these contract documents. Parameters not otherwise specified to be tested, as required to adequately demonstrate system performance, may constitute up to 10 percent of the 30 percent (3 percent of total).

C. 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.

D. The CxA along with the Building Mechanical Systems Contractors and their Subcontractors, especially the Testing, Adjusting, and Balancing Subcontractor, and HVAC&R Instrumentation and Control Subcontractor, shall prepare detailed testing plans, procedures, and checklists for Building Mechanical Systems based on the actual installed equipment and the contract documents.

E. Perform tests using design conditions whenever possible.

1. 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.

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

3. 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.

F. If tests cannot be completed because of a deficiency outside the scope of the Building Mechanical System, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests. If deficiencies cannot be resolved, refine tests as required to adequately test Building Mechanical Systems within the constraints of the deficiency.

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

3.3 TESTING, ADJUSTING, AND BALANCING (TAB) VERIFICATION

A. Prior to performance of TAB Work, provide copies of approved sample report forms, checklists, and certificates to the CxA.

B. Notify the CxA at least 10 days in advance of TAB Work, and provide access for the CxA to witness Testing, Adjusting, and Balancing Work.

C. Subsequent to approval of formal TAB report, TAB Work will be subject to field verification. Provide technicians, instrumentation, and tools to verify testing and balancing of Building Mechanical Systems at the direction of the CxA. Roughly 10% of required TAB data points identified in TAB specification will be selected for subsequent field verification.

1. The CxA will notify TAB Subcontractor 10 days in advance of the date of field verification. Notice will not include data points to be verified..

2. The TAB Subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.

3. 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.

4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.4 SPECIFIC COMPONENT ANS SYSTEM COMMISSIONING TESTS

A. Cooling Generation Systems

1. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of chillers, refrigerant compressors and condensers, 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, as required demonstrating that any selected operating performance criteria are met or exceeded.

B. Air Distribution Systems

1. TAB Air Flow Verification:

a. Prerequisites: Completion of "Examination" Article requirements and correction of deficiencies, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

b. Completion of "Preparation" Article requirements for preparation of a TAB plan that includes strategies and step-by-step procedures, and system-readiness checks and reports, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

c. Scope: HVAC&R air systems and hydronic piping systems.

d. Purpose: Differential flow relationships intended to maintain air pressurization differentials between the various areas of Project.

e. Conditions of the Test:

1) Commissioning Test Demonstration Sampling Rate: As specified in "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

2) Systems operating in full heating mode with minimum outside-air volume.

3) Systems operating in full cooling mode with minimum outside-air volume.

4) For measurements at air-handling units with economizer controls; systems operating in economizer mode with 100 percent outside air.

f. Acceptance Criteria:

1) Under all conditions, rechecked measurements comply with "Inspections" Article in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."

2) Additionally, no rechecked measurement shall differ from measurements documented in the final report by more than two times the tolerances allowed.

3) Under all conditions, where the Contract Documents indicate a differential in airflow between supply and exhaust and/or return in a space, the differential relationship shall be maintained.

C. General Hydronic System Testing

1. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 23 piping Sections. HVAC&R Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:

a. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.

b. Description of equipment for flushing operations.

c. Minimum flushing water velocity.

d. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

D. Air System Energy Recovery Systems

1. Energy Recovery Testing and Acceptance Procedures: Testing requirements are specified in Division 23 Section “Testing, Adjusting, and Balancing for HVAC”. Provide submittals, test data, inspector record, and heat exchanger certification to the CxA. Heat exchanger shall exchange the energy flows scheduled with no greater pressure drop or approach temperatures than scheduled.

E. Exhaust Systems

1. Exhaust Fan Testing and Acceptance Procedures: Testing requirements are specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC". Provide submittals, test data, inspector record, and exhaust fan performance certification to the CxA. Exhaust fans shall be equipped with all accessories as specified and scheduled and shall be demonstrated to operate on the approved fan curve with no greater than the approved power requirements.

F. Air-Handling Units

1. Air-Handler Mixed-Air Control:

a. Prerequisites: Installation verification of the following:

1) Minimum Position Input Device: DDC system time schedule.

2) Output Device: DDC system analog output to modulating damper actuator(s).

3) Heating Reset Input Device: DDC system software.

4) Supply-Air Temperature Input Device: Electronic temperature sensor.

5) Display the following at the operator's workstation:

a) Mixed-air-temperature indication.
b) Mixed-air-temperature set point.
c) Mixed-air damper position.

b. Scope: Air handler with mixed-air control and associated controls.

c. Purpose:

1) Occupied time control.
2) Minimum damper position control.
3) Heating reset control.
4) Supply-air temperature control.
5) Cooling reset control.
6) Unoccupied time control.

d. Conditions of the Test:

1) Occupied Time Control: Start in unoccupied schedule. Advance to occupied schedule time.

2) Minimum Damper Position Control: Command system to mode in which minimum damper position is required.

3) Heating Reset Control: Create a call for heating.

4) Supply-Air Temperature Control: Override supply-air temperature set point to a value 2.0 deg F above current supply-air temperature.

5) Unoccupied Time Control: Advance to unoccupied schedule time.

6) Control Data Trend Log: Set up a data trend log of the following input device values and output device commands. Record data at hourly intervals. Submit trend data for 24-hour periods in which natural conditions require heating reset control, supply-air temperature control, and economizer cooling control.

a) Minimum position input device.
b) Heating reset input device.
c) Supply-air temperature input device.
d) Cooling reset input device.

e. Acceptance Criteria:

1) Occupied Time Control: Mixed-air control is active in occupied mode.

2) Minimum Damper Position Control: Controller positions outdoor-air dampers to minimum position.

3) Heating Reset Control: Controller sets outdoor-air dampers to minimum position.

4) Supply-Air Temperature Control: Controller modulates outdoor-, return-, and relief-air dampers to maintain temporary supply-air temperature set point plus or minus 1.0 deg F.

5) Economizer Cooling Control: Controller sets outdoor-air dampers to mazimum position when outdoor-air enthalpy is less than return-air enthalpy.

6) Unoccupied Time Control: Controller positions outdoor- and relief-air dampers closed and return-air dampers open.

7) Control Data Trend Log: Data verifies control according to sequence of control.

G. Fan-Coil Units

1. Fan-Coil Unit Testing and Acceptance Procedures: Testing requirements are specified in Division 23 Section “Testing, Adjusting, and Balancing for HVAC”. Provide submittals, test data, inspector record, and Fan-Coil Unit performance certification to the CxA. Fan-Coil Unit shall be equipped with all accessories as specified and scheduled and shall be demonstrated to deliver the scheduled airflow and heat capacity at no greater noise or power use levels than specified.

H. Finned-Tube Radiation

1. Finned Tube Radiation (FTR) Testing and Acceptance Procedures: Testing requirements are specified in Division 23 Section “Testing, Adjusting, and Balancing for HVAC”. Provide submittals, and test data certification to the CxA. FTR shall be installed level and plumb, neat and secure, with ready access to hydronic specialties as required for service, equipped with all accessories as specified and scheduled and shall be demonstrated to provide the specified and approved heating capacity while operating with no greater than the specified water flow.

I. Energy Management And Control System

1. Testing requirements are specified in Division 23 Section “Instrumentation and Control for HVAC”, Section 3.11 SYSTEM TESTING AND COMMISSIONING. Provide submittals, test data, inspector record, and EMCS performance certification to the CxA.

2. Provide password and any other hardware and software as required to enable CxA to communicate directly, with full graphics and control capability, with the EMCS from the CxA’s office over an internet browser interface. Install complete early in project.

J. Electrical Power Distribution Systems Serving The Above Listed Mechanical (Plumbing and HVAC&R) Systems

1. Be prepared for CxA to take thermal images of field connections for any line voltage power connections.

END OF SECTION 23 08 00

SECTION 23 09 00 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Review and study all drawings and this entire project specification to become familiar with the equipment and system operation as designed and to verify the quantities and types of controllers, valves, dampers, operators, alarms, points, etc., required.

1.2 SUMMARY

A. This section describes the requirements for a complete Energy Management and Control System (EMCS) for building mechanical systems and components, based upon Direct Digital Control (DDC) logic including WEB served operator interface via one new as well as the existing computer Operator Work Stations, distributed microprocessor controls, and integrated electronic components, interfaces, and actuation, all installed complete as specified.

B. Perform all work in cooperation with the Owner, Architect, Construction Manager, and other Prime Contractors. Coordinate all work with the construction schedule established by the Owner, Architect, and Construction Manager, and immediately report any delays including circumstances causing the delays.

C. It is the Owner's intent to extend the School District's existing Johnson Controls Facility Explorer Energy Management System (EMCS). This shall be accomplished through:

1. Removal of existing stand-alone electronic control systems included in the work areas indicated on the drawings.

2. Removal of all existing pneumatic control components included in the work areas indicated on the drawings.

3. Providing new controls included in the work areas indicated on the drawings complete as specified herein.

4. Provide new programming and graphic displays for all new controls, and custom configure graphic displays to meet Owner and Engineer requirements.

5. Provide extension of (EMCS) communication network to the work areas indicated on the drawings as required to furnish a complete interoperable control system.

6. Provide full control capability as described in the sequence of operation for new equipment via field mounted controls or interfacing with equipment furnished with BACnet communication capability.

7. Provide wireless control capability for the District Bus Garage and Pump House to the EMCS.

8. Provide each of the following portions of the complete EMCS as a standalone system that can communicate with any other Direct Digital Control (DDC) system which is following the same protocol:

   a. Operator Work Stations (OWS): Provide one desk top computer as a complete OWS, installed at a location of the Owner's choosing; and integrate this project's controls complete with the EMCS at the District's facilities offices and other buildings. Provide software and programming for new OWS and update software at existing EMCS complete to incorporate this addition. Provide guaranteed seamless two way communications from each, including full control, with the EMCS provided as a part of this project and the existing campus EMCS.

   b. The OWS shall monitor, display, and control information from the EMCS through one software package. Rebooting of the OWS, or opening a separate program to access the existing building's multiple systems is not acceptable.

   c. The new OWS shall meet the hardware and performance requirements of this specification.

   d. The OWS shall allow customization of the system as described in this specification.

   e. The OWS shall:

      1) Provide new color graphic control panels for all equipment provided or modified as part of this project, as outlined below and on the drawings,
      2) Allow operators to view and work with all DDC points associated with all DDC equipment provided or modified as part of this project,
      3) Allow operators to create custom graphics and/or control programming generation for any and all new equipment.

9. Network Control Unit (NCU): Provide central processor WEB server capability for and fully integrated two way communications with all energy use and management equipment provided or modified by this project, along with any third party stand alone controls provided by the manufacturers of the Air Handlers, Refrigeration Machinery, Boilers, and Variable Speed Drives. NCU shall be capable of supporting a minimum of 127 field devices, providing reserve capacity for addition of future points and expansion of DDC system into building. The DDC system's NCU shall communicate with the OWS entirely using the BACnet protocol, with a conformance class of 5, as defined in the latest officially amended version of ANSI/ASHRAE 135-2004.

10. Distributed Controls: System controls shall include but not be limited to all controllers, sensors, devices, wiring, and all other hardware and software required to perform all of the functions and controls described later in this specification and on the drawings, including fully integrated two-way control of boilers, chiller, condensing units, pumps, VSDs, heat exchanger, and all associated temperatures, pressures, and other controllable parameters of mechanical equipment and systems provided or modified as part of this project. Provide control through the EMCS as outlined in the general controls sequences of operations below, as shown on the project drawings, and with controls similar to as shown where the exact configuration is not explicitly covered by the drawing and specification sequence of operations.

11. Engineer's Office: Provide password and any other hardware and software as required to enable Engineer to communicate directly, with full graphics and control capability, with the EMCS from the Engineer's office over an internet browser interface. Install complete early in project. Engineer will utilize to check progress of installation, to check operation of system during the punch list period, and to monitor system operation after completion of the work.

1.3 DEFINITIONS

A. DDC: Direct Digital Control.

B. PC: Personal computer.

C. EMCS: Energy Management and Control System, includes the complete automatic temperature control and energy use management system specified herein, based upon DDC technology, incorporating all necessary input and output devices, connecting hardware, software, and accessories.

D. OWS: Operator Workstation which is the main operator interface with the EMCS, comprised of a PC with graphical two way interface with, and data base and control capabilities for, the entire EMCS.

E. UC: Unitary Controller, a version of the SCU which is a smaller microprocessor-based controller, possibly pre-programmed to function specifically for the operation of a particular piece of equipment, such as a standard configuration air handler, unit ventilator, variable air volume box, lighting circuit, etc.

F. NCU: Network Control Unit, a secure central processing unit microprocessor based WEB server residing directly on the Owner's Ethernet TCP/IP LAN/WAN; providing direct communications to SCUs, UCs, and other field devices; integrating and processing their data and presenting it as custom HTML WEB pages in accordance with custom programmed graphical interface edited at an OWS.

G. LAN: Local Area Network - the Owner's existing Ethernet communications backbone which connects all of the owners buildings (and various rooms) on their campus. To be used by the Contractor where possible to connect OWSs, NCUs, SCUs, and UCs. Coordinate with Owner to determine extent of interconnection possible.

H. BACnet: A Data Communication Protocol for Building Automation and Control networks as defined in American National Standard ANSI/ASHRAE 135-1995, including any updates or revisions to this document.

I. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.

J. MS/TP: Master slave/token passing.

K. I/O: Input/output.

L. Modbus: a serial communications protocol originally published by Modicon (now Schneider Electric) in 1979 for use with its programmable logic controllers (PLCs).

M. PID: Proportional plus integral plus derivative.

N. RTD: Resistance temperature detector.

O. System Modem: a modem which is installed on the EMCS so that a remote SCU, UC, or OWS can connect up to the LAN and can function the same as if it were locally-installed.

P. System Printer: a printing device which is installed on the LAN so that all EMCS components can utilize it as an output device.

Q. TCC: Temperature Controls Contractor - The entity responsible for the work described by this section of specifications.

R. WEFC: Wireless Enabled Field Controller

1.4 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:

1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.

2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.

3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.

4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.

5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.

6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.

7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.

8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:

a. Water Temperature: Plus or minus 1 deg F.
b. Space Temperature: Plus or minus 1 deg F.
c. Ducted Air Temperature: Plus or minus 1 deg F.
d. Outside Air Temperature: Plus or minus 2 deg F.
e. Dew Point Temperature: Plus or minus 3 deg F.

f. Temperature Differential: Plus or minus 0.25 deg F.
g. Relative Humidity: Plus or minus 5 percent.
h. Air Pressure Differential (Ducts): Plus or minus 0.05-inch wg.
i. Carbon Monoxide: Plus or minus 5 percent of reading.

1.5 QUALITY ASSURANCE

A. Provide all labor, material, equipment, software, and programming necessary to meet the functional intent of the EMCS, and the rigid requirements as specified herein and as shown on the drawings. Provide, without additional cost to the Owner, all equipment and labor not specifically referred to herein or on the plans, which are required to meet the functional intent expressed in the sequences of operations herein or on the drawings. The contractor is responsible for all costs of changes in the work required by substitute equipment.

B. The TCC must have been in business for at least ten years, providing DDC systems as their primary business with documented success. They shall have a minimum of five years as a manufacturer's authorized distributor or branch office representative for one or more of the manufacturers specified. They must have a trained staff of application engineers, project managers, software engineers, commissioning staff, training staff, and service staff experienced in the configuration, programming and service of the EMCS. They must have a local service department and stock the manufacturer's standard replacement parts.

C. The EMCS shall be installed only by skilled mechanics employed directly by the TCC except wiring may be installed by their first tier subcontractor under the TCC project manager’s direct supervision. Any subcontractor shall have documented success installing controls with the TCC for a minimum of five years prior to this project. Sub-contractual relations shall in no way relieve the contractor of any of their obligations under their contract.

D. The TCC shall have a training facility with regularly scheduled training as outlined below so as to provide ongoing regularly scheduled application training.

E. Manufacturer must be a firm regularly engaged in manufacture of microprocessor temperature control equipment, of configuration and capabilities similar to or better than specified equipment, for at least ten years, and must have similar earlier vintage models that have been in continuous satisfactory use for not less than ten years in similar service.

F. All work shall conform to the following Codes and Standards, as applicable to the Contracted Work at the Project job site and to the relevant Authorities Having Jurisdiction at the Project site. All products shall be labeled with the appropriate approval markings. In the case of conflict or discrepancy, the latest and most stringent regulation or code shall apply.

1. National Electrical Code (NEC) and applicable local Electrical Codes.
2. Underwriters Laboratories (UL) listing and labels.
3. UL-916; Energy Management Systems for BAS components and ancillary equipment.
4. NFPA 70 – National Electrical Code.
5. Factory Mutual (FM).
6. American National Standards Institute (ANSI).
7. National Electric Manufacturer’s Association (NEMA).
8. American Society of Mechanical Engineers (ASME).
9. Institute of Electrical and Electronic Engineers (IEEE).

10. American Standard Code for Information Interchange (ASCII).
11. Electronics Industries Association (EIA).
12. Occupational Safety and Health Administration (OSHA).
13. American Society for Testing and Materials (ASTM).
14. Federal Communications Commission (FCC) including Part 15, R.F. Devices.
15. Americans Disability Act (ADA).
16. Uniform Building Code (UBC).
17. NEMA 250 – Enclosures For Electrical Equipment (1,000 V Maximum).
18. NFPA 101 – Life Safety Code.
19. IESNA – Illumination Engineering Society of North America.
20. UL 50 – Cabinets and Boxes.

1.6 GUARANTEES

A. Guarantee the EMCS complete to be free from defects in durability, materials, and workmanship, except for damages from other causes, for a period of one year after final acceptance.

B. Guarantee System to:

1. Maintain temperatures within +/- 1ºFof setting, within capacity of HVAC equipment.

C. Provide a one (1) year maintenance agreement to run concurrently with the Guarantee period, consisting of 24 hour emergency service and scheduled service (once per month minimum), as required addressing reported issues, for inspection and adjustment of operating controls, and replacement of parts or instruments found deficient or defective during this period.

D. Provide system backup and restore, software, programming, and sequence of operations enhancements, revisions, and adjustments at no charge to the Owner both during construction and commissioning and during this warrantee period.

1.7 SEQUENCE OF OPERATION

A. Refer to controls schematic drawings including written sequence of operations for specific pieces of equipment. Provide controls as specified and as required to achieve sequence of operations shown on drawings as well as specified below in general programming, and with controls similar to as shown where the exact configuration is not explicitly covered by the drawing and specification sequence of operations.

1.8 SUBMITTALS

A. Submit complete with the diagrams, Specification Compliance Reports, product information, and supporting documentation outlined below. Arrange the submittal in order of the specification article numbers, with tabs (bookmarked .pdf files for electronic submittals) at each division. The submittal shall be designed for use as both a clear demonstration of qualifications and as an installation and maintenance manual.

B. Include the following in a complete submittal:

1. Submit name of any proposed installation subcontractors, along with their statement of qualifications.

2. EMCS network wiring diagram showing interconnection of all panels, workstations, system printer(s) etc. A diagram describing system architecture for this project with product code numbers for workstation, network controllers, application specific controllers, transducers, sensors, communication networks, etc.. Diagram shall include all components intended to be used to meet or exceed specification requirements, shown in their functional relation to one another.

3. Provide information on owner training provided as part of the bid package as well as additional opportunities and factory schools available with associated costs. Include details of Operator HVAC Training System as specified herein.

4. Specification Compliance Report. The specification compliance report shall address every paragraph within this specification (230900), utilizing an outline format indicating clearly how the proposed system complies with this specification as follows:

   a. No Exception - proposed system complies without exception to both the letter and intent of this specification. Include Data Communications Protocol Certificates certifying that each proposed DDC system component complies with ASHRAE 135.

   b. Substitution Exception - proposed system is believed to meet the functional intent, but not the letter of the specification. For each paragraph for which a Substitution Exception is taken, the Specification Compliance Report shall identify all deviations from what is specified in the given paragraph and provide a complete description of what is included and how the proposed substitution meets the functional intent.

   c. Non-Compliance Exception - proposed system does not meet specification letter or functional intent, and the contractors intent is that the paragraphs requirements will not be provided. For each paragraph for which a Non-Compliance Exception is taken, the Specification Compliance Report shall identify all deviations from what is specified in the given paragraph and provide a complete description of what is included and why the contractor believes their proposed system should still be considered in spite of the non-compliance

   d. For all paragraphs indicated as “No Exception” or “Substitution Exception”, provide and reference factory product documentation to substantiate compliance.

5. Hardware Product Data Bulletins for all specified products, including PC components of OWS. Each bulletin shall describe product features, model numbers and manufacturer’s name.

6. Software Product Data Bulletins for all specified software features. Each bulletin shall describe product features, model numbers, and manufacturer’s name.

C. As job progresses and in ample time for review and iteration as required for complete approval, submit the following:

1. Complete written description of all proposed control sequences and control strategy, with any deviations from the specified sequence of operations highlighted and explained.

2. Detailed wiring and piping control diagrams and system description for each system.

3. Detailed layout and nameplate list for all control panels, including pneumatic, unit-specific controllers, data-gathering panels, microprocessor-based panels, third party microprocessor controllers, etc.

4. Damper schedule giving size, type, velocity, pressure drop, configuration, location, and number, type, and size of motorized actuators. Include apparatus bulletins and data sheets. Include all existing to remain dampers proposed for reuse along with comments on condition.

5. Valve schedule giving valve identification tag abbreviation, location, service, failsafe position, pipe size, valve size, make/model, type, configuration, design flow, capacity index (cv), and pressure drop. Include apparatus bulletins and data sheets.

6. Schedule showing direct integration to all third party microprocessor controllers included in this project, including all points available in a point listing describing point type (analog input, binary input, analog output and binary output), point address, units, applicable software interlocks (alarm, interlock, sequence, etc.), and a verbal description of the function and intended control of the point.

7. Termination schedule and point listing describing point type, (analog input, binary input, analog output and binary output), physical point location (eg. AHU #1 mixed air) and software interlocks (alarm, interlock, sequence, etc.).

8. A complete listing of inputs and outputs, control loops and/or routines, timing functions, and facilities management system functions for each controlled system. This listing shall include point logical names and identifiers.

9. For all equipment, submit copy of written installation, maintenance, and operating directions and details, along with manufacturer's printed installation instructions for all equipment furnished, showing required installation and location of the above items.

10. Provide a sample of program language and description of how programming is accomplished.

11. Color printout sheets of representative samples of all proposed graphics and text based OWS pages.

D. Software and Firmware Operational Documentation: Include the following:

1. Software operating and upgrade manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.

4. Printout of software application and graphic screens.
5. Software license required by and installed for DDC workstations and control systems.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
2. Interconnection wiring diagrams with identified and numbered system components and devices.
3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.

1.9 RELATED AND ANCILLARY WORK

A. Electrical control wiring associated with building fire alarm system and duct smoke detectors: Installation is specified under Division 26.

B. Power source wiring for general (non-controls) HVAC motorized equipment: Installation specified under Division 26.

C. Provide power source and controls wiring for all EMCS equipment, complete back to breakers designated as temperature control power breakers on electrical drawings or other approved electrical power panel space. Includes all controls power source wiring, communication wiring, and actuated device power and control wiring. Installation specified both herein and in applicable sections of Division 26.

D. Piping work as required to maintain pressure tight integrity of all hydronic, potable water, and refrigerant based systems for the installation of all piping mounted controls components, including control valve installation, valve and control manifolds, pressure and temperature taps, flow switches, thermal wells, and similar devices: Installation specified both herein and under applicable piping section.

E. Sheet metal work as required to maintain pressure tight integrity of all airside systems for the installation of all airside mounted controls components, including dampers, pressure and temperature probe taps, flow sensors, and similar devices: Installation specified both herein and under applicable sheet metal and ductwork sections.

F. Insulation work as required to maintain the thermal integrity of the various systems associated with and subsequent to controls component installations: Installation specified in Division 23 section on Insulation.

G. For all equipment: Provide and follow written installation directions and details, with manufacturer’s printed installation instructions for all equipment furnished, showing required installation and location of the above items.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for submittal, approval, fabrication, and shipping of control devices to equipment manufacturer in ample time for factory installation without impacting project schedule.

B. System Software: Update to latest version of software at Project completion.

1.11 INSTRUCTION AND TRAINING

A. Factory Authorized Control System Training:

1. Provide factory trained and authorized instructors and control technicians to instruct the Owner's operating personnel.

2. Factory authorized on site training - Provide two (2) on site training sessions each four (4) hours in duration covering network layout, controllers, and software functions. Both generic and product specific training shall be provided. Sessions shall be scheduled by the Contractor at the Owner's convenience, at any time up to two years after system installation.

3. Provide videotaping and audio taping of all training sessions, both off and on site. Turn over two copies of tapes and three copies of maintenance manual to Owner's representative.

B. Include in closeout documentation signed letter of acknowledgment of receipt of factory authorized training, videotapes, and maintenance manuals.

1.12 COORDINATION

A. Coordinate all controls work required for a complete operable controls system as specified. Carefully review project summary and scoping documentation and coordinate with contractors responsible for various ancillary portions of controls work. Where supportive or ancillary work is not specifically assigned to another contractor, provide complete as required for a complete operable system.

B. Coordinate equipment with Division 28 Sections on Fire Detection and Alarm Systems to achieve compatibility with equipment that interfaces with that system.

C. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

D. Coordinate equipment with Division 26 Sections on Electrical Power Monitoring and Control to achieve compatibility of communication interfaces.

E. Coordinate equipment with Division 26 Sections on Panelboards to achieve compatibility with starter coils and annunciation devices.

F. Coordinate equipment with Division 26 Sections on Motor Controls to achieve compatibility with motor starters and annunciation devices.

G. Coordinate size and location of concrete bases. Refer to Section 23 05 00 – COMMON WORK RESULTS FOR HVAC SYSTEMS for additional information.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Temperature Control Sub-Contractors (TCCs): Existing Energy Management and Control System (EMCS) and Basis of Design Energy Management and Control System (EMCS) is Johnson Controls Facility Explorer. Subject to compliance with requirements, available TCCs offering products and services that may be incorporated into the Work include, but are not limited to, the following:

1. Automated Logic Controls as installed by Logical Control Solutions.
2. Delta Controls as installed by EMCOR Services Tri-Tech.
3. Schneider Electric Controls as installed by Day Automation.
4. Siemens Controls as installed by Siemens Building Technologies, Landis Division.
5. TAC / Tridium / Niagara Controls as installed by TBS, Inc.

2.2 GENERAL SYSTEM ARCHITECTURE

A. The EMCS shall consist of the following:

1. Operators' Workstations (OWS).

2. File Server (FS).

3. Network Control Units (NCU).

4. Standalone Control Units (SCU).

5. Application Specific Unitary Controllers (UC).

6. Wireless Enabled Field Controller (WEFC).

7. All controls power wiring 120 volts or less, all network and communication wiring, fiber optic cable, and other controls communication media.

8. All EMCS communications devices.

9. All related field devices including remote I/O cabinets, transformers and power supplies, relays, contactors, transducers, switches, cabling, and related electronic control equipment.

10. All necessary software and custom programming, including graphics and reports.

11. All necessary inputs, outputs, and devices required to meet the features and intent described herein including but not limited to:

    a. Transducers.
    b. Differential Pressure sensors.
    c. Hydronic control valves.
    d. Opposed blade (control) or parallel blade (shutoff), low leakage dampers.
    e. Temperature, pressure, and humidity sensors and safety devices.
    f. Electronic valve and damper actuators.

12. All other equipment necessary for a complete, operational, EMCS.

B. The design of the EMCS shall network OWSs, FCs, NCUs, SCUs, UCs, and all sensors, safeties, actuators, and other devices. Inherent in the system's design shall be the ability to access and expand or modify the network via the Internet, the Level 1 LAN, the Level 2 bus, or via auto e-mail or auto-dial telephone line modem connections, or via a combination of all four networking schemes. LAN communications between buildings shall be standard ETHERNET TCP/IP and shall be compatible with the district's existing ETHERNET LAN.

C. The EMCS shall:

1. Be modular in nature, with distributed controllers operating in multi-user, multi-tasking environment on token-passing network.

2. Be re-programmable and programmed to control mechanical, electrical, and plumbing systems.

3. Be capable of integrating multiple building functions, equipment supervision and control, alarm management, energy management, historical data collection, and archiving.

4. Permit expansion of both capacity and functionally through the addition of components and programming.

5. Include an operator workstation which permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

6. Not be dependent upon any single device for alarm reporting and control execution. Each DDC panel shall operate independently by performing its own specified control, alarm management, operator I/O, and historical data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

D. The system architecture shall consist of no more than two communication levels as follows:

1. Level 1 shall be on the Owner's ETHERNET LAN as possible within the constraints of this specification. Contractor shall field verify extent and capacity of existing LAN with Owner prior to creation of network layout drawings, and shall include any and all extensions of the LAN required for complete and robust functioning of the EMCS:

    a. Level 1 communications shall use the BACnet protocol.

b. This LAN operates under ETHERNET protocol at 10 Mbps or other speed as determined by the Owner. The Level 1 LAN will provide transfer of point data, alarms and file activity among OWSs, NCUs, and SCUs.

c. Any data from a Level 2 controller can also be transmitted onto this bus through a Level 1 controller. The high speed LAN shall support multi-user communications and multi-session activity. That is, all global data sharing shall occur simultaneously with the transmission of alarm data or user activity.

d. OWSs and NCUs shall reside directly on the LAN such that communications may be executed directly between controllers, directly between workstations, and between controllers and workstations, on a peer-to-peer basis.

e. SCUs and UCs may reside directly on the Level 1 Lan at the TCCs option.

2. Level 2 shall be on a EIA-485 bus or other comparable technology, designed to support a family of dedicated local controllers for control of HVAC equipment and lighting. The Level 2 bus shall communicate bi-directionally with the Level 1 LAN through NCU controllers for transmission of global data:

a. The Level 2 bus, or field bus, shall support local control units (SCUs and UCs) of modular size for operation of the building's HVAC and lighting systems. This bus shall operate at a minimum speed of 200 kbps with a length of 4000 feet and 10Mbps with a length of 150 feet, with 32 nodes before requiring a network repeater. A minimum of 127 controllers shall be configurable on the field bus.

b. The field bus shall permit peer-to-peer communications among all Level 2 controllers and allow simultaneous communications with portable computer service tools that are connected to a Level 2 controller. Failure of any Level 1 NCU controller shall not impair the operation of its associated field bus.

c. All Level 2 field wiring that connects non native BACnet unitary controllers shall have an additional wiring set run in parallel dedicated for future use by native BACnet replacement controllers.

E. NCUs shall be able to access any data from, or send control commands and alarm reports directly to any other NCU or combination of NCUs on the network without dependence upon a central processing device. NCUs shall also be able to send alarm reports to multiple operator workstations without dependence upon a central processing device.

F. Dynamic Data Access:

1. All operator devices, network resident, internet connected, or connected via dial-up modems, shall have the ability to access all point status and application report data, or execute control functions for any and all other devices via the LAN. Access to data shall be based upon logical identification of building equipment.

2. Access to system data shall not be restricted by the hardware configuration of the EMCS. The hardware configuration of the EMCS network shall be totally transparent to the user when accessing data or developing control programs.

3. All points contained on Level 1 and Level 2 controllers shall be considered global points. Any program in any controller on the network shall be able to reference any point in any controller regardless of its location on the network.

G. General Network Design:

1. Network design shall include the following provisions:

a. Data transfer rate for alarm reporting, report generation from multiple controllers, and upload/download between SCUs and OWSs shall be a minimum of 2.5 Megabaud.

b. Support of any combination of controllers and operator workstations directly connected to the local area network. A minimum of 50 devices shall be supported on a single local area network.

c. Detection and accommodation of single or multiple failures of either OWSs, SCUs, or the network media. The network shall include provisions for automatically reconfiguring itself to allow all operational equipment to perform their designated functions as effectively as possible in the event of single or multiple failures.

d. Message and alarm buffering to prevent information from being lost.

e. Error detection, correction, and re-transmission to guarantee data integrity.

f. Default device definition to prevent loss of alarms or data, and ensure alarms are reported as quickly as possible in the event an operator device does not respond.

g. Commonly available, multiple sourced, networking components and Ethernet protocols shall be used to allow the EMCS to coexist with other networking applications on the Owner's existing LAN/WAN. Ethernet and BACnet are acceptable technologies. BACnet system shall conform to the latest ASHRAE Standards and recommendations.

h. Use of an industry standard IEEE 802.x protocol.

i. Provide synchronization of the real-time clocks in all EMCS panels.

2.3 OPERATOR WORK STATION (OWS)

A. Provide FCC certified class B computer systems as the OWS to control operator input/output, data storage and transmission to and from the system controllers, and to perform all software functions as noted hereafter. Provide hardware and software commercially available nationally from local vendors, with repair parts and service available locally from these vendors. Provide computer products by one of the following:

1. Apple or equal.
2. Dell or equal
3. Hewlett Packard or equal.
4. IBM or equal

B. Central Server Computer (minimum requirements):

1. Dimensions to fit standard 2S-2U slots.

2. Single 750w Hot Plug Power supply, complete with UPS.

3. INTEL Core i7 3.8 GHz minimum, 8MB L2 cache microprocessor

4. Minimum 24GB dual-channel DDR3 1600MHz SDRAM memory.

5. Provide four (4) internal minimum 500 GB, 7200rpm SATA 3Bbps 3.5 Hot-Plug with 12 – Hot Swap hard disk drives, with average access time of less than 30 milliseconds for storage of primary system data base and operating parameter files.

6. Provide a 56K baud auto answer/auto dial modem as manufactured by US Robotics.

7. Provide two (2) parallel and two (2) serial communications ports. The serial communications ports shall be capable of transfer rates of at least 9600 baud (RS-232-C standard). Provide at least four unused USB 2.0 ports.

8. Provide built-in ethernet networking capabilities (10/100Mbits) and wireless capability.

C. Desktop Workstation Computer (minimum requirements):

1. INTEL Core i7 3.8 GHz minimum, 8MB L2 cache microprocessor.

2. Minimum 24GB dual-channel DDR3 1600MHz SDRAM memory.

3. The CPU shall be for desktop use and shall have at least three (3) unused expansion slots.

4. Provide an Integrated AC'97 Full-Duplex Audio card.

5. Provide a 13 in 1 media reader.

6. Provide an on board Combo Drive: 40x/10x/24x CD-RW and 8x DVD-ROM.

7. Provide two (2) internal minimum 500 GB each, 7200rpm hard disk drives, with average access time of less than 30 milliseconds.

8. Provide a 56K baud auto answer/auto dial modem as manufactured by US Robotics.

9. Provide two (2) parallel and two (2) serial communications ports. The serial communications ports shall be capable of transfer rates of at least 9600 baud (RS-232-C standard). Provide at least four unused USB 2.0 ports.

10. Provide built-in ethernet networking capabilities (10/100Mbits) and wireless capability.

11. Provide graphics controller similar to 4GB NVIDIA® GeForce® GTX 745 DDR3.

12. Accessories:

    a. Provide a 24” flat panel monitor, backlit LCD, TFT, Midnight Gray, Up to 1920x1080 Pixels, 0.27 mm Pixel Pitch, Anti-glare with Hard Coating, 15-Pin D-Sub / 24-Pin DVI-D / S-Video / Composite Video / USB 2.0 Connectors.

    b. Provide a black and white laser printer with parallel interface, twelve pages per minute minimum at 1200 dpi equivalent, ½ ream paper storage minimum, dual side printing.

    c. Provide a 101-key enhanced style keyboard capable of generating all the standard ASCII characters. Function keys "F1" through "F12" and numeric keyboard shall also be a part of keyboard.

    d. Provide stereo speakers.

    e. Provide an optical mouse, two buttons and wheel, to serve as the pointing device.

    f. Provide a UL listed 1500 VA minimum UPS with surge protector, with at least six (6) electrical outlets, one (1) cable outlet, and one (1) modem outlet.

D. Operator Workstation Software

1. Operating System: Microsoft Windows 10, or comparable OS (verify with Owner and provide system compatible with Owner’s IT system), with high-speed Internet access.

2. EMCS Application Software General Requirements:

    a. The software shall communicate with the EMCS over the Owner’s LAN using ASHRAE 135 and ISO 8802-3 (Ethernet) datalink/physical layer protocols.

    b. The software shall be a standard application for the off the shelf MS Windows OS selected above, and shall not require a dedicated OWS, nor a different operating system from the Owner’s other office management software.

    c. Standard utility software packages shall be available through local retail outlets.

    d. The OWS shall output advisories and unacknowledged change-of-state or out-of-limits occurrences in a dedicated and protected area of the viewing screen.

    e. Graphical and Text Based Displays: At the option of the user, Operator workstation shall provide consistent graphical or text based displays of all system points and application data described in this specification. Point identification, engineering units, status indication and application naming conventions shall be the same at all workstations.

    f. Individual point information shall be coded via eight different colors. These colors shall be defined with respect to system type and condition.

g. Multiple, Concurrent Displays: provide the ability to simultaneously view several different types of system displays in overlapping windows to speed building analysis. For example, provide the ability to simultaneously display a graphic depicting an air handling unit, while displaying the trend graph of several associated space temperatures to allow the user to analyze system performance. If the interface is unable to display several different types of displays at the same time, the TCC shall provide at least two networked operator stations.

h. Employ browser-like functionality for ease of navigation, with a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. Provide menu-pull downs and toolbars, "hot-button" commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System or basic computing skills. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.

i. Provide for modifying common application objects, such as schedules, calendars, and set points in a graphical manner, for example using a graphical slider, without requiring operator keyboard entry.

3. Application Software Features:

a. Security:

1) The software shall be designed so that up to 256 users of the software can each have a unique username and password. Each username/password combination shall be linked to a set of capabilities within the software, set and editable only by a system administrator. The sets of capabilities shall range from View only, Acknowledge alarms, Enable/disable and change values, Program, and Administer. The system shall allow the above capabilities to be applied independently to each and every class of object in the system. Passwords shall be changeable through on-line keyboard entry by either the individual user or the administrator.

2) There shall be an adjustable inactivity timer that automatically logs off the current operator after the timer has expired.

3) Record all operator inputs executed under a valid password in a data log, including operator name.

4) At no time shall the actual password numbers be printed on the screen, except for operators with the strictest level of password, who shall be able to generate a password summary listing.

a) The password summary shall include at least a 24-character name, login ID, password, time out value, and security level.

5) Passwords shall be exactly the same for all operator devices, including stationary or portable OWS, or panel mounted network terminals. Any additions or changes made to password definition shall automatically cause passwords at all EMCS panels on a network to be updated and downloaded to minimize the task of maintaining system security. Users shall not be required to update passwords for EMCS panels individually.

6) Operators will be able to perform only those commands available for their respective passwords. Menu selection displayed at any operator device, including portable or panel mounted devices, shall be limited to only those defined for the access level of the password used to log on.

7) Provide user definable, adjustable, automatic log off timer to activate after from 1 to 60 minutes of inactivity (adj.), to prevent operators from inadvertently leaving devices online.

b. I/O capability from each OWS

c. Automatic system diagnostics; monitor system and report failures.

d. Database creation and support.

e. Automatic and manual database save and restore.

f. Object and property status and control.

g. Automatic restart of field equipment on restoration of power.

h. Custom report development.

i. Utility and weather reports.

j. Workstation application editors for controllers and schedules.

k. Maintenance management.

l. Trend logs: Support customized trend log reports with variables assignable at the OWS, automatic archive of trended values, with data retrievable in spreadsheets and database programs.

m. Data collection, reports, and logs. Include standard reports for the following:

1) Current values of all objects.
2) Current alarm summary, sorted by priority.
3) Alarm history.
4) Disabled objects.
5) Alarm lockout objects.
6) Logs.

n. Summaries:

1) System log shall log the status of points within system.
2) Alarm summary shall log specified alarm points which are actually in alarm.
3) Off-normal summary shall log points specified by the operator to be in the off-normal mode.
4) Lockout summary shall log points specified to be in the lockout condition.

o. Messages:

1) The system shall support a minimum of 500 different automatic messages defined by the authorized operator on-line via word processing editor with minimum available length of 256 alpha-numeric characters. Messages shall also indicate whether acknowledgment is necessary.

2) Messages may be assignable as pop-up reactions to operator inputs, system alarms, event processes, and other system messages as required and deemed useful by the programmer, Engineer, and Owner.

p. Totalization:

1) The energy management system shall allow for analog or digital point totalization with respect to time.

2) Run time totalization shall be provided to track the run time of point assigned. A summary shall be generatable listing run time points and their present values.

3) Analog totalization shall be provided to measure analog data over real time span. A summary shall be generatable which lists analog totalization points and their current period values, current dry values, previous period and previous day totalized values.

4) Provide customized totalization reports for each major HVAC system.

q. Scheduling:

1) The system shall be capable of initiating equipment based on a preselected time-of-day schedule. This program shall provide scheduling for seven days of the week with 500 unique schedules. The user shall not be required to enter control programs to alter time-of-day schedules.

2) Provisions shall be made to program in holidays up to one year in advance; up to 366 consecutive holidays shall be enterable.

3) On-Line Graphic Generation:

4) This program shall allow the operator to generate color graphics on-line using symbols selected from a standard library of symbols.

4. Energy Management Features: The following energy management programs shall reside in the OWS for global control purposes:

    a. Demand limiting program shall monitor total demand at the on-site meter and reduce load, if possible, to maintain a fixed value.

    b. Duty cycling program shall periodically turn selected loads off to reduce energy consumption.

    c. Optimal run time program shall control the start-up and shutdown of HVAC equipment based on the most energy efficient schedule. Startup shall be staggered to minimize inrush currents.

    d. The energy management program shall not allow the energy management features listed above to shut down air systems (air handling units, unit ventilators, cabinet heaters, etc.) which are providing ventilation air to the occupied spaces during the occupied cycle.

    e. Programs shall be supervised by an energy management program, which shall oversee the execution of global energy management functions. These programs may also reside in individual field panels on systems of this architecture. If the host computer is to act only in a supervisory mode, specific panels shall be assigned to global function duty.

5. Custom Application Software:

    a. English language oriented.
    b. Full-screen character editor/programming environment.
    c. Allow development of independently executing program modules with debugging/simulation capability.
    d. Support conditional statements.
    e. Support floating-point arithmetic with mathematic functions.
    f. Contains predefined time variables.

6. Control Programming: Definition of operator device characteristics, EMCS panels, individual points, application, and control sequences shall be performed through fill-in-the-blank templates and a graphical programming approach. Allow the user to define the software configuration of EMCS panel logic for HVAC system control sequences, fan interlocks, pump interlocks, PID control loops, and other control relationships through the creation of graphical logic flow diagrams.

    a. Graphical Programming: Control sequences are created by using a mouse input device to draw interconnecting lines between symbols and depicting inputs, operators (comparisons and mathematical calculations), and outputs of a control sequence. As a minimum, graphic symbols shall be used to represent:

        1) Process inputs, such as temperature, humidity, or pressure values, status, time, date, or any other measured or calculated system data.
        2) Mathematical process operators, such as addition, subtraction, multiplication, or greater than, equal to, or less than, etc.

3) Logical process operators such as IF, AND, OR, ELSE, GO TO, Exclusive OR, NOT, etc.
4) Time delays.
5) Process control outputs such as start/stop control points, analog adjust points, etc.
6) Process calculation outputs.
7) Text file outputs and advisories.

b. Network-wide Strategy Development: Inputs and outputs for any process shall not be restricted to a single EMCS panel, but shall be able to include data from any and all other EMCS panels to allow the development of network wide control strategies. Processes shall also allow the operator to use the results of one process as the input to any number of other processes (cascading).

c. Sequence testing and simulations: Provide a software tool which allows a user to simulate control sequence execution to test strategies before they are actually applied to mechanical systems. Users shall be able to enter hypothetical input data and verify desired control response and calculation results via graphical displays and hard copy printouts.

7. Dynamic Color Graphic Displays:

a. Provide graphics generation software to allow the user to add, modify, or delete system graphic displays that include any manipulated point data from any networked EMCS panels. Develop graphic screens using any drawing package capable of generating a GIF, BMP, or JPG file format, including AutoCadd and Visio. Use of proprietary graphic file formats shall not be acceptable. In addition to a graphic background, support the use of scanned pictures.

b. Provide for simultaneous viewing of several graphics at the same time (windowing) to analyze total building operation, or to allow display of a graphic associated with an alarm to be viewed without interrupting work in progress.

c. Provide libraries of pre engineered screens and symbols depicting standard air handling unit components (e.g. fans, cooling coils, filters, dampers, etc.), complete mechanical systems (e.g. constant volume terminal reheat, VAV, etc.) and electrical symbols.

d. The graphic development package shall use a mouse or similar pointing device in conjunction with a drawing program to allow the user to perform the following:

1) Define symbols
2) Position and size symbols
3) Define background screens
4) Define connecting lines and curves
5) Locate, orient, and size descriptive text
6) Define and display colors for all elements
7) Establish correlation between symbols or text and associates system points or other displays.

e. Each graphic display shall consist of a static section and a dynamic section. The static section shall consist of elements which usually do not change with time or point condition. The dynamic section shall consist of elements which usually do change with point conditions, and shall be integrated with the respective static section, appearing in appropriate locations in it.

1) A minimum capability of 256 different static sections shall be provided. Each static section shall be capable of being associated with any number of dynamic sections. The elements of a static section shall be capable of outputting in any one of eight different colors. A static section does not have to be associated with a dynamic section to be used as chromatic output. The elements of static sections shall include, but not be limited to: lines, line drawings, symbols, and character strings (single/double sized).

2) The dynamic section shall accommodate a minimum of 40 elements. The elements of a dynamic section shall be capable of outputting in any one of the eight colors. Symbols shall be a pictorial illustration of the point condition. This illustration shall not be dependent on the type of sensor/device being represented. The elements of a dynamic section shall include, but not be limited to: point identifier, point expanded identifier (if abbreviated), analog value, engineering units, mode units, symbols, lines, text strings. Dynamic temperature values, humidity values, flow values, and status indication shall be shown in their actual respective locations, and shall automatically update to represent current conditions without operator intervention.

3) System graphic display shall update the dynamic elements to the current point condition, at least every 30 seconds. System shall include a list of standard symbols. Lines shall include, but not be limited to: vertical, horizontal, diagonal, curved. Character strings shall include alpha/numeric characters and shall be capable of 60 characters minimum length.

4) Dynamic element shall be capable of being used a multitude of times on a single chromatic display and shall be stored in a symbols library program.

f. When a point is in alarm on the screen, the OWS shall be able to display an alarm graphic with a minimum number of keystrokes. Alarm graphic individual point information shall include, but not be limited to: point identification, point location, alarm point value, alarm limit value, engineering units (^{o}F, KWH, etc.), mode units (on/off, alarm).

8. Web Browser Features:

a. On-Line Help: Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext. All system documentation and help files shall be in HTML format.

b. Security: Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system administrator shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.

c. System Diagnostics: The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.

d. Alarm Console:

1) The system will be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm. The use of the Alarm Console can be enabled or disabled by the system administrator.

2) When the Alarm Console is enabled, a separate alarm notification window will supercede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and un-acknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.

9. Web Browser Clients

a. The system shall be capable of supporting at least 64 clients using a standard Web browser such as Internet Explorer or Netscape Navigator. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, are only acceptable if 64 licensed copies of the client machine software are provided, installed, and tested. The system shall support a minimum of ten (10) simultaneous clients.

b. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the EMCS, shall only be acceptable if 64 workstation or workstation hardware upgrades are provided.

c. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.

d. The Web browser client shall support at a minimum, the following functions:

1) User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.

2) Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.

3) HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.

4) Storage of the graphical screens shall be in the Building Control Units (BC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.

5) Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.

6) Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:

a) Modify common application objects, such as schedules, calendars, and set points in a graphical manner.

b) Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.

c) Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.

d) Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.

e) View logs and charts

f) View and acknowledge alarms

7) The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.

8) Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

2.4 NETWORK CONTROL UNITS (NCUs)

A. General: Network Control Units shall be microprocessor based, multi-tasking, multi-user, and employ a real time operating system. Each NCU control panel shall consist of modular hardware including power supply, CPU board, and input/output modules. A sufficient number of NCUs shall be supplied to fully meet the requirements of this specification and the controls requirements shown on the drawings.

1. Basis of design NCUs: Schneider Electric Continuum bCX1-CR-xxx with InfbCX1 controller.

B. Webserver Functionality: All NCUs shall reside directly on the Owner's Ethernet TCP/IP LAN/WAN and shall be capable, out-of-the box, to be set up as a Web Server. The NCU shall have the ability to store HTML code and "serve" pages to a web browser. Provides the ability for any computing device utilizing a TCP/IP Ethernet connection and capable of running a standard Internet browser (Microsoft Internet Explorer™, Netscape Navigator™, etc.) to access real-time data from the entire BAS via any NCU.

1. Graphics and text-based web pages shall be constructed using standard HTML code. The interface shall allow the user to choose any of the standard text or graphics-based HTML editors for page creation. It shall also allow the operator to generate custom graphical pages and forms.

2. The WEB server interface shall be capable of password security, including validation of the requesting PC's IP address. The WEB server interface shall allow the sharing of data or information between any controller, process, or network interface (BACnet, LonTalk and TCP/IP) that the BMS has knowledge of, regardless of where the point is connected on the BAS network or where it is acquired from.

3. The BAS network controller must act directly as the WEB server. It must directly generate HTML code to the requesting user (i.e. WEB browser), eliminating the need for and reliance on any PC-based WEB server hardware or software. To simplify graphic image space allocation, HTML graphic images, if desired, shall be stored in any shared network device. The BAS Web server shall have the ability to acquire any necessary graphics using standard pathing syntax within the HTML code mounted within the BAS WEB server. External WEB server hardware and software are not acceptable.

C. Hardware Specifications

1. Memory: A minimum of 4MB of RAM shall be provided for NCUs with expansion up to 8MB. The 8MB versions shall include a floating-point math co-processor.

2. Communication Ports: Each NCU shall provide communication to both the Workstation(s) and the field buses. In addition, each NCU shall have at least three other communications ports that support a telephone modem, portable service tool, serial printer and connection to third party controllers such as a chiller control panel. On a LAN/WAN system, the NCU shall be provided with a 10Mbps plug-in Ethernet TCP/IP network interface card (NIC).

3. Input/Output (I/O): Each NCU shall support the addition of the following types of inputs and outputs:

    a. Digital Inputs for status/alarm contacts
    b. Counter Inputs for summing pulses from meters.
    c. Thermistor inputs for measuring temperatures in space, ducts and thermowells.
    d. Analog inputs for pressure, humidity, flow and position measurements.
    e. Digital Outputs for on/off equipment control.
    f. Analog Outputs for valve and damper position control, and capacity control of primary equipment.

4. Modular Expandability: The system shall employ a modular I/O design to allow easy expansion. Input and output capacity is to be provided through plug-in modules of various types or DIN-mountable IOU modules. It shall be possible to combine I/O modules as desired to meet the I/O requirements for individual control applications.

5. Real Time Clock (RTC): Each NCU shall include a battery-backed, real time clock, accurate to 10 seconds per day. The RTC shall provide the following: time of day, day, month, year, and day of week. In normal operation, the system clock shall be based on the frequency of the AC power. The system shall automatically correct for daylight savings time and leap years and be Year 2000 compliant.

6. Power Supply: The power supply for the NCUs shall be auto sensing, 120-220VAC, 60/50 Hz power, with a tolerance of +/- 20%. Line voltage below the operating range of the system shall be considered outages. The controller shall contain over voltage surge protection, and require no additional AC power signal conditioning. Optionally, if indicated on the drawings, the power supply shall accept an input voltage of (–48 VDC).

7. Automatic Restart After Power Failure: Upon restoration of power after an outage, the NCU shall automatically and without human intervention: update all monitored functions; resume operation based on current, synchronized time and status, and implement special start-up strategies as required.

8. Battery backup: Each NCU with the standard 120-220VAC power supply shall include a programmable DC power backup system rated for a minimum of 72 hours of battery backup to maintain all volatile memory or, a minimum of 2 hours of full UPS including modem power. This power backup system shall be configurable such that at the end of a settable timeframe (such as 1 hour) of running on full UPS, the unit shall shut off full UPS and switch to memory retention-only mode for the remainder of the battery power. The system shall allow the simple addition of more batteries to extend the above minimum battery backup times.

D. Software Specifications

1. General: The NCU shall contain flash ROM as the resident operating system. Application software shall be RAM resident. Application software shall only be limited by the amount of RAM memory. There shall be no restrictions placed on the type of application programs in the system. Each NCU shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.

2. User Programming Language: The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be English language-based and programmable by the user. The language shall be structured to allow for the easy configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, passwords, and histories. The language shall be self-documenting. Users shall be able to place comments anywhere in the body of a program. Program listings shall be configurable by the user in logical groupings.

E. Control Software:

1. The NCU shall have the ability to perform the following pre-tested control algorithms:

   a. Proportional, Integral plus Derivative Control (PID)
   b. Two Position Control
   c. Digital Filter
   d. Ratio Calculator
   e. Equipment Cycling Protection

2. Mathematical Functions: Each controller shall be capable of performing basic mathematical functions (+, -, *, /), squares, square roots, exponential, logarithms, Boolean logic statements, or combinations of both. The controllers shall be capable of performing complex logical statements including operators such as >, <, =, and, or, exclusive or, etc. These shall be able to be used in the same equations with the mathematical operators and nested up to five parentheses deep.

3. Energy Management Applications: NCUs shall have the ability to perform any or all of the following energy management routines:

   a. Time of Day Scheduling
   b. Calendar Based Scheduling
   c. Holiday Scheduling
   d. Temporary Schedule Overrides
   e. Optimal Start
   f. Optimal Stop
   g. Night Setback Control
   h. Enthalpy Switchover (Economizer)
   i. Peak Demand Limiting
   j. Temperature Compensated Duty Cycling
   k. CFM Tracking

l. Heating/Cooling Interlock
m. Hot/Cold Deck Reset
n. Free Cooling
o. Hot Water Reset

4. History Logging: Each controller shall be capable of logging any system variable over user defined time intervals ranging from 1 second to 1440 minutes. Any system variables (inputs, outputs, math calculations, flags, etc.) can be logged in history. A maximum of 32,767 values can be stored in each log. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logs can be automatic or manual. Logged data shall be downloadable to the Operator Workstation for long term archiving based upon user-defined time intervals, or manual command.

5. Alarm Management: For each system point, alarms can be created based on high/low limits or conditional expressions. All alarms shall be tested each scan of the NCU and can result in the display of one or more alarm messages or reports.

6. Up to 8 alarms can be configured for each point in the controller.

   a. Messages and reports can be sent to a local terminal, to the front-end workstation(s), or via modem to a remote-computing device.

   b. Alarms shall be generated based on their priority. A minimum of 255 priority levels shall be provided.

   c. If communication with the Operator Workstation is temporarily interrupted, the alarm shall be buffered in the NCU. When communications return, the alarm shall be transmitted to the Operator Workstation if the point is still in the alarm condition.

7. Reporting: The NCU shall be able to generate user-definable reports to a locally connected printer or terminal. The reports shall contain any combination of text and system variables. Report templates shall be able to be created by users in a word processing environment. Reports can be displayed based on any logical condition or through a user command.

2.5 I/O INTERFACE

A. Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

B. Binary Inputs: Allow monitoring of on-off signals without external power.

C. Pulse Accumulation Inputs: Accept up to 10 pulses per second.

D. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.

E. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.

F. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.

G. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.

H. Universal I/Os: Provide software selectable binary or analog outputs.

2.6 POWER SUPPLIES

A. Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

1. Output ripple of 5.0 mV maximum peak to peak.
2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

B. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:

1. Minimum dielectric strength of 1000 V.
2. Maximum response time of 10 nanoseconds.
3. Minimum transverse-mode noise attenuation of 65 dB.
4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.7 UNITARY CONTROLLERS

A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.

1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.

2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.

3. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.

4. Enclosure: Dustproof rated for operation at 32 to 120 deg F.

2.8 ANALOG CONTROLLERS

A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.

B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F, and single- or double-pole contacts.

C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.

2.9 ELECTRONIC SENSORS

A. Current Transducer:

1. Solid or split core self powered analog current transducer slips over power wiring to provide combination load status and power use trending data.

    a. Linear output from 0 to full scale.
    b. 0-5Vdc output
    c. Operating conditions: -15-60 deg C, 0-95%rh.
    d. 2 second response time
    e. Use solid core for new applications, split core for retrofits away from terminals.
    f. Split core +/- 2% of full scale accuracy from 10% to 100%.
    g. Solid core +/- 2% of reading accuracy from 10% to 100%.
    h. Similar to Hawkeye 722, 922/932, size and range as required for load.

B. Static Pressure Transmitter / Transducer:

1. Senses differential gauge (static) pressures and converts this pressure difference to a proportional analog output signal.

    a. Variable capacitance type, with stainless steel diaphragm and insulated positioning electrode.
    b. Voltage Requirement (input): +/- 12 V DC.
    c. Output: linear, 4 to 20 mA or 0 - 5 V DC.
    d. Pressure ranges 0 to 0.1 in w.g. through 0 to 25.0 in. w.g.
    e. Over Pressure Protection: Minimum 10 x full scale.
    f. Pressure Part Volumes: Positive part - 0.020 $in.^3$; reference part - 2.0 $in.^3$
    g. Accuracy: +/- 1% full scale (includes non-linearity hysteresis and non-repeatability).
    h. Factory calibrated with zero span adjustment capability.
    i. Temperature compensated output over the entire operating temperature range.
    j. Operating Environments: 40 deg. F to 100 deg. F.

C. Toxic Gas Transmitters & Sensors

1. Transmitters:

a. UL 1244 and CSA 22.2 labeled transmitter must manufactured within an ISO 9002 product environment.

b. Powered by the control panel power output rated at 17-27 Vac or by an external power supply rated at 17-27 Vac or 24-38 Vdc.

c. Fully addressable, capable of communicating digitally and transmitting gas concentrations via analog 4-20ma signal to the EMCS thru RS-485 communication port, installed in a true daisy chain configuration.

d. Capable of remote placement at distance of up to 300 feet (25 feet for Class I environment) from sensing element, the gas transmitter will incorporate either an electrochemical cell (for toxic gas monitoring) or a catalytic combustion cell (for explosive gas monitoring), or a diffusion fuel cell (for oxygen sensing). Unit sensing cell must compensate for variations in relative humidity and temperature to maintain high levels of accuracy.

e. Provide 5A, 30 Vdc or 250 Vac (resistive load) DPDT relay, activated at programmable setpoints (and programmable time delays) through the control panel.

f. A ten step LED display, will provide local reading of concentrations of gas. Normal operation will be indicated by a green LED. Fault operation will be indicated by a yellow or red LED.

g. Fully programmable audible alarm.

h. Operating range RH 5-90%, temperature 32-100 degrees F (-40 to 160 degrees F for Class I environment).

i. Sensors and transmitters placed in Class I environment shall additionally have the following features:

1) Integrated sensor guard protects sensing element from water spray/splash, dust and dirt.

2) Equipped with self-test feature that will provide an accurate meantime before calibration, built in auto-zero adjustment, and the measure the sensing cell's remaining useful life.

3) Magnetic controls on the face of the unit along with calibration circuitry, with the use of calibration port, will permit the unit to be calibrated without the need to declassify the space monitored.

4) When placed into a network configuration the transmitter will be capable of two alarm levels.

5) Housings must meet Class1, Division 1, Group; B, C and D specifications and have FM label. Sensor must meet Class1, Division 1, Group; B, C and D specifications.

j. Transmitter alarm levels to activate and installation levels:

Toxic Gasses	First Alarm Setpoint (TLV-TWA)	Second Alarm Setpoint (TLV-STEL)	Sensor Location	Radius of Coverage
Carbon Monoxide	35 ppm	35 ppm	3-5' above floor	50 feet
Chlorine	.5 ppm	35 ppm	1'above the floor	20 feet

D. Temperature Sensors:

1. Temperature sensors shall be:

a. Platinum wound RTD Type ± 1°F. Factory calibration point - 70°F at 1000 OHMS or 0°C at 1000 OHMS. Adjustments for zero and span. Output 4-20 mA.

Or (for non averaging sensors)

b. Contractor may use thermistors which are compatible with system as follows:

1) Accurate to 0.35°F over a range of -40° to 240°F,
2) Noncalibrated devices, accuracy traceable to NBS testing,
3) Guaranteed stability of 0.2°F over a 15 year period,
4) Interchangable with any other in the new system, and
5) Shielded cable not require for the guaranteed performance.

2. Room element assemblies shall be located in conditions representative of the zone, on an interior wall where air is free to circulate around the element but away from non-representative air conditions such as drafts or heat radiation. Mount the assembly 5 feet above the floor on a standard electrical wallbox, or as otherwise directed or required to obtain satisfactory results. A mounting bracket, wallplate, decorative cover and tamper resistant screens shall be furnished with the assembly. May be S.S. wall plate type where applicable.

3. Outside air temperature sensing: The outside air sensor shall be mounted where the effects of sunlight and radiant heat are at a minimum (north wall) for true "dry-bulb" reading. Provide in enclosure to fit 1/2" threaded rigid conduit, designed for exterior dry-bulb sensing. Seal off fittings shall be used to prevent condensation on the element in the housing. Monitoring range to suit controls.

4. Duct temperature sensors: Duct insertion sensors for fan discharge and other thoroughly mixed applications designed for control and/or indication shall have a single sensor with an accuracy of 0.25% of scale range. Provide averaging type sensing elements for transmitters and capillary thermostats in mixed air and coil discharge applications to counteract effects of stratification. Length as required to provide at least four full passes across the duct – two long dimension and two diagonal. Capillary systems to be fully compensated. The element shall consist of nickel wire encased in a copper tube. Monitoring range to suit controls.

5. Liquid temperature sensors shall be mounted in separable brass immersion wells with 1/2" - 14 NPT threads, filled with "Insulgrease" or other approved heat transfer compound. Monitoring range to suit conditions. Well and spring loading device to assure RTD contact with end of sensing well. Whenever a sensing element and well are installed in a chilled water line, plumber's putty or some other suitable sealant shall be applied around the adapter as well as the point where the two sensors leads pass through the adapter. This is to prevent condensation of moisture in the well and failure of the element. Minimum well length to be equal to 1/2 of the pipe diameter; match bulb length to well length.

6. Battery powered “wireless communicating” sensors which use batteries as the source of power for transmission and communication of data are not acceptable.

E. Thermostats:

1. Electronic room thermostats shall be similar to room temperature sensors with occupancy over-ride, bias adjustment, and LCD space / setpoint temperature readout functions built in.

2. Provide with durable cast aluminum or polycarbonate guard where required to prevent unauthorized access.

3. Battery powered “wireless communicating” thermostats which use batteries as the source of power for transmission and communication of data are not acceptable.

4. Incidental electric thermostats specifically indicated as not connected to EMCS shall be heavy duty type with concealed adjustment.

2.10 WIRELESS CONTROL COMPONENTS

A. All wireless control components shall be from the EMCS manufacturer.

1. Network Automation Engine (NAE) and Network Control Engine (NCE) shall be Web-enabled, Ethernet-based, supervisory controllers that connect BAS networks to Internet Protocol (IP) networks and the Web. NAEs and NCEs provide scheduling, alarm and event management, trending, energy management, data exchange, dial-out capability, and password protection.

2. Wireless Field Bus Coordinator: Device shall provide a wireless interface between supervisory controllers on a wired BACnet MS/TP network and wireless-enabled field controllers.

3. Wireless Router: Compatible with in field equipment controller and I/O modules to provide a wireless interface between a field controller and NAE, NCE or associated wireless field sensor.

   a. Router shall be powered directly from the connected field controllers 15 VDC output.

4. Field Controllers: As required to provide the full sequence of operation.

5. Sensors: As required to provide the full sequence of operation.

2.11 HVAC PROCESS FLOW CONTROL COMPONENTS

A. CONTROL DAMPERS (AAD)

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

    a. American Warming and Ventilating; a division of Mestek, Inc.
    b. Arrow United Industries; a division of Mestek, Inc.
    c. Nailor Industries Inc.
    d. Ruskin Company.
    e. Vent Products Company, Inc.

2. Low-leakage rating with linkage outside air stream and bearing AMCA CLASS 1A.

3. Frames:

    a. Hat shaped.
    b. Galvanized-steel channels, 0.064 inch thick.
    c. Mitered and welded corners.

4. Blades:

    a. Airfoil, multiple blade with maximum blade width of 8 inches.
    b. Parallel- and opposed-blade design.
    c. Galvanized steel.
    d. 0.064 inch thick.
    e. Blade Edging: Closed-cell neoprene edging.

5. Blade Axles: 1/2-inch- diameter; zinc-plated steel and brass; ends sealed against blade bearings.

    a. Operating Temperature Range: From minus 40 to plus 200 deg F.

6. Bearings:

    a. Oil-impregnated, stainless steel.
    b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
    c. Thrust bearings at each end of every blade.

B. Valves:

1. Valve Types:

    a. Ball valves – full port for two position on/off service, with characterizing disc for modulating service.
    b. Butterfly valves - two-position on/off service or for use in modulating service where specifically called out as such on drawings.
    c. Globe valves - modulating service.

2. Valve Bodies:

   a. Screwed bronze bodies (2" size and smaller).

   b. Flanged iron bodies (larger than 2" size).

   c. Ball valves shall be of two piece full port stainless steel ball and stem design similar to those described in SECTION 23 05 23 but with reinforced actuator duty stems, adapters, and electronic actuators.

   d. Butterfly valves shall be similar to those described in SECTION 23 05 23 with reinforced actuator duty stems, adapters, and actuators.

   e. Globe valves shall have characteristic type throttling plug, #316 stainless steel or Monel stem, and removable composition seats, tight closing to class 4 standard minimum. Provided with necessary features to operate in sequence with other valves or damper operators and adjustable throttling range.

   f. Two or three way as required.

   g. Designed for 125 psi operating pressure.

   h. Arrange to spring return to fail-safe position as called for, quiet operating.

3. Two position valves to be full line size unless otherwise indicated. Modulating water control valves shall be sized on the basis of the smaller of 15% of the total system pressure drop or 8 ft. of water column pressure drop, based on the system design flowrates. Include valve pressure drops in submittal for review. Tag each valve before delivery to project site with scheduled valve identification for location and service.

4. Provide valves and actuation so valves fail safe in normally open or closed positions as required to provide freeze, humidity, force, temperature, etc. protection. Fail position choice shall be submitted for review.

5. Select two-way modulating valves to have equal percentage characteristics.

6. Select three-way valves to have linear characteristics.

C. Actuators:

1. Electronic actuators:

   a. Electronic actuators shall be motor driven with cast aluminum enclosure, with completely oil-immersed metal gear trains, sealed integral spiral spring return mechanism, force sensor safety stop, and shall have torque as needed to insure positive movement against system stall pressure. Furnish entire mechanism in housings designed for easy removal for service or adjustment.

   b. Size each actuator motor to operate with sufficient reserve power to provide smooth modulating or 2-position action as specified.

c. Provide permanent split-capacitor, shaded pole, or synchronous motors with gear trains completely oil-immersed and sealed.

d. Equip motors for outdoor locations and for outside air intakes with "0 ring" gaskets designed to make motors completely weatherproof, and equip with internal heaters to permit normal operation at -40 deg F (-40 deg C).

e. All actuators for exterior use shall be electronic style and shall have NEMA 4 enclosures with a rain shield covering the valve stem and entire actuator housing.

f. Damper actuators shall be direct-coupled over the damper shaft, and shall be installed without connecting linkage where possible.

    1) Where linkages are required, for example with multiple section dampers or dampers where actuator must be installed in the air-stream, provide with linkage furnished by the damper manufacturer and designed for the actuator being used.

g. Ball and Butterfly valve actuators shall be direct-coupled over the valve shaft, installed without connecting linkage.

    1) Globe valve actuators shall have a rack and pinion linkage provided by the valve manufacturer and designed for the actuator being used.

h. The actuator shall have electronic overload and digital rotation sensing to prevent damage to the actuator through the entire rotation range of the actuator.

i. Actuators shall be capable of both clockwise and counter clockwise motion by changing mounting orientation.

j. Provide proportional actuators for modulating services that accept a 0 to 10 VDC or 4 to 20mA control input and provide a 2 to 10 VDC or a 4 to 20mA operating range. An actuator capable of accepting a pulse width modulated / floating point control signal and providing full proportional operation is only acceptable for hydronic valve services where there is no connection to outside air.

k. All 24 VAC/DC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC or more than 8 watts for DC applications. Actuators operating on 120VAC power shall not require more than 10VA. Actuators operating on 230VAC power shall not require more than 11VA.

l. All actuators shall have an external manual gear release and actuators with more than 60 in-lb torque capacity shall have a manual crank to allow manual positioning when the actuator is not powered.

m. All modulating actuators shall have an external, built-in switch to allow the reversing of direction of rotation.

n. Actuators shall be provided with a conduit fitting and minimum three foot electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.

o. Actuators shall be UL Standard 873 listed and CSA Class 4813 02 certified as meeting correct safety requirements.

p. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuators rated torque and shall have a minimum 2-year manufacturer's warranty, starting from the date of installation.

q. Design make: TAC-I/A *DuraDrive* series and Belimo models as required by torque.

2.12 SAFETY DEVICES

A. Low Limit: Electric type with 20' long serpentine element, coldest foot sensitivity, with automatic reset and auxiliary contacts to the EMCS. Set for 37 deg. F for "freeze" protection and 55°F for fan discharge application.

B. High Limit: Electric type, with manual reset; and auxiliary contacts to the EMCS, UL listed for fire, set for 125 deg. F.

C. Filter switches: Differential pressure type with adjustable set point, visual and audible trip indication, and auxiliary contacts to the EMCS.

D. Surge Suppression (Sp) Receptacle:

1. Surge suppression receptacle with metal oxide varister to dissipate the electrical energy of voltage spikes.
2. 20 ampere, duplex, NEMA 5-20R configuration.
3. Back and side wiring, high impact nylon body.
4. May be integral to panels.

2.13 MISCELLANEOUS DEVICES

A. Provide all necessary relays, controllers, accumulators, positioners, switches, solenoids, transformers, temperature sensors, and transducers for a complete system.

B. Locate these devices on local panel unless specified otherwise.

C. Wiring:

1. Controls power wiring: Provide wiring in accordance with requirements of Section 23 05 13 , Division 26, and the National Electrical Code.

2. Controls communications and data cabling:

a. Provide plenum rated cables, in full accordance with the requirements of Divisions 26 (Electrical).

b. Provide cabling as recommended in writing by the controls manufacturer for optimized communications, similar to:

1) 22AWG single twisted pair, low capacitance (12.5pF/ft), shielded or unshielded plenum rated cable for low voltage communications.
2) 18AWG single twisted pair, low resistance (6mW/ft), shielded plenum rated cable.

3. Controls communications and data fiber optic cabling: Provide in accordance with the stricter of the requirements of Divisions 26, 27, and the written recommendations of the manufacturer of the equipment served.

4. Where additional wire to wire terminations are required beyond end device and controller termination strips, make connections using NEMA rated termination blocks with barrier isolated strip/screw or tube/screw connections, all labeled for current function. Flying splices not permitted.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which materials and methods are to be installed and notify Architect in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in acceptable manner.

1. Installation indicates conditions are acceptable to Contractor as required to ensure requirements for applicable warranty or guarantee can be satisfied.

2. Electrical Wiring: Check all electrical wiring associated with equipment for compliance with specifications and correctness of connections. Correct wiring in event equipment or devices fail to function in specified manner, whether due to incorrect connections or improper information and wiring diagrams.

3. Verify that conditioned power supply is available to control units and operator workstation as required.

3.2 WORK INCLUDED

A. Provide all labor, materials, equipment, and services required for the complete removal of all existing controls components being replaced or upgraded as a part of this project or which serve equipment being removed as a part of this contract.

1. Insure that controls for areas outside of this contract's work remain intact and functional. Report any existing problems with functionality before demolition. New problem areas not otherwise a part of this scope that result from this demolition work: rebuild original functionality or upgrade to be included in the new controls.

B. Provide all labor, materials, equipment, and services required for the complete EMCS installation, including Related Work, as required in the Contract Documents. Provide all programming labor required for creating the specified sequences of operation and associated graphics. Include labor required for integrating any software and programming enhancements made both during construction and commissioning and during the warrantee period. Include labor for any programming modifications required due to special circumstances not adequately described in the written sequences of operations, as required to control systems operation as intended.

C. Provide all controls wiring required to connect devices furnished as part of or adjunctive to this EMCS regardless of the source of supply. Provide connections to Owner's LAN, WAN, telephone, and internet as required to perform controls work. Coordinate all fiber optic, telecommunications, and other electrical connections with Owner.

D. Provide power wiring for controls requiring connection to AC power. Control circuits to be 120 vac maximum. Install wiring in accordance with requirements of SECTION 23 05 13 - COMMON ELECTRICAL REQUIREMENTS FOR HVAC EQUIPMENT, Division 26, and the National Electrical Code. Provide actuator power wiring to all automatic dampers including fire/smoke dampers. Coordinate required relays, etc.. with fire alarm system control wiring by Division 16.

E. Provide all necessary devices required for proper system operation, including special electrical switches, conditioned power supplies, transformers, disconnect switches, relays, circuit breaker protection, as required.

F. Provide all controllers, actuators, sensors, etc. as specified later herein, and as required to meet the specified sequence of operation.

G. Furnish all valves, control wells, and dampers to Contractor responsible for their installation, as specified and as required to meet the sequence of operation.

H. Provide interface connections from EMCS hardware to equipment starting circuits, alarms, etc.

I. The system shall include all accessory equipment and electrical wiring to fulfill the intent of this specification, including all control and communications components required to interface with the Owner's Ethernet LAN, forming a complete and interoperable system.

J. Each portion of the District EMCS system as described above shall include all gateways, translators, interpreters, software, programming, or other accessory devices as required to achieve BACnet communications over the LAN.

3.3 INSTALLATION

A. System shall be installed and adjusted by trained mechanics and technicians, with a demonstrated experience of not less than (5) years, in the installation, adjustment, and repair of temperature control systems.

B. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

C. Connect and configure equipment and software to achieve sequence of operation specified.

D. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."

E. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."

F. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping."

3.4 SYSTEM COMPONENTS

A. Current Transducer: As required; install per manufacturer's written instructions.

B. Static Pressure Transmitter: As required; install per manufacturer's written instructions.

C. Temperature Sensors: Install per manufacturer's written instructions, in locations representative of the controlled spaces' temperature as required for proper control. Include proposed sensor locations in wiring diagram submittal.

1. Provide room temperature sensors for all spaces where thermostats are not specifically called for, as required to properly and individually control all building mechanical HVAC and domestic hot water equipment in accordance with the sequence of operation. For large spaces, provide at least one room sensor per 2000 square feet, in locations representative of the room's various exposures and internal loads.

2. Temperature Sensor with Guard: Provide sensor with guard (preferably S.S. wall plate sensor) wherever temperature sensor is called for in publicly accessed spaces similar to corridors, vestibules, lobbies, stairwells, cafeteria, gymnasium, auditorium, etc..

3. Duct and pipe temperature sensors: Provide as shown on the controls schematics and as required to properly control per the written sequence of operations.

4. Outdoor air sensors: Provide as required to accurately sense outdoor air conditions for proper economizer control, at least five separate locations facing each of East, West, North, and South, as well as a representative rooftop location.

D. Thermostats: Locate thermostats on walls symmetrical with adjacent items. Verify exact room location to avoid doors, fixed and portable equipment. Install to minimize damage. Do not install adjacent to lighting dimmers or other heat generating equipment. Include proposed thermostat locations in wiring diagram submittal.

1. Provide thermostats as specified and as required to properly and individually control all building mechanical HVAC equipment for all administrative offices, staff work and break rooms, classrooms, small group instruction rooms, large group instruction rooms, mechanical rooms, and spaces similar to these in function. Specifically not included in this list are corridors, vestibules, lobbies, stairwells, utility closets, and storage rooms.

2. Thermostat Guards: For bidding purposes, assume 10% of thermostats listed in 3.4.E.1 above will require guards – coordinate locations with Owner and Engineer during submittals. In addition to these and the multiple room sensors required by 3.4.D.1 above, provide single thermostat with protective guard for media center, cafeteria, gymnasium, and auditorium.

E. Automatic Dampers: Furnish dampers, tagged for proper location, (with multiple section damper linkages). Install per manufacturer's printed instructions. Adjust to close tightly. Allow for conduit sleeve or blank space for roof fan dampers.

F. Valves: Install with union or flanged connection. Locate close to apparatus controlled with pipe reducers and increasers located adjacent to valve. Locate, arrange, and pipe per installation diagram in an upright position (stem vertical).

G. Actuators: Install per manufacturer's printed instructions as to motor size and quantity, linkage arrangement, drive connection point. Where ducts or valves are insulated, set damper operators at least 2 in. away from equipment to allow for insulation.

H. Safety Devices:

1. Low Limit: Install on all equipment handling both water and any percentage of unheated outside air, including equipment in boiler rooms handling combustion air, serpentined on the discharge face of heating and/or cooling coils, or elsewhere as required for proper freeze protection, set at 37 deg F. Low limit trip shall report an alarm to the EMCS, which shall prevent the unit's fans from operating (not applicable to boiler burner fans), cause full flow of water in elements being protected, and fully close the outside air intake and exhaust air dampers until automatically reset (combustion air dampers shall not be closed when combustion is required for building heating). If some other sequence is required for proper freeze protection of special equipment or circumstances, provide this and detail in submittal.

2. High Limit: Install in the supply medium at the discharge of each fuel fired appliance. High limit trip shall report an alarm to the EMCS, which shall prevent the units burner from operating until manually reset.

3. Water Flow Switch: Install on the discharge side of each (pair of) constant speed pump(s), including base mounted and inline pumps. Analog current sensor for each pump motor may be used in lieu of flow switch if capable of differentiating between normal pump running current and reduced current draw as a result of reduced water flow. Coordinate with balancing work and Engineer to field calibrate device to alarm at a reduced flow rate to be determined on an individual basis.

4. Filter switches: Install across each bank of air filters in each air handling system.

5. Carbon Monoxide Sensor / Transmittor: Install in each space harmful vapors and gases to provide ventilation in the sequence of operations in location closely associated with breathing zone. If space is documented as having a fully mixed air space design and unit is designed to run 24 hrs/day, sensor may be duct mounted in return air.

6. Airborn contaminant Sensors: Install in locations most likely to sense contaminant in question, calibrated for reasonable levels of safety while avoiding nuisance trips, in each space where called for by sequence of operations or as otherwise shown on the drawings.

I. Air Flow Stations: As required; install per manufacturer's written instructions.

J. Surge suppression receptacle: As required; install per manufacturer's written instructions.

K. Miscellaneous Devices: As required; install per manufacturer's written instructions.

3.5 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Install signal and communication cable as follows:

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Install exposed cable in raceway.
3. Install concealed cable in raceway.
4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.6 SYSTEM SOFTWARE

A. Provide completely installed and ready for use.

B. System Configuration and Definition:

1. All temperature and equipment control strategies and energy management routines shall be definable by the operator. System definition and modification procedures shall not interfere with normal system operation and control.

2. The system shall be provided complete with all equipment and documentation necessary to allow an operator to independently add, delete, or modify the following:

   a. SCUs.
   b. OWSs.
   c. UCs.
   d. Points of any type, and all associated point parameters and using constants.
   e. Alarm reporting definition for each point.
   f. Control loops.
   g. Energy management applications.
   h. Time and calendar based programming.
   i. Totalization for every point.
   j. Historical data trending for every point.
   k. Custom control processes.
   l. All graphic displays, symbols, and cross references to point data.
   m. Dial-up telecommunication definition.
   n. All operator passwords.
   o. Alarm messages.

3. System Definition/control Sequence Documentation: All portions of system definition shall be self documenting to provide hard copy printouts of all configuration and application data. Control process and EMCS control loop documentation shall be provided in logical, graphical flow diagram format to allow control sequence to be easily interpreted and modified at any time in the future.

4. Database Save/Restore/Back-Up: Back-up copies of all standalone EMCS panel databases shall be stored in at least one personal computer operator workstation, and a secure electronic copy of the original complete database setup shall be stored at the offices of the TCS, available for the Owner’s use.

5. Continuous supervision of the integrity of all EMCS panel databases shall be provided. In the event that any EMCS panel on the network experiences a loss of its databases for any reason, the system shall automatically download a new copy of the respective database to restore proper operations. Database back-up/download shall occur over the local area network without operator intervention. Users shall also have the ability to manually execute downloads of any or all portions of an EMCS panel database.

3.7 SCU PANEL LOCAL OR PORTABLE OPERATOR'S TERMINALS

A. Each EMCS panel shall be capable of supporting an operator's terminal for local command entry, instantaneous and historical data display, and program additions and modifications.

   1. There shall be a provision for both permanently mounting the standalone EMCS panel operator terminal, or using it as a portable hand held unit.

   2. The EMCS panel operator terminal shall simultaneously display a minimum of 6 points with full English identification to allow an operator to view single screen dynamic displays depicting entire mechanical systems.

3. The operator functions provided by the EMCS panel operator terminal shall include, but not be limited to, the following:

    a. Start and stop points
    b. Modify setpoints
    c. Modify PID loop setpoints
    d. Override PID control
    e. Change time/date
    f. Add/modify start/stop weekly scheduling
    g. Add/modify setpoint weekly scheduling
    h. Enter temporary override schedules
    i. Define holiday schedules
    j. View analog limits
    k. Enter/modify analog warning limits
    l. Enter/modify analog alarm limits
    m. Enter/modify analog differentials
    n. Viewpoint history files

4. The EMCS panel operator terminal shall provide access to all real or calculated points in the controller to which it is connected, or any other controller in the network. This capability shall not be restricted to a subset of predefined "global points", but shall provide totally open exchange of data between the operator terminal and any EMCS panel in the network.

5. Operator access at all EMCS panel operator terminals shall be identical to each other, as well as identical to the PC or Laptop operator workstations. Any password changes shall automatically be downloaded to all controllers on the network.

6. The EMCS operator terminal shall provide English language prompting to eliminate the need for the user to remember command formats of point named. Prompting shall be provided consistent with a user's password clearance and the types of points being displayed, to eliminate the possibility of operator error.

7. A multifunction touch pad shall be provided for point and command selection, as well as parameter entry. To minimize the possibility of operator error, the EMCS panel operator terminal shall change the limit touch pad functions based upon an operator's password clearance, the function being performed, and types of points being displayed. Screen displays shall clearly indicate only valid touch pad functions.

8. Context Sensitive Help: On-line, interactive user's "Help" manuals and tutorials shall be provided. Based upon operator request, the "Help" function shall provide general system operating instructions and specific descriptions of commands available in the currently displayed menus.

9. Identification for all real or calculated points shall be consistent for all network devices. The same English language names used at PC workstations shall be used to access points at the EMCS panel operator's terminal to eliminate cross reference or look up tables.

10. In addition to instantaneous summaries, the EMCS panel operator's terminal shall allow a user to view a point history file for system points. Point history files shall provide a record of value of analog points over the last 24 hours, at 30 minute intervals, or a record of the last ten status changes for binary type points.

3.8 GENERAL CONTROLS SYSTEM PROGRAMMING DESCRIPTION

A. Provide color graphic floor plan displays and system schematics detailing all mechanical and electrical systems as indicated in the sequence of operations, at least one for each system and piece of mechanical equipment, including air handling systems, chilled water systems, and heating systems. Create displays to represent logical grouping of system points or calculated data based upon building function, and mechanical system points which aid the operator in the analysis of the facility. The operator shall be able to view and control these systems via graphical and text-based displays and controls.

1. Provide access to the various system schematic and floor plan graphics via any and all of mouse driven graphical penetration scheme, menu selection, “file tree” organization, or text based commands.

a. Graphical menu penetration: locate and display systems graphics via a mouse driven procedure, designed and implemented to optimize performance analysis and speed alarm recognition. Five clicks maximum from whole district map to details of critical alarm via this route.

1) Whole District Map: Include each building shown as an active link; point and click to go to building. Display any building with (Owner defined, TCS implemented) alarms present as highlighted for rapid system review and diagnosis. Include at least three levels of alarm to facilitate prioritizing; each level shall be obvious and visually distinct. The most critical alarm in any building shall define the alarm level of that entire building in this graphic.

2) Main Building Display: Include a full floor key plan of each floor, broken into areas of detailed floor plans, with similar active point/click penetration scheme and highlighted alarm areas.

3) Detailed Floor Plans: Indicate the location of mechanical equipment (boilers, chiller, air handlers, duct and reheat / VAV systems, pumps and pumping systems, metering equip. etc.) and electrical equipment (switch gear, lighting, etc.) on the detailed floor plans. Highlight any systems when in alarm. Outline limits of each control zone (typically along walls, etc..) and provide active multicolored background for each zone. Zone background color shall change with space temperature deviation from setpoint, with a minimum of 8 background colors, colors to be distinct from alarm highlight colors.

4) System Specific Graphics: Provide pictorial schematically correct representations of each and every mechanical system controlled and/or monitored. Include all associated points, digital status, analog values, appropriate and/or significant calculated values, alarms, active adjustment of all user adjustable setpoints, links to all scheduling, trend logs, sequence of operations description, associated systems schematics in appropriate locations, etc. Include plain English descriptions of each active point / link shown. Include appropriate plain English warnings for alarms. Modify as required by Owner and Engineer during system review, start-up, and commissioning.

b. Menu and text based penetration: An operator request for information about a specific system shall cause the associated graphic display to be automatically selected and output on the viewing screen. The operator request may be entered via either the graphical menu penetration procedure or via a pull down directory tree style menu system with "specific building", "specific mechanical room", and "specific system" levels of identification. The pull down menu system shall cause the graphical menu system to be updated.

B. Graphic Representations

1. General: The program shall allow the operator to generate color graphics on-line using standard symbols selected from a standard library of symbols.

2. Provide customized graphics with dynamic point values and set points. Graphics shall include but not be limited to:

a. Each third party microprocessor controlled system with all points available.

b. Heating Hot Water System with heat injection systems, primary hot water system, secondary hot water systems, 3-ways, 2-ways, etc.

c. Air Handling Units, air and water sides, with coil pumps, zones, etc.

d. Floor Plans - The operator interface shall allow the user to access the various graphical schematics via a graphical penetration scheme of the floor plans. Minimum breakdown shall include:

1) Whole District map, showing all buildings.
2) Key plan of each building.
3) Floor plans of each building with zoom in capability.

C. Time Schedule Programs

1. The programs for the EMS shall schedule each system's operation on an hourly basis controlled through daily, weekly and/or monthly schedules. Schedules for each individual system, room or area shall be programmed and modified by the user on a calendar-like display at the OWS.

2. The programs shall store 60 months of schedules.

3. An internal time clock shall automatically compensate for daylight savings time and calendars generated by software shall automatically compensate for leap years.

D. Trend Logs:

1. Provide customized trend log reports with up to twenty variables per report for each HVAC system. Points shall be assignable at the OWS; coordinate desired points on each log with Owner during training and commissioning. Archive trended values on the system hard disk for future inquiry, with back up copies automatically prompted for and generated on removable media.

E. Alarm Points

1. All temperature inputs to the DDC system (space, return air, mixed air, discharge air, supply and return water, boiler and cooling systems) shall be alarmed at the host computer if the temperature is out of range 10 deg. F (adj.) above or below setpoint.

2. Fan status shall be monitored by analog current sensing devices or differential pressure switch. If the fan is scheduled to run and the status is not proven, an alarm condition shall be shown at the host computer.

3. Pump status shall be monitored by analog current sensing devices. If the pump is scheduled to run and the status is not proven, an alarm condition shall be shown at the host computer.

4. All alarm points of any stand alone controllers such as boiler burner controls, chiller or condensing unit controls, etc.., shall be monitored.

5. For all alarms, provide appropriate text and graphical annunciation to facilitate ease of understanding of source and location of problem. Coordinate annunciation with Engineer, equipment manufacturers, and Owner's representatives.

F. Optimum Start Program

1. The building shall initially be brought to occupied temperature through an optimal start program. This program shall gradually increase space temperature requirements over a predetermined time to not only bring the building to required temperature but also soft start building mechanical equipment.

2. Each system shall have an independent modular program.

3. The program shall minimize the total energy consumption during daily start-up of each heating/cooling system.

4. A control algorithm shall compare the outside air temperature to space temperature and historical startup data to calculate a start time for each air handling system.

5. The start time for each system shall bring its respective zone to occupied setpoint at the time of occupied mode start.

6. The optimum start program shall be adjustable to the rate structure of the local energy company.

G. Optimum Stop Program

1. Each system shall have independent modular program.
2. The program shall minimize the total energy consumption during daily shut-down of each heating/cooling system.
3. A control algorithm shall compare the outside air temperature to space temperature to calculate a stop time for each air handling system.
4. The stop time for each system shall shut-down its respective zone as early as possible without letting the temperature drift out of the specified comfort range.
5. Minimum outside air ventilation shall be maintained where required by occupied status requirements of space served.

H. Fan Shut Down

1. When fire alarm condition is initiated, the fire alarm system shall directly cause all fans 1000 cfm and larger to shut down and shall provide a signal to the EMCS to note fire alarm condition.

2. When fire alarm condition signal is received from the fire alarm system, initiate the following sequence:

   a. Cause all building fans 1000 cfm and larger to shut down. This is in addition to the direct shutdown caused by the fire alarm system.

      1) Allow variable speed drives to ramp down and ramp up on restart.

   b. Cause all smoke dampers and fire-smoke dampers to close and remain closed for the duration of the alarm condition. Delay closing smoke dampers until associated fan system has completely stopped (10 sec. Maximum).

   c. Do not permit unrelated HVAC equipment (heating valves, pumps, etc..) in building to lose control.

   d. Provide separate control wiring, connections to fire alarm system, all required smoke dampers, etc.., as required to accomplish the required sequence.

   e. Upon termination of the fire alarm condition as indicated by a signal from the fire alarm system, cause all automatic fire/smoke dampers to open and prove open, then return all affected fans to their normally scheduled operation using the demand limiting staggered start algorithm.

I. Day/night Setback

1. The day/night setback will consist of lowering the space heating setpoint and raising the space cooling setpoint during the unoccupied mode, thereby reducing the heating and cooling energy requirements. The occupied and unoccupied areas will be specified by the owner and will be coordinated with the control system.

J. Economizer Cooling Cycle

1. The controls shall incorporate an enthalpy logic center with outdoor and return air temperature and humidity sensors that shall maximize the use of outdoor air for cooling before the mechanical cooling is energized and during operation through comparison of outdoor and return air enthalpy as follows. Note that multiple outdoor temperature conditions will be present at different outside air intake locations, and as such a comparable number of outside air sensors are required. Some mechanical systems may share a single outdoor air enthalpy center, for example adjacent UVs each facing east, providing the outdoor air conditions can be demonstrated to be virtually identical from an energy management perspective. Provide at minimum East, West, South, North, and Rooftop outdoor air sensors.

2. When the outdoor air enthalpy is less than the return air enthalpy during cooling mode, the logic circuitry shall cause the outdoor and return air dampers to modulate to the balanced outdoor air position that satisfies the critical space temperature transmitter set point before opening the system chilled water cooling valve.

3. If the outdoor air enthalpy is less than the return air enthalpy and the critical space temperature transmitter set point cannot be satisfied with 100% outside air, then the system shall circulate 100% outside air and the cooling water valve shall modulate open to satisfy the zone temperature requirements.

4. If the enthalpy sensors indicate that the return air has lower enthalpy than the outdoor air, then the system shall revert to normal cooling mode.

5. Upon a call for cooling to maintain the night setback temperature, only the economizer mode shall be operational. The chilled water control valve shall not be opened, and upon satisfying the space temperature transmitter night setback set point, the system shall revert to the normal unoccupied mode.

K. Maintenance Management: Continuously totalize run hours for equipment controlled and/or monitored for use by the maintenance management program.

L. Equipment Scheduling

1. Equipment shall be capable of 7 days, 24 hours schedules with separate holiday hours.
2. There shall be capability for five different holiday schedules which can be selected from the occupancy schedule graphic.
3. Holidays shall be programmed so that they shall need a minimum of manual adjustment year to year and can easily be modified at front end if necessary.
4. All schedule programming shall reside in local controllers, but shall be configurable from the front end.

M. Coil Freeze Protection.

1. Heating and cooling coils and any other equipment provided as a part of this project which are circulating water (not required for glycol coils) or are otherwise subject to water freeze damage, subject to the following, that have any percentage of unheated outside air entering them, shall have coil freeze protection.

2. Mixed outside and return air and the preconditioned discharge air from air to air energy recovery units shall be considered unheated for this purpose.

3. The first stage of coil freeze protection shall incorporate analog input temperature sensing at the expected freeze location. Sensing devices may be immersion style return water temperature sensor piped as close as practical to the outlet of the coil (within the rooftop unit if applicable), surface temperature sensors on the coil surface at the expected freeze location, or other comparable devices approved as applicable to the circumstances. Include details of freeze protection scheme for all such equipment in submittal. When the sensed temperature is above 60ºF (adj.), the coil control valve shall be under space temperature control. If at any time the expected freeze location sensed temperature drops below 60ºF (adj.), the control valve shall temporarily open to raise that coil's return water temperature to above 80ºF (adj.), and the EMCS shall report an alarm to the OWS

4. The second stage of coil freeze protection shall be the low limit freeze stat air temperature sensors with the sequence defined under safeties, above.

3.9 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 unit operation. Remove and replace malfunctioning units and retest.
2. Test and adjust controls and safeties.
3. Test each point through its full operating range to verify that safety and operating control set points are as required.
4. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
5. Test each system for compliance with sequence of operation.
6. Test software and hardware interlocks.

C. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.

2. Check instruments for proper location and accessibility.

3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.

4. Check instrument tubing for proper fittings, slope, material, and support.

5. Check installation of air supply for each instrument.

6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.

7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.

8. Check temperature instruments and material and length of sensing elements.

9. Check control valves. Verify that they are in correct direction.

10. Check DDC system as follows:

    a. Verify that DDC controller power supply is from emergency power supply, if applicable.
    b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    c. Verify that spare I/O capacity has been provided.
    d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.10 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.

2. Make three-point calibration test for both linearity and accuracy for each analog instrument.

3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.

4. Control System Inputs and Outputs:

    a. Check analog inputs at 0, 50, and 100 percent of span.
    b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
    c. Check digital inputs using jumper wire.
    d. Check digital outputs using ohmmeter to test for contact making or breaking.
    e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

5. Flow:

    a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
    b. Manually operate flow switches to verify that they make or break contact.

6. Pressure:

    a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
    b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

7. Temperature:

   a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
   b. Calibrate temperature switches to make or break contacts.

8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.

9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.

10. Provide diagnostic and test instruments for calibration and adjustment of system.

11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

3.11 SYSTEM TESTING AND COMMISSIONING

A. Test complete control system for control device operation prior to the systems acceptance. Demonstrate complete sequence of operations to Architect's and Owner's representatives.

1. Verify operation of system inputs and outputs, control loops and/or software programming, timing functions, operator entered constants, facilities management functions, etc., and observe that they perform their intended functions. Generate check out data sheets for each system so verified.

2. Field verify analog input calibration, analog output operation, digital input function, digital output operation, and coordination of system inputs and outputs between system graphics and field devices for schematic accuracy. Coordinate device testing with Testing and Balancing Agency – refer to section 23 05 93 – Testing, Adjusting, and Balancing for HVAC for additional information. Generate check list of all devices, keyed with descriptive locations and functions, along with complete calibration, testing, and coordination data, certified by Contractor and TAB agency.

3. Provide complete values and points logs, printed with hourly values for one week, demonstrating correct control functions and programming.

B. When above procedure has been completed and control systems are operating satisfactorily, produce and submit a report of entire systems performance for review, including all data described above. Submit three copies to the Architect's Representative advising them that the control system is 100% complete and operates in accordance with the Contract Documents.

3.12 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 23 09 00

SECTION 23 21 13 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes pipe and fitting materials, special-duty hydronic systems fittings, equipment, valves, and specialties, and joining methods for the following:

1. Hydronic Systems piping.
2. Air conditioning condensate drain piping.
3. Air-vent piping.

B. Related Sections include the following:

1. Section 23 01 20 - Hydronic System Cleaning and Water Treatment
2. Section 23 05 19 - Meters and Gauges for HVAC Systems.
3. Section 23 05 23 - General Duty Valves for Hydronic Piping.
4. Section 23 05 29 - Hangers and Supports for HVAC components.
5. Section 23 05 43 - Mechanical Vibration, and Movement Control.
6. Section 23 09 00 – Instrumentation and Control for HVAC.
7. Section 23 21 23 - Hydronic Pumps.

1.3 PERFORMANCE REQUIREMENTS

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

1. Steel and Copper Hydronic Piping: 125psig at 250 deg F.
2. PVC Hydronic Piping: 90psig at 110 deg F.
3. CPVC Hydronic Piping: 90psig at 140 deg F.

1.4 ACTION SUBMITTALS

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

1. Above Grade Piping
2. Pipe Fittings.
3. Dielectric Fittings.
4. Specialty Valves.
5. Air and Pressure Control.

6. Pressure Control
7. Special Duty Hydronic Components.

B. Shop Drawings: Include in coordination drawings details of the piping layout showing proposed piping routing including locations of offsets, fittings, elevations with drain and vent fittings, pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Provide enlarged details of congested areas, custom anchor fabrication, and other details as required to clearly delineate the proposed construction.

C. Welding Quality Control Submittals

1. When welded or brazed pipe work is required or proposed as a part of this project, submit following for approval before beginning any welding or brazing work:

a. Welding and Brazing Procedure Qualification: Prepare and submit for approval welding and brazing procedure qualification specification qualifying all proposed procedures as specified in Quality Assurance below with copies of all back-up data.

b. Welders' and Brazers' Certification: Submit for approval certification that each proposed welder, welding operator, brazer, or brazing operator has been qualified in all procedures proposed for that worker as specified in Quality Assurance below with copies of all back-up data.

D. Qualification Data: For Mechanical Grooved and Pressure Sealed Joint Installers.

1.5 CLOSEOUT SUBMITTALS

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

1.6 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with all applicable sections of the following:

1. ANSI / ASME B 31.9: "Building Services Piping".
2. ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications".
3. New York State Labor Department Industrial Code Rule No. 4 (cited as 12 NYCRR4)
4. New York State Labor Department Industrial Code Rule No. 14 (cited as 12 NYCRR14).
5. Building Code of New York State.
6. ANSI / ASHRAE 15 "Standard Safety Code for Mechanical Refrigeration".
7. ASME label on all pressure vessels and safety valves.
8. ANSI / ASME B31 – "Code for Pressure Piping".

B. Installer Qualifications:

1. Pressure Seal Joint Quality Control:

a. Installer Certification: Provide installers trained in and familiar with the installation of the mechanical joint systems, certified by the approved joint manufacturer as having been trained and qualified to join piping with manufacturer's system.

b. Single Source: Obtain mechanically joined piping system components from single approved manufacturer for each system type, grooved or pressed.

c. Proper Tools: Fabricate and install joints using the proper tools, actuators, rolls, cutters, jaws, rings, etc., as manufactured and instructed by the approved manufacturer.

d. Manufacturer's Inspection: Certify grooved system installation for compliance with manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Refer to Part 3 for Piping Applications Article.

B. 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:

1. Anvil International, Inc.
2. Cerro Flow Products, Inc.
3. Mueller Industries, Inc.
4. S. P. Fittings; a division of Star Pipe Products.
5. Viega LLC
6. Victaulic Company of America.

C. Copper Tubing: ASTM B 88, Annealed or Drawn Temper, Types M, L, and K.

D. Copper Tube Fittings:

1. Solder Fittings

a. Tees, Elbows, Reducers, Adapters: ANSI B16.22 streamlined pattern wrought copper or ANSI B16.18 cast bronze; solder end connections; ASTM B62.
b. Unions: Solder type, cast bronze, ground joint, Class 150.
c. Cast Bronze Flanges: ANSI B16.24 Class 150 solder connection flanges, raised ground face, ANSI pattern drilled and spot faced bolt holes.

2. Pressure-Seal Fittings:

   a. Housing: Copper conforming to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117.
   b. Sealing elements: EPDM, factory installed by fitting manufacturer.
   c. Leakage path designed into un-pressed fittings assuring readily visible leakage of system liquids past the sealing element of any un-pressed connection.
   d. Tools: Manufacturer's special tools that compress fittings and effect pressure seal.
   e. Minimum 200-psig working-pressure rating at 250 deg F.

3. Mechanically Formed Tee Option:

   a. Outlet: formed by proprietary rotating tool expanding drilled side hole of main tube into precision collar.

   b. Branch Inlet: Formed by proprietary tool that radius clips tube ends matching circumference of main tube, and dimples indicating correct insertion depth and orientation that remain visible after brazing.

   c. Connection: Brazed joint, stronger than original main tube, with smoothly radiused branch entry and 0% flow obstruction.

2.2 STEEL PIPE AND FITTINGS

A. Refer to Part 3 for Piping Applications Article.

B. Steel Pipe: ASTM A53-S , A53-E, or A106 Schedule 40 or 80, seamless (type S) or electric-resistance welded (type ERW), Grade B, black or ASTM A123 and A153 galvanized steel pipe, plain or threaded ends.

C. Threaded Fittings:

   1. Pipe threads in accordance with ANSI/ASME B1.20.1 National Pipe Thread taper (NPT) standards.
   2. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.
   3. Unions: ASME B16.39 malleable iron, threaded, Class 150 or higher, ground joint bronze to iron seat.
   4. Cast-Iron Fittings: ASME B16.4; Class 125 or higher.

2.3 PLASTIC PIPE AND FITTINGS

A. CPVC Plastic Pipe: ASTM F 441/F 441M, Schedules 40 and 80, plain ends as indicated in Part 3 "Piping Applications" Article.
B. CPVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM F 438 for Schedule 40 pipe; ASTM F 439 for Schedule 80 pipe.
C. PVC Plastic Pipe: ASTM D 1785, Schedules 40 and 80, plain ends as indicated in Part 3 "Piping Applications" Article.

D. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D 2665 for DWV fittings, ASTM D 2466 for Schedule 40 pipe fittings; ASTM D 2467 for Schedule 80 pipe fittings.

2.4 JOINING MATERIALS

A. Solder Filler Metals: Use solder conforming to ASTM B 32-95; alloy grades Sn96, Sn95, Sn94, E, AM, WS; lead free alloys with maximum lead content of 0.1percent by weight, minimum solidus temperature of 430 deg. F, and approved for use with potable water. Higher lead content solder not acceptable. Include water-flushable flux according to ASTM B 813.

B. Brazing Filler Metals: Select brazing filler metals compatible with piping to be joined:

1. AWS A5.8 BCuP Series, copper-phosphorus alloys for joining copper with copper only.

2. AWS A5.8 BAg series, cadmium free silver bearing alloys for joining dis-similar metals including copper with any brass, bronze, steel, or stainless steels, or other dis-similar brazeable materials.

C. Solvent Cements for Joining Plastic Piping:

1. CPVC Piping: ASTM F 493.

   a. Use CPVC solvent cement that has a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   b. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), in contrasting color.

2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

   a. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   b. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), in contrasting color.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials, designed to join dis-similar metallic piping materials with dis-similar metals separated by dielectric material in a configuration to minimize galvanic corrosion of the less noble piping material.

B. 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:

1. Advance Products & Systems, Inc.
2. Capitol Manufacturing Company.
3. Central Plastics Company.
4. Elster-Perfection Corporation.
5. Hart Industries International, Inc.
6. Lochinvar Corporation.

7. Pipeline Seal and Insulator, Inc.
8. Precision Plumbing Products, Inc.
9. Sioux Chief Manufacturing Company, Inc.
10. Victaulic Company of America.
11. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
12. Zurn Plumbing Products Group; AquaSpec Commercial Products Division.

C. All Materials: Suitable for system fluid, pressure, and temperature.

D. Dielectric Nipples:

1. Galvanized steel nipple with insert of noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

E. Dielectric Couplings:

1. Galvanized-steel coupling with insert of noncorrosive thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

F. Dielectric Unions:

1. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

2.6 VALVES

A. Isolation, Check, Balancing, Vent, and Drain Valves: Comply with requirements specified in Section 23 05 23 -General-Duty Valves for HVAC Piping
B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Section 23 09 00 - Instrumentation and Control for HVAC.

2.7 HYDRONIC PIPING ACCESSORIES

A. Escutcheons: Chrome plated, stamped steel, hinged, split-ring escutcheons, with setscrew. Inside diameter closely fits pipe outside diameter or outside diameter of pipe insulation where piping is insulated. Outside diameter completely covers opening in floor, wall, or ceiling.

1. Manufacturer: Manufacturers offering acceptable products include Grinnell.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Closed Loop Hydronic Piping, aboveground, NPS 2 and smaller**.**

1. Type L drawn-temper copper tubing with wrought-copper fittings, and soldered, pressure sealed**,** or brazed joints.
2. Schedule 40 steel pipe with welded, threaded joints.

B. Air-Conditioning Condensate Gravity Drain Piping:

1. Type M or L, drawn-temper copper tubing, wrought-copper drain fittings, and soldered joints.
2. Schedule 40 PVC or CPVC plastic pipe, DWV style fittings, and solvent-welded joints.

C. Air-Vent Piping:

1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

3.2 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated piping locations and arrangements were used to size piping, calculate friction loss, expansion compensation, pump sizing, fill volume, and other design considerations. Install piping generally as indicated unless deviations to layout are approved on Coordination Drawings.

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

C. Install piping in concealed locations except in equipment rooms and service areas, unless otherwise indicated on drawings: install in walls, pipe chases, utility spaces, above ceilings, etc.

D. Install piping orthogonal to building walls as possible within constraints required for sloped drainage, non-orthogonal building construction, etc. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install fittings for changes in direction and branch connections, unless otherwise specified.

1. Branches two or more sizes smaller than main may be weld-o-let welded to steel pipe and brazed to copper using listed mechanically formed outlets similar to “T-drill”.

2. Minor offsets in copper fin-tube piping required to segment enclosures along curved exterior walls may be created by smooth bends in annealed type L or K copper tube. Do not bend fin element.

3. Where corridors or other general construction meets at angles other than standard pipe fitting angles, provide custom bend angle elbows to match general construction and maintain piping orthogonal to building.

F. Install piping so as to provide for positive drainage and air elimination.

1. Install straight piping free of sags and bends. Do not install bent piping – remove from site.

2. Install gravity drain lines at uniform slope down in direction of flow. Maintain maximum slope feasible up to one quarter inch rise per foot of run, but not less than 1% (approximately one eight inch per foot). Where height restrictions do not allow for minimum required slope, provide for pumped condensate removal as shown.

3. Install pressurized pumped flow piping at a uniform grade of 0.2 percent upward in direction of flow or at otherwise indicated slopes.

4. Avoid local high and low points where possible.

5. Install branch connections out the top of mains to serve equipment above mains, and out the bottom of mains to serve equipment below, or otherwise as required to provide drainage and venting with a minimum of drain and vent fittings.

6. Provide eccentric pipe size reducers and increasers, installed so as to allow for both positive drainage and air elimination. In general, where piping is sloped up in direction of flow, reduce pipe sizes with level side up and increase pipe sizes with level side down.

G. Install piping allowing for proper servicing of hydronic systems.

1. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

2. Install piping and specialties with sufficient clearance to allow application of specified insulation.

3. Install valves with sufficient clearance and orientation to permit both ease of operation and servicing.

4. Install unions, on equipment side of isolation valve**,** as required to remove and service all serviceable components without system drain-down or cutting piping.

a. Provide unions for NPS 2 and smaller, flanges for NPS 2-1/2” and larger.

b. Install adjacent to control valves, at final connections of equipment, as required to adjust threaded pipe joints after fixed (non-rotatable) joints are made, and elsewhere as indicated.

c. Install out of the line of coil pull, removal access space, etc.

d. Install so sensor wires, thermometers, gauges, etc., need not be rotated, removed, or disconnected to service equipment.

e. Install within two feet of control valves with no elbows between valve and union as required for ease of replacement.

f. One dis-assemble able fitting may be used for two components (ex., both control valve and equipment service) if they are separated by no soldered, brazed, or welded elbows and no more than three feet of pipe.

H. Identify piping as specified in Section 23 05 53 - Identification for HVAC Components.

I. Install sleeves for piping penetrations of walls, ceilings, and floors.

J. Install escutcheons for exposed piping penetrations of walls, ceilings, and floors.

K. Install sleeve seals for piping penetrations of concrete walls and slabs.

3.3 PIPE JOINT CONSTRUCTION

A. General Pipe Joint Construction:

1. Cut all pipe ends square.
2. Ream ends of pipes and tubes removing burrs past original pipe wall to restore full pipe ID.
3. Remove scale, slag, dirt, and debris from both inside and outside of piping and fittings before assembly.
4. Remake leaking joints using new materials.

B. Threaded Joints:

1. Provide threaded pipe ends in conformance with ANSI B1.20.1, tapered pipe thread standards

2. Cut threads full and clean using sharp cutting oil flooded dies.

3. Note internal length of threads in fittings or valve ends and proximity of internal seat or wall to determine pipe threading and align threads at point of assembly.

4. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified) and assemble joint “wrench-tight” with paired wrenches, one wrench on adjacent pipe and one wrench on valve end where pipe is threaded.

5. Damaged Threads: Do not use pipe or fittings with torn, corroded or damaged threads.

6. Do not use portions of pipe where weld opens during cutting or threading operations.

C. Soldered Joints:

1. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook,"

2. Square cut tubing to correct length required to fill sockets.

3. Ream ends and clean surfaces of oils, grease, and oxidation to bright finish with fine sand cloth, cleaning pads, or special wire brush.

4. Apply thin film of solder flux to both surfaces to be joined. Do not clean, flux and assemble joint more than 3 hours before soldering, and do not use acid core, paste type solder, or solder flux combinations.

5. Remove heat-sensitive portions of components prior to soldering. Provide wet rag strip heat sink wrapped around stem and seat of valves and protect all components for soldering heat damage. Replace any components with any evidence of heat damage.

6. Heat joint uniformly and rapidly and fill completely with solder while minimizing external and internal over-soldered dripping.

7. Disassemble joints for inspection of solder penetration as directed. Remake faulty joints at no additional cost.

D. Brazed Joints:

1. Comply with the procedures contained in AWS "Brazing Manual", using qualified processes and brazing operators according to Part 1 "Quality Assurance" Article.
2. Remove stems, seats, and packing of valves and accessible internal parts at piping specialties before brazing.
3. Fill the pipe and fittings with an inert gas (i.e. nitrogen or carbon dioxide) during brazing to prevent formation of scale.
4. Heat joints using oxyacetylene torch. Heat to proper and uniform temperature.
5. Completely fill sockets with braze materials, and make neat fillets on butt joints.

E. Plastic Piping Solvent-Welded Joints:

1. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

2. PVC Pressure Piping: Join ASTM D 1785 schedule number, PVC pipe and PVC socket fittings according to ASTM D 2672.

3. PVC Non-pressure Piping: Join according to ASTM D 2855.

4. Square cut and ream pipe ends to correct length.

5. Clean exterior of pipe and interior of fittings with rags and water and dry thoroughly before solvent cleaning with primer.

6. Check dry fit for interference fit to ensure pipe can be pushed at least 1/3 of way into fitting by hand. Ensure pipe that “bottoms” is snug.

7. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.

8. Use only approved cement and primer suitable for types of pipes and fittings used and suitable for intended service, including temperature, pressure pipe size, and fluids served. Use only fresh cement; do not use thickened, lumpy, or "jelly like" cement.

9. Clean pipe and fitting with cement manufacturer’s primer or cleaner. Use contrasting color primer and cement

10. Stir or shake cement before use. Apply thin coat of cement in socket, then evenly coat pipe end to socket depth. Avoid puddling, especially on thin walled pipe.

11. Assemble joint by twisting pipe 1/4 turn while pushing to full socket depth. Provide adequate anchorage and leverage to assemble pipe to full socket depth of fittings; hand pressure is inadequate and not acceptable for larger sizes. Hold pressure for 30 seconds or as required avoiding push out. Allow additional time for cement to set in colder weather to ensure cement film cures without blisters. Wipe off excess cement between socket and pipe with clean, dry rag.

12. Keep cement cool in hot weather and work as quickly as possible to avoid cement setting up before joint is assembled. Keep lid on cements, cleaner, and primers when not in use. Do not mix cleaner or primer with cement.

13. Use 3/4-inch dauber on small diameter pipes, 1-1/2 inch dauber up through 3 inch pipe, and natural bristle brush, swab, or roller 1/2 pipe diameter on pipes 4 inch and up.

F. Mechanically Formed, Copper-Tube-Outlet Joints:

1. Use manufacturer-recommended tools and procedure.
2. Insure alignment dimples are properly oriented and visible after brazing.
3. Braze joints using approved procedures and brazers.

G. Pressure-Sealed Joints:

1. Make copper and copper alloy press connections in accordance with the manufacturer's installation instructions.
2. Fully insert the tubing into the fitting with a visible mark on the tubing showing proper insertion. Align the tubing as required.
3. Check the fitting alignment against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. Leave insertion marks visible on pipe after assembly.
4. Press the joints using the tool(s) approved by the joint manufacturer in a manner to assure tubing remains properly aligned.
5. Remove and replace misaligned, kinked, or otherwise damaged tubing installations. .

3.4 HYDRONIC SPECIALTIES INSTALLATION

A. At each system local or global low point, both in piping and heat transfer elements, and as required for complete system drainage, install drain consisting of a tee fitting and drain valve as described in Section 23 05 23 – General Duty Valves for HVAC Piping.

B. At each system local or global high point, both in piping and heat transfer elements, at the end of each horizontal run before a drop in elevation, and elsewhere as required for complete and serviceable venting of system air, install vent consisting of a tee fitting and air vent as described in Section 23 05 23 – General Duty Valves for HVAC Piping.

C. Install all components of Energy Management and Control System (EMCS) into hydronic systems as required for complete EMCS installation and as required by this section maintaining integrity if hydronic systems. Coordinate all locations and quantities with contractor responsible for the EMCS – refer to Section 23 09 00 – Instrumentation and Control for HVAC.

1. Install control valves in accessible locations close to connected equipment or as otherwise shown, with dis-assemble able connections.
2. Install wells for pressure, temperature, and other sensors as shown on details and as called for by the sequence of operations.

D. Install ports and wells for pressure gages and thermometers at coil inlet and outlet connections according to Division 23 Section "Meters and Gages for HVAC Piping."

E. Install pressure / temperature test ports (P/T plugs) at the supply and return of every heat transfer element, and as otherwise called for on drawings.

F. Install piping to pumps. Details of near pump piping are specified in Section 23 21 23 – Hydronic Pumps

3.5 VALVE APPLICATIONS

A. Install General Duty Valves (isolation valves, check valves, balancing valves, air vent valves, and drain valves) as specified in section 23 05 23 – General Duty Valves for HVAC Piping.

3.6 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.

B. Sound, vibration, and movement control is specified in Section 23 05 43 – Mechanical Vibration and Movement Control.

3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Size supply and return piping run-outs to equipment connections same as shown on the drawings. Where connecting to existing piping run-outs, use same size as existing unless shown otherwise. Transition to equipment connection size close to equipment. If equipment connection size is smaller than piping shown, transition to piping size shown immediately with no elbows (except reducer elbows) or other fittings closer to the equipment than the required transition fitting.

B. Provide for thermal movement of piping adjacent to terminal equipment, using flexible hose connections, swing joints, etc. Refer to Section 23 05 43 – Mechanical Vibration and Movement Control for details.

3.8 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. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.

3. 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.

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 "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 23 21 13

SECTION 23 21 23 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Inline maintenance free circulator pumps
2. Pump Accessories.

1.3 SUBMITTALS

A. Action Submittals:

1. 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. Demonstrate equal or better performance to basis of design equipment in terms of construction, efficiency, dimensions, system connections, etc.

2. Shop Drawings: Show pump layout and connections. Include dimensioned setting drawings for installing foundation and anchor bolts and other anchorages.

3. Motor Data: Motor horsepower, electrical characteristics, and construction details demonstrating compliance with requirements.

B. Closeout Submittals:

1. Operation and Maintenance Data: For pumps to include in emergency, 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. Refer to specification Section 01 60 00 "Product Requirements."

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.

PART 2 - PRODUCTS

2.1 GENERAL PUMP REQUIREMENTS

A. Materials: Provide materials suitable for fluid, pressures, temperatures, and conditions for each application.

B. Performance: Minimum of design make throughout operating ranges, including capacity, head, NPSHR, and efficiency.

C. Configuration and Characteristics

1. Provide dynamically balanced pumps for all applications.
2. Provide tapped connections for pressure gauges at inlet and outlet, and vent and drain taps at high and low points.

2.2 INLINE MAINTENANCE FREE WET ROTOR CIRCULATOR PUMPS

A. Manufacturers: Basis of design is as scheduled. 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. Armstrong Pumps Inc.

2. Bell & Gossett Models Series e-60 or equal
3. Grundfos Incorporated.

B. The pumps shall be of a horizontal, permanently lubricated type, specifically designed for quiet operation. Suitable for 225° F operation at 175 PSIG working pressure. The pump shall be single stage, vertical split case design, in cast iron bronze fitted (or all bronze) construction. The pump internals shall be capable of being services without disturbing piping connections.

C. 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.

D. The pumps shall have a solid SAE1144 steel shaft supported by two sealed ball bearings. A non-ferrous shaft sleeve shall be employed to completely cover the wetted area under the seal.

E. Pump shall be equipped with an internally-flushed mechanical seal assembly. Seal assembly shall be the unitized type with stainless steel drive tabs, EPR bellows and seat gasket, stainless steel spring, and be of a carbon silicon-carbide design with the carbon face rotating against a stationary silicon-carbide face.

F. Bearing assembly shaft shall connect to either a cast bronze impeller. Impeller shall be hydraulically and dynamically balanced, keyed to the shaft and secured by a locking capscrew or nut.

G. A flexible type coupling shall be employed between the pump and motor.

H. Pump shall be designed to allow for true back pull-out access to the pump's working components for ease of maintenance.

I. Pump volute shall be of cast iron design. The connection style on cast iron and bronze pumps shall be flanged. Volute shall include gauge ports at nozzles, and vent and drain ports.

J. To ensure alignment the motor shall be mounted to the bearing assembly via a bolted motor bracket assembly, and a rubber motor mount shall be used to assist in aligning the motor shaft with the pump shaft.

K. Motors shall meet scheduled horsepower, speed, voltage, and enclosure design. Motors through 1 HP shall be resilient mounted, motors over 1.5 HP shall be rigid mounted. Motors shall have permanently lubricated ball bearings and must be completely maintenance free. Motors shall be non-overloading at any point on the pump curve and shall meet NEMA specifications.

L. Pump shall be of a maintainable design and for ease of maintenance shall use machine fit parts and not press fit components.

M. Each pump shall be factory tested and name-plated before shipment and shall be provided with a (3) year warranty from date of installation.

N. Drive motor shall be wet rotor, stainless steel sheathed, directly connected to the shaft, with static o-ring seal. Provide single speed, three speed, or auto-adapt ECM motor as scheduled.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which pumps are to be installed and notify Architect in writing of any conditions detrimental to proper and timely installation. Correct unsatisfactory conditions as required, and do not proceed with installation until unsatisfactory conditions have been corrected in an acceptable manner.

1. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

B. Beginning installation constitutes Contractor’s acceptance of substrates and conditions required to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied.

3.2 PUMP INSTALLATION

A. Install in accordance with manufacturer's specific recommendations and in accordance with all related sections of technical specifications. Obtain manufacturer's instructions and follow them, using the instructions written below as a minimum standard for comparison.

B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

C. Support piping adjacent to pump connections independently of pumps such that load from piping is not transmitted through pumps.

1. Support piping adjacent to inline pumps securely as required to support pumps from piping. Support with piping supports as specified, with continuous-thread hanger rods and vibration isolators of size required to support weight of in-line pumps.

D. In-line pump mounting:

1. Install in-line pumps weighing under 30 pounds supported from adjacent piping.

2. Provide additional independent supports for in-line pumps weighing 30 pounds and over, similar to flange supports or volute base bracket mountings as recommended by pump manufacturer.

3. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

E. Adjust GPM of each pump to capacity called for during balancing.

3.3 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 isolation valves on both suction and discharge that are same size as piping shown approaching the pumps, prior to any size change required at pump connections.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

END OF SECTION 23 21 23

SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig.
2. Suction Lines for Heat-Pump Applications: 535 psig
3. Hot-Gas and Liquid Lines: 535 psig.

1.4 SUBMITTALS, GENERAL

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of refrigerant, piping, valve, and refrigerant piping specialty proposed. Include pressure drop, based on manufacturer's test data, for the following:

1. Refrigerant.
2. Thermostatic expansion valves.
3. Solenoid valves.
4. Hot-gas bypass valves.
5. Filter dryers.
6. Strainers.
7. Pressure-regulating valves.

B. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

1.6 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.
B. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.8 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.9 COORDINATION

A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 88, Type K or LASTM B 280, Type ACR.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Brazing Filler Metals: AWS A5.8.

E. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inchmisalignment in minimum 7-inch-long assembly.
4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.2 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

B. Check Valves:

1. Body: Forged brass, or cast bronze; globe pattern.
2. Bonnet: Forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

C. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

D. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.

1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Electrical: Molded, watertight, replaceable AC coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and voltage as required.
6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240 deg F.
8. Include Manual operator.

E. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
2. Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Seat Disc: Polytetrafluoroethylene.

4. End Connections: Threaded.
5. Working Pressure Rating: 400 psig.
6. Maximum Operating Temperature: 240 deg F.

F. Thermostatic Expansion Valves: Comply with ARI 750.

1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Suction Temperature: 40 deg F.
6. Superheat: Adjustable.
7. Reverse-flow option (for heat-pump applications).
8. End Connections: Socket, flare, or threaded union.
9. Working Pressure Rating: 700 psig.

G. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.

1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
5. Seat: Polytetrafluoroethylene.
6. Equalizer: Internal.
7. Electrical: Molded, watertight, replaceable AC coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and voltage as required.
8. End Connections: Socket.
9. Throttling Range: Maximum 5 psig.
10. Working Pressure Rating: 500 psig.
11. Maximum Operating Temperature: 240 deg F.
12. Include manual operator.

H. Straight-Type Strainers:

1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

I. Angle-Type Strainers:

1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

J. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

K. Replaceable-Core Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina or charcoal.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Rated Flow: Refer to capacities on equipment schedules.
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240 deg F.

L. Receivers: Comply with ARI 495.

1. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
2. Comply with UL 207; listed and labeled by an NRTL.
3. Body: Welded steel with corrosion-resistant coating.
4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
5. End Connections: Socket or threaded.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

M. Liquid Accumulators: Comply with ARI 495.

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

2.3 REFRIGERANTS

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. Atofina Chemicals, Inc.

2. DuPont Company; Fluorochemicals Div.
3. Honeywell, Inc.; Genetron Refrigerants.
4. INEOS Fluor Americas LLC.

B. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines NPS 1-1/2and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

B. Hot-Gas and Liquid Lines: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm packless valves in suction and discharge lines of compressor.

B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.

E. Install a full-sized, three-valve bypass around filter dryers.

F. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

G. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

H. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:

1. Thermostatic expansion valves.
2. Hot-gas bypass valves.
3. Compressor.

I. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor, if not provided as part of installed equipment manufacturer.

J. Install receivers sized to accommodate pump-down charge.

K. Install flexible connectors at compressors.

3.3 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 Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. 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.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

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

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

J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

L. Install refrigerant piping in protective conduit where installed belowground. Provide for drainage and liquid accumulation.

M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

N. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

O. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

P. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23.

R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23.

S. Install escutcheons for piping penetrations of walls, ceilings, and floors in finished areas.

3.4 PIPE JOINT CONSTRUCTION

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

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in specification Section 23 05 29 - Hangers and Supports for HVAC Components.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feetlong.
2. Roller hangers and spring hangers for individual horizontal runs 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. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.

D. Support multifloor vertical runs at least at each floor.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.

2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.

3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.

a. Fill system with nitrogen to the required test pressure.
b. System shall maintain test pressure at the manifold gage throughout duration of test.
c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Verify that compressor oil level is correct.
2. Open compressor suction and discharge valves.
3. Open refrigerant valves except bypass valves that are used for other purposes.
4. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 23 23 00

SECTION 23 31 00 - DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Sheet metal duct materials and construction.
2. Sheet metal duct fittings materials and construction.
3. Flexible duct and connectors.
4. Ductwork ancillary components materials and construction.

1.3 DEFINITIONS

A. Aspect Ratio: The ratio of duct width to height.

B. Hydraulic Radius: The ratio of duct cross section area to perimeter, or practically, a term used to define flow resistance of duct with differing aspect ratios, with resistance to flow being approximately proportional to hydraulic radius.

C. NRC: Noise Reduction Criteria

D. Offset: A change in the duct centerline location but not direction occurring within one piece of duct.

E. RGD: Registers, Grilles, and/or Diffusers

F. STC: Sound Transmission Class

1.4 PERFORMANCE REQUIREMENTS

A. Provide duct system able to withstand the loads and stresses described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and these contract documents.

B. Fabricate outdoor duct and casings to withstand wind load and snow load indicated on Structural series drawings and specifications. Calculate the snow load as a negative pressure on the top duct surface.

1.5 SUBMITTALS

A. Comply with requirements of SECTION 01 33 00 - Submittals and as modified below.

B. Identify in writing, any proposed deviations from contract Drawings and Specifications.

1. Highlight all changes from plans required by obstructions and job conditions.

2. Bring any proposed deviations from contract plans and specifications to Architect's attention in writing, by separate letter attached to submittal with proposed deviations, along with samples for clarification, demonstrating benefit to Owner.

C. Product Data: Submit for approval annotated Shop Construction Standards showing upgrades as required for conformance in detail to specifications for all factory and shop fabricated air ducts, components, and accessories.

D. Shop Drawings:

1. Prepare and submit 1/4" = 1’ scale or larger shop drawings for all areas indicated below within 45 days after contract award. Refer to section 01 33 00 – Submittals for additional information.

a. Provide shop drawings for the following areas:

1) Library
2) Band/Choral Rooms

b. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.

c. Factory- and shop-fabricated ducts and fittings.

d. Duct layout indicating sizes, configuration, liner material, and SMACNA pressure class required for all duct.

e. Indicate duct elevation above floor (top and bottom of ducts), bottom of structure especially at critical passages, and ceiling height for each room.

f. Dimensions of main duct runs from building grid lines.

g. Fittings.

h. Reinforcement and spacing.

i. Seam and joint construction.

j. Equipment installation based on equipment being used on Project.

k. Indicate locations and sizes of all dampers, turning vanes, access doors and panels, and other required accessories.

l. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.6 CLOSEOUT SUBMITTALS

A. Contract Closeout Submittals: Comply with requirements of SECTION 01 77 00 – Closeout Procedures, including submission of operating and maintenance instructions as item in "Operating and Maintenance Data" manual described in that section.

B. Field quality-control reports – duct leakage, duct cleanliness.

1.7 QUALITY ASSURANCE

A. Provide ductwork by experienced and approved workers specializing in sheet metal fabrication and installation in accordance with the stricter of the below referenced standards and the requirements outlined in these contract documents.

B. Referenced Standards

1. The latest editions of the publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

2. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)

   a. ASHRAE / ANSI 62.1 – Ventilation for Acceptable Indoor Air Quality.
   b. ASHRAE / ANSI 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings

3. American Society for Testing and Materials (ASTM):

   a. A167 99 Standard Specification for Stainless and Heat Resisting Chromium Nickel Steel Plate, Sheet, and Strip

   b. A653-09 Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy coated (Galvannealed) by the Hot-Dip process

   c. A1011-09a Standard Specification for Steel, Sheet and Strip, Hot rolled, Carbon, structural, High-Strength Low-Alloy, High Strength Low-Alloy with Improved Formability, and Ultra-High Strength

   d. B209 07 Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate

   e. C1071-05e1 Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)

   f. D6386 Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting

g. D7803 Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Powder Coating

h. E84-09a Standard Test Method for Surface Burning Characteristics of Building Materials

4. National Air Duct Cleaners Association (NADCA):

a. ACR "Assessment, Cleaning and Restoration of HVAC Systems", for duct cleanliness standards.

5. National Fire Protection Association (NFPA):

a. 90A Standard for the Installation of Air Conditioning and Ventilating Systems
b. 96 Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations

6. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):

a. HVAC Duct Construction Standards, Metal and Flexible
b. HVAC Air Duct Leakage Test Manual

PART 2 - PRODUCTS

2.1 DUCT MATERIALS

A. General Material Requirements:

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated.

2. Provide sheet metals per mill specs and free of pits, voids, seam or roller marks, stains, discolorations, inadvertent bends and kinks, and other imperfections.

B. Standard Supply, Return and Exhaust: Galvanized steel, ASTM A-653/653M G90, lock forming quality, unless otherwise specified.

C. Standard Supply, Return and Exhaust duct which will be exposed to view in the finished project and will not be externally insulated or painted: Galvannealed steel, ASTM A-653/653M G90, lock forming quality, unless otherwise noted.

D. Standard Supply, Return and Exhaust duct which will be exposed to view in the finished project and will be painted: Galvannealed steel, ASTM A-653/653M G90, lock forming quality, prepared for painting via mill phosphatizing and subsequent heat treatment in accordance with ASTM D6386 and ASTM D7803 as applicable, unless otherwise noted.

E. Flexible Ducts:

1. Flexible Duct (standard ventilation air register, grille, and diffuser connections where noted on Drawings. Maximum installed length to be 5'-0"): Medium pressure CPE or polymeric coated woven fiberglass cloth liner, enclosed spring steel wire, R-6 fiberglass insulation covered by metalized polyester film bi-directionally reinforced vapor barrier. Similar to types S-TL (uninsulated for field insulation), M-KE, or M-KC, with FlexFlow elbow supports, all by Thermaflex (design make).

2. Flexible Duct (High Temperature applications similar to diesel and / or industrial engine exhaust systems): Minimum factory temperature rating of 1000 deg. F., constructed with two ply, triple overlap, silicone impregnated woven glass and nomex fiber cloth with an enclosed spring steel wire. Factory attached fittings. Type "HTC" by Car-Mon Products (design make).

2.2 RECTANGULAR DUCTS AND FITTINGS

A. Conform to appropriate SMACNA rectangular duct reinforcement tables and figures for the velocity-pressure classification duct construction required as defined in part three of this document, and additionally as follows.

1. Seal all joints and seams in accordance with SMACNA seal classification required for duct in question.

   a. Additionally, seal field assembled longitudinal seams for seal class B duct.

2. Transverse Joints: in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure for "Rectangular Duct/Transverse Joints".

   a. For all duct requiring reinforcement, provide SMACNA T-24 or T-25 type flanged duct connection system at traverse joints.

      1) Joints may be factory manufactured slip on type or integrally shop fabricated onto the duct sheet metal on machinery designed for that purpose. Corner closure pieces are required at each corner.

      2) Manufacturers: Subject to compliance with requirements, available manufacturers offering pre-manufactured slip on reinforcement products that may be incorporated into the Work include, but are not limited to, the following:

         a) Ductmate Industries, Inc, or equal.
         b) Lockformer TDC or equal.
         c) Nexus PDQ type G or J or equal.

3. 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."

4. Tie rods are not permitted on duct or plenums narrower than 72". Where an option for tie rod or heavier gauge sheet metal / shorter joint length / higher category reinforcement is presented in table, the heavier, shorter, more reinforced duct with no tie rods is required.

B. Offsets:

1. Where offset dimension is equal to or less than 0.2 times duct dimension in plane of offset, offset may be angled at maximum 15 degrees (SMACNA type 1).

2. Where offset dimension is greater than 0.2 times duct dimension in plane of offset (example: 10 x 20 duct offset in plane of 10" dimension greater than 2 inches), offset to consist of paired curved elbows, each of the required angle, combined into one fitting (SMACNA type 3).

   a. Conform to elbow requirements as indicated below.
   b. Offset may be replaced with paired curved elbows if required for installation, otherwise provide combined fitting.

C. Transitions of shape or cross section:

1. Reductions in cross section shall have a maximum included cone angle of 60 deg., with a maximum single side angle of 45 deg. from axial, unless otherwise specified in writing.

2. Transformations of section without a net reduction of cross section shall have no section of reduced hydraulic radius nor any local expansion of more than 15 deg. net included cone angle, as defined by ASHRAE and SMACNA.

3. Expansion sections, unless specifically drawn and noted otherwise, shall have:

   a. No section of reduced hydraulic radius
   b. No section of local expansion of more than 15 deg. net included cone angle.
   c. No single side expansion angle of more than 15 deg. from axial unless otherwise specified in writing.

D. Elbows:

1. Make all changes in direction (as opposed to offsets above where direction remains the same) regardless of angle with elbow fittings unless specifically drawn and noted otherwise.

2. Curved Rectangular Elbows:

   a. Along critical pressure drop paths, provide curved rectangular elbows.

      1) Critical pressure drop paths shall be as indicated on drawings or if not indicated shall be considered to be entire duct run from air handling unit along mains to or from furthest terminal. Systems with more than one main branch shall be considered to have more than one critical pressure drop path.

2) Provide critical path elbows with throat radius not less than dimension of duct in plane of radius or use smaller inner radius elbows with splitter vanes such that the ratio of inner to outer radius of curvature of any section of the elbow shall not be less than 1/2.

b. Along non-critical pressure drop paths, curved rectangular elbow radius requirements may be relaxed to a throat radius not less than one half the dimension of the duct in plane of radius or use smaller inner radius with splitter vanes such that the ratio of inner to outer radius of curvature of any section of the elbow shall not be less than 1/3.

c. Construct all curved elbows of increasing or decreasing cross section in accordance with critical pressure drop path criteria.

d. Fabricate splitter vanes per SMACNA Duct Manual construction standards.

3. Mitered rectangular elbows

a. Only elbows not along critical pressure drop path may be of curved or mitered construction.
b. Mitered rectangular elbows with angle of bend under 15 deg. may have miter at duct end similar to SMACNA type 1 offset.
c. Provide turning vanes in mitered rectangular elbows with angle of bend over 15 degrees.
d. Mitered elbows with angle of bend over 100 deg. or less than 80 deg. shall not use commercially available 90 deg. turning vanes

4. Single Wall Turning Vanes

a. Provide in mitered rectangular elbows of increasing or decreasing cross section and those with a turning angle greater than 100 degrees or less than 80 degrees.

b. Blades of single wall 16 gauge construction with leading and trailing edges aligned to the direction of flow, installed per SMACNA Duct Manual standards so as to provide smooth area transition. Maximum spacing 3 inch, unless otherwise approved.

E. Duct Branches:

1. Install branches, inlets, and outlets so that air turbulence is reduced to a minimum and air volume properly apportioned. Install airflow adjustment devices at all junctions to permit adjustment of the amount of air entering or leaving the branch.

2. Where a duct branch is to handle more than 25 percent of the air handled by the duct main, use a complete elbow as specified, assembled into a single fitting with the main duct. Size the separate branch and remaining main as shown on the drawings, and partition the division of the combined duct such that each of the branch and main have the same velocity, with cross sectional area proportional to the respective airflow. Join the leading / trailing edge where the branch and main meet airtight via welding or brazing.

3. Where a duct branch is to handle less than 25 percent of the air handled by the duct main, construct the branch connection with a 45 degree side take-off with volume damper in branch line close to takeoff. Round branches off of rectangular main, use 45 deg. entry takeoff with integral transition to round.

    a. Supply: increase duct dimension on upstream side of branch by 25 percent, minimum 4 inch.
    b. Return: increase duct dimension on downstream side of branch by 25 percent, minimum 4 inch.
    c. Multiple flow direction takeoffs: provide twin entries or bell mouths.

4. Where an air-diffusion device is shown as being installed in close proximity to (less than one main duct width) the side, top, or bottom of a duct, provide a commercially manufactured vaned volume extractor fitting to allow adjustment of the air quantity and to provide an even flow of air across the device it services.

F. Duct Entries

1. Wherever air does not enter the duct system from grilles, registers, or louvers, but instead enters directly from an enclosed or exposed plenum space, provide a duct entry transition with a minimum area ratio of inlet to nominal duct size of 2:1 unless otherwise specifically shown and noted.

2. Duct entry may be angled (pyramidal or conical) or with bell-mouth radius.

    a. Provide angled duct entries with a maximum single side angle to axial of 30 deg. Any combination of sides, top, and bottom may be angled (or conical for round duct) to suit space restrictions, but maintain the specified area ratio.

    b. Provide bell-mouthed entries with radius as required maintaining the specified area ratio.

3. Provide entry grille or if not shown, provide at minimum 1/2 inch welded wire mesh (WWM) secured over the large side of the opening of all duct entries.

2.3 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. Spiral lock-seam duct, joints, and fittings:

        1) Lindab Inc.
        2) McGill AirFlow LLC.
        3) SEMCO Incorporated.

4) Sheet Metal Connectors, Inc.
5) Spiral Manufacturing Co., Inc.

b. Longitudinal fusion-welded duct, joints, and fittings as described in appropriate SMACNA manuals and herein – shop fabricated.

c. 26 ga. G-60 longitudinal snap-lock construction duct, joints, and fittings.

B. 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", and as follows:

1. Spiral lock seam duct:

a. Machine locked spiral seams with or without formed standing reinforcement ribs.
b. Leakage through the duct wall and joints certified no greater than design make.
c. Provide minimum 12 ft. long un-joined lengths, except where interrupted by fittings.

2. Longitudinal seam duct shall have fusion-welded butt seams.

a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.

3. Snap-lock seam duct:

a. Limit snap-lock construction components and systems to concealed round duct run-outs to individual diffusers, registers, and grilles, in sizes 12 inch and under, with all transverse and longitudinal seams sealed.

b. Longitudinal seams field assembled by interlocking machine formed sprung tabs, with sealant brushed on before and after assembly.

c. Provide minimum 10 ft. long un-joined lengths, except where interrupted by fittings or shorter lengths are required to work through existing structure.

C. 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", and as follows:

1. 24 in. diameter and less: slip fit collars or sleeve couplings, reinforced by rolled beads, insertion length 2 inch. Secure with hexagon head drill point screws or other approved mechanical fasteners 6 inch o.c. max and duct sealant.

2. Over 24 inch to 42 inch diameter, general, concealed joints: Provide roll formed, welded angle ring flanges similar to SMACNA T-24 or T-25 configuration. Attach flange to duct with internal stitch or button welds 6 inch o.c. max and duct sealant. Size angle ring gauges per SMACNA recommendations. Secure with #10 “Tec” screws 6 inch o.c. maximum, seal with closed cell gasket.

3. Exposed over 24 inch diameter, all over 42 inch diameter: two piece angle ring flanges, loose fit outer ring in a "Van Stone" configuration. Provide a 5/8 inch flange inner ring as a gasketing surface for sealing, integrally rolled or attached to the pipe with internal button or stitch welds 6 inch o.c. max and duct sealant. Provide outer rolled, welded angle ring sized per SMACNA recommendations. Secure with bolts 8 inch o.c. maximum, seal with closed cell gasket.

D. Elbows:

1. Fabricated to a centerline radius of minimum 1.5 times the cross-section diameter.

   a. Where space constrictions do not allow specified centerline radius or where shown as such on drawings only, provide mitered elbow of fully welded construction with single thickness turning vanes spaced 3 inch o.c. max.

2. For use with snap-lock round duct, where allowed as described above: Gored adjustable elbows, seal adjustable joints after installation.

3. For standard bends (ex. 45 deg. and 90 deg.), diameters through 9 inch: Two-section stamped and welded 22 ga. elbows.

4. Diameters 10 inch through 30 inch, any angle: Gored standing seam construction similar to United McGill “UNI-SEAM”. Less than 36 deg. - two gores, 36 deg. to 72 deg. - three gores, over 72 deg. - five gores.

E. Tees and Lateral Branches: 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", and as follows:

1. Bull-Headed Tees:

   a. Provide wye fitting with subsequent partial bend elbows for critical run bull-headed tees.
   b. Provide capped main and twin lateral branches as described below for general purpose bull-headed tees.
   c. Provide “bird-mouthed” fitting with turning vanes only where space restrictions require and where specifically shown as such on the drawings.

2. Fabricate lateral tees and all branches with fittings as described herein:

   a. Fabricate to longitudinal welded duct standards. Where possible, provide gored standing seam construction similar to United McGill “UNI-SEAM”, otherwise stitch or button welded or riveted. Seal all joints.

b. Fitting entrance free of weld build-up or spatter, burrs, or irregularities, not projecting into either the main or branch runs.

c. Provide manual volume damper at all branch connections.

d. Typical round branch connections to round main duct, provide 45 deg. reducing lateral takeoff fitting, with subsequent elbow resulting in required branch angle to main.

1) Where space restrictions do not permit this combination, provide 90 deg. angled oval to round takeoff fitting or conical takeoff with similar loss coefficient.

2) For critical run (ie. maximum pressure drop) round branch connections to round main ductwork, provide high performance 45 deg. reducing conical lateral takeoff fitting, with subsequent elbow resulting in required branch angle to main.

3) Exposed, duct side mounted register connections may be tapped into side wall of length of duct.

F. Turning Vanes:

1. As described for mitered rectangular elbows of unequal inlet and outlet cross section above.

G. Offsets:

1. All offsets to consist of paired curved elbows, each of the required angle, combined into one fitting.

H. Transitions of shape or cross section and duct entries:

1. As described for rectangular duct above.

2.4 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, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.

1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 175 deg F.
4. Insulation R-Value: Comply with ASHRAE/IESNA 90.1-2004.

C. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action or Nylon strap in sizes 3 through 18 inches, to suit duct size.

2.5 EXTERIOR DUCT

A. Construction as detailed above with the additional requirements listed herein.

B. Seal all exterior duct completely water tight, including all longitudinal and transverse seams, fittings, and branch connections. Seal both during assembly and from the exterior. Use only exterior all weather grade gaskets and sealants. Apply sealants neatly, avoiding exposed sealant on surface. Where sealant must be exposed for function apply in neat fillets.

C. Fabricate all transverse joints using an **INTEGRAL** standing flange reinforcement similar to SMACNA T-24 or T25 as described in the SMACNA HVAC Duct Construction Standards Manual. Use of "slip-on" reinforcing flanges not permitted.

D. Install all exterior duct with minimum 1 inch per 10 ft pitch to avoid standing water puddles on top surface.

E. Provide leakage test and prove tight to less than 0.5% of the specified flow rate leakage under system stall pressure, including all penetrations and fittings.

2.6 EXPOSED DUCT SPECIAL CONSIDERATIONS

A. Provide paintable galvanized steel for all exposed supply, return and exhaust duct which will not be externally insulated. Mill phosphatizing in accordance with ASTM A2092 is acceptable material. Use forming lubricants which are compatible with specified painting systems and provide painters with factory recommendations for appropriate and compatible solvents, primers, etc.

B. Welds: exposed welds ground smooth and all weld spatter scraped or ground off.

C. Sealants: use only paintable sealants, applied neatly, avoiding exposed sealant on surface. Where sealant must be exposed for function apply in neat fillets.

D. Avoid all shipping and handling damage to surfaces. Replace pieces that are damaged and not repaired so that repair is not visible.

E. Joints: rotate all spiral seams of round duct so as to form continuous helical spiral. Carefully coordinate installation of exposed duct side mounted register connections as required.

F. Provide tapered "ramp" couplings for joints where allowed by size.

2.7 FUME HOOD EXHAUST DUCTS:

A. Material: 18 gage minimum stainless steel number 4 polish for duct exposed to view in finished space, or 16 gage minimum black steel acceptable for concealed locations.

B. In compliance with NFPA 45 and NFPA 33 as applicable, all related code requirements, and the additional requirements of this section.

C. Construction:

1. Continuous external tig welded construction, not cross-broken.

2. Grind and polish all exposed welds to match #4 finish and remove all weld heat discoloration. Distortion from overheating or forcing is unacceptable.

3. Smooth radius elbows with ratio of outer radius to inner radius no greater than 2, smooth transitions with no steps, no mechanical fasteners extending into airstream, eliminate all eddies and other locations where condensables or particulates will inadvertently accumulate.

4. Prove liquid tight at all welds, seams, and joints.

D. Slope duct continuously per code and NFPA, minimum one quarter inch per foot (1:48 or 2% slope) up to 75 feet horizontal, or above 75 feet horizontal at one inch per foot (1:12 or 8.3% slope) preferably back to the equipment.

E. Verify size of hood and fan duct connections in field, provide duct to fit equipment connections with smooth transitions to duct size indicated or if not indicated on drawings to next full inch size smaller than that which would have velocity of 1500 fpm at given cfm. Configure duct so that duct velocity is not less than 500 fpm at any point in the duct.

2.8 DUCTWORK ANCILLARY COMPONENTS

A. In general, duct accessories associated with specialized requirements which are called out and / or scheduled on the drawings are specified in section 23 33 00 – Air Duct Accessories. The ancillary components included in this section are generally required in all air duct systems, need not be specifically called for on the drawings other than by specification or standard symbols and abbreviations, and are required to be detailed in the shop standards submittal.

B. Duct Connectors

1. Flexible Connectors - Duct to Equipment:

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) Ventfabrics, Inc.
4) Ward Industries, Inc.; a division of Hart & Cooley, Inc.

b. Provide factory fabricated flexible connectors with heavy gauge metal edge bands double roll crimped each side onto water, flame-retardant, mildew resistant, NFPA approved flexible fabric connector strip.

c. Metal Edge Bands: 2 strips of 2-3/4-inch- wide, 0.028-inch- thick G90 galvanized sheet or stainless steel, or 0.032-inch- thick aluminum sheets. Provide same metal and corrosion resistance as connected ducts.

d. Fabric Connector Strip: 5-3/4" wide, minimum 20 oz. per square yard fiberglass fabric strip double coated with neoprene (general service), hypalon (outdoors), nitrile (chemical resistant service similar to fume hoods), or silicone (high temperature service similar to kiln or engine exhaust).

e. Coatings and Adhesives: Comply with UL 181, Class 1.

2.9 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. 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.

C. 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, use sealant that has 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."

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.10 VEHICLE EXHAUST DUCTS:

A. Material: 20 gage minimum stainless steel.

B. Construction:

1. Fabricate duct from minimum 20 gauge externally continuously tig welded stainless steel, not cross-broken.

2. Grind and polish all welds to match #4 finish and remove all weld heat discoloration. Distortion from overheating or forcing is unacceptable.

3. Smooth radius elbows with ratio of outer radius to inner radius no greater than 2, smooth transitions with no steps, no mechanical fasteners extending into airstream, eliminate all eddies and other locations where fumes will inadvertently accumulate.

4. Prove liquid tight at all welds, seams, and joints.

C. Verify size of fan duct connections in field, provide duct to fit equipment connections with smooth transitions to duct size indicated or if not indicated on drawings to next full inch size smaller than that which would have velocity of 1500 fpm at given cfm. Configure duct so that duct velocity is not less than 500 fpm at any point in the duct.

2.11 HANGERS AND SUPPORTS

A. Provide complete system of Air Duct Hangers and Supports as required by the Air Duct systems included. Refer to Section 23 05 29 – "Hangers and Supports for HVAC Components" for details of Hanger and Support requirements for Air Ducts and associated components.

B. Provide complete system of Air Duct Vibration and Movement Control as required by the Air Duct systems included. Refer to Section 23 05 43 – "Mechanical Vibration and Movement Control" for details of vibration isolation and movement control requirements for Air Ducts and associated components.

C. Flexible Duct Supports and Accessories:

1. Elbow Supports: UL listed for plenum installation molded fiber reinforced plastic elbow support at connections to ceiling mounted devices designed to maintain tension in flex duct and eliminate collapsed elbows. Basis of design: Thermaflex FlexFlow elbows.

2. Flexible Duct Supports: UL listed for plenum installation molded fiber reinforced plastic 1-1/2" wide straps adjustable for 4" to 16" diameter flex duct, supports duct without damaging vapor barrier or collapsing soft insulation or duct. Basis of design: Thermaflex FlexTie straps.

3. Clamps: Re-usable stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size, or single use "zip-tie" strap of plenum rated plastic, sizes 3 through 10 inches diameter maximum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions under which duct work is to be installed for compliance with requirements for proper installation.

1. Check all drawings for detailed information and locations and field verify all conditions affecting installation.
2. Notify Architect in writing of any conditions detrimental to proper and timely installation.
3. Obtain Architect's approval before fabrication of any changes in size required by obstructions and job conditions.
4. Proceed with installation only after unsatisfactory conditions have been corrected in an acceptable manner.
5. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 DUCT FABRICATION

A. Fabricate and install as shown on Drawings and in manner coordinated with all construction requirements.

B. Sizes shown on plans are clear inside duct dimensions representing the design hydraulic radius of the duct. Generally, fabricate ductwork of sizes shown on plans. During field verification, confirm that duct of aspect ratio shown fits within general construction constraints coordinated with all other trades. Adjust aspect ratio, joint spacing, reinforcement, etc., as required during coordination process to fit duct of equivalent hydraulic radius where shown. If duct of reduced hydraulic radius is required due to field conditions, submit RFI for direction before proceeding.

C. Flexible Connections: Provided at intake and discharge connections to all motor powered fan air handling equipment and other vibration isolated air handling component connections.

D. Fabricate all ductwork to the SMACNA pressure classification reinforcement standards shown on the drawings and to the following minimum standards.

1. Conform to special duct pressure classification requirements for all duct between air handler blowers and last fire or fire/smoke damper in series, and duct after the last fire or fire/smoke damper in series up to the next 90 deg. turn:

a. Fabricate to the SMACNA pressure classification reinforcement standards required by the system supply or return blower dynamic stall pressure; assume the larger of 200% of external operating pressure scheduled or 150% of fan total pressure listed as a minimum. VIF with approved equipment fan curves and adjust pressure classification values accordingly.

2. Where there are no fire or fire / smoke dampers and past the 90 degree turn mentioned above, complete to the last branch duct volume damper, VAV box, induction unit, or other pressure restricting device, fabricate duct to pressure classification as required by the system supply or return operating pressure listed on the drawings, minimum plus or minus two (2) inch water column.

3. Fabricate branch run-out duct between the last pressure restricting device and the air terminal register, grille, or diffuser to minimum plus or minus one (1) inch water column pressure classification.

E. Deliver and store all duct with duct interior clean and all openings sealed with film designed for the purpose of keeping uninstalled duct clean. Unless section of duct is being actively extended during construction, keep all openings and RGD properly sealed and prevent entrance of dust, dirt, construction debris, etc.

F. Extend all access openings, damper rods, and levers to outside of external insulation for convenience of operation and maintenance.

G. Provide all necessary transitions, fittings, aspect ratio changes, etc., as required to install duct work. Where aspect ratio changes are required to fit within structural or other existing construction constraints, provide duct of equal or larger hydraulic radius.

3.3 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 concealed in general construction unless otherwise specified or indicated on Drawings.

C. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

D. Provide all necessary openings, sleeves, hanger inserts, chases, recesses, etc., in general construction work. Coordinate duct openings provided by others in ample time to avoid delays.

E. Provide collars to trim all duct openings in general construction work.

F. Make final ductwork connections to equipment where indicated on the drawings.

G. Install ductwork in all spaces as high as possible and in locations to avoid interference with recessed lights, piping, general construction, etc.

H. Install round ducts in maximum practical lengths.

I. Install ducts with fewest possible joints.

J. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

K. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

L. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

M. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

N. Route ducts to avoid passing through transformer vaults, electrical equipment rooms and enclosures, and stairwells.

O. 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.

P. Where duct passes through exterior walls and roofs from interior to exterior, provide water and airtight penetration detailing as required, preserving the thermal, moisture, and vapor penetration resistance of the surrounding assembly.

Q. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.4 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 and surrounding heat affected zone 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.

3.5 DUCT SEALING

A. Make system air tight / water tight as required and approved, replacing any poor joints or careless work. Fabricate ductwork to the following SMACNA leakage standards:

1. Seal Class A - Greater than 2 inch w.g. and for air and water tight ductwork described below.
2. Seal Class B – 2 inch w.g. and less general supply, return, and exhaust ductwork.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with the requirements of the following:

1. SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
2. Section 23 05 29 – Hangers And Supports for HVAC Components.
3. Section 23 05 43 – Mechanical Vibration and Motion Control.

3.7 CONNECTIONS

A. Make connections at all intake and discharge connections between duct and vibration producing equipment with fans, including BCU, AHU, RTU, FCU, etc.., where duct passes through building expansion joints, and as shown on the drawings, with flexible connectors as specified.

1. Round connections: Adhesive and approved metal draw bands; ends tightly bolted together.

2. Rectangular flanges: Material securely held in grooved seam, tightly clipped or screwed on 6 inch centers.

3. Connections not over 2 inch between duct and equipment, with at least 1 inch excess material.

4. Install neatly so as not to interfere with air flow through connection. Provide round metal center ring or rectangular metal center collar to prevent flex fabric collapse inside of nominal connected duct dimensions.

5. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.

B. Registers, Diffusers, and Grilles:

1. Install flexible duct connections to registers, diffusers, and grilles with no more than 20 degree unsupported bend in flex. Where horizontal duct connects to vertical axis collar (ex., ceiling mounted diffuser), provide elbow support as specified or hard elbow.

2. Exposed, duct side mounted: Mount outlet outside of air stream with extension collars full size of register or grille frame outside margin, with turned in duct flange and turned out terminal mounting flange. Provide vaned air extractor with internal mechanism / external rotating knob adjuster.

3. Exposed ductwork hard piped connections: per Duct Manual.

3.8 PAINTING

A. Paint interior of ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

3.9 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. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

3. Test for leaks before applying external insulation.

4. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.

5. Give seven days' advance notice for testing.

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

D. Prepare test and inspection reports.

3.10 START UP

A. Air Balance: Comply with requirements in Section 23 05 93 - "Testing, Adjusting, and Balancing for HVAC."

END OF SECTION 23 31 00

SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Manual volume dampers.
2. Fire Dampers.
3. Flange connectors.
4. Turning vanes.
5. Flexible connectors.
6. Duct accessory hardware.

1.3 SUBMITTALS, GENERAL

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.4 ACTION SUBMITTALS

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

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.
b. Manual volume damper installations.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

B. Source quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

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 AMCA 500-D testing for damper rating.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60.
2. Exposed-Surface Finish: Mill phosphatized.

C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

D. 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.

2.2 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. 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:

   a. Hat-shaped, galvanized-steel channels, 0.064-inch minimum thickness.
   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. Bearings:

   a. Molded synthetic.
   b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Galvanized steel.

B. Jackshaft:

1. Size: 1-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.3 FIRE 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. Arrow United Industries; a division of Mestek, Inc.
3. Cesco Products; a division of Mestek, Inc.
4. Greenheck Fan Corporation.

5. Nailor Industries Inc.
6. NCA Manufacturing, Inc.
7. Prefco; Perfect Air Control, Inc.
8. Ruskin Company.
9. Vent Products Company, Inc.
10. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Type: Static; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.

D. Fire Rating: 1-1/2 hours.

E. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.052 or 0.138 inch thick, as indicated, and of length to suit application.

2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical as indicated.

H. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

I. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.4 FLANGE 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. Nexus PDQ; Division of Shilco Holdings Inc.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Description: Add-on, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

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. 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 2-3, "Vanes and Vane Runners," and 2-4, "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. Ventfabrics, Inc.
4. 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 5-3/4 inches wide attached to 2 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.

F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd..
2. Minimum Tensile Strength: 500 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F.

2.7 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.8 COMBINATION FIRE AND SMOKE 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. Cesco Products; a division of Mestek, Inc.
3. Greenheck Fan Corporation.
4. Nailor Industries Inc.
5. Ruskin Company.

B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.

D. Fire Rating: 1-1/2 hours.

E. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

F. Smoke Detector: By Div. 26

G. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

H. Leakage: Class I.

I. Rated pressure and velocity to exceed design airflow conditions.

J. Mounting Sleeve: Factory-installed, 0.052-inch- thick, galvanized sheet steel; length to suit wall application.

K. Damper Motors: two-position action.

L. 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.

2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.

4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.

5. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.

6. Electrical Connection: 115 V, single phase, 60 Hz.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where air terminal units 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.
C. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

3.2 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel,

C. Install backdraft or control 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.

1. Install steel volume dampers in steel 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. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

I. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

J. Connect flexible ducts to metal ducts with draw bands.

K. Install duct test holes where required for testing and balancing purposes.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Inspect turning vanes for proper and secure installation.

END OF SECTION 23 33 00

SECTION 23 34 00 - HVAC FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Utility set fans.
2. Centrifugal roof ventilators.
3. In-line centrifugal fans.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on actual Project site elevations.
B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS, GENERAL

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.5 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. Roof curbs.
6. 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.

1.6 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.

1.7 CLOSEOUT SUBMITTALS

A. Field quality-control reports.
B. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

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 commercial 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.

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. Belts: One set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 UTILITY SET FANS

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. Carnes Company.
2. Loren Cook Company.
3. New York Blower Company (The).
4. PennBarry.

B. Housing: Fabricated of galvanized steel with side sheets fastened with a deep lock seam or welded to scroll sheets.

1. Housing Discharge Arrangement: Adjustable to eight standard positions.

C. Fan Wheels: Single-width, single inlet; welded to cast-iron or cast-steel hub and spun-steel inlet cone, with hub keyed to shaft.

1. Blade Materials: Steel.
2. Blade Type: Backward inclined, Airfoil.

D. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.

E. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings with ABMA 9, L_{50} of 200,000 hours.

1. Extend grease fitting to accessible location outside of unit.

F. Belt Drives:

1. Factory mounted, with final alignment and belt adjustment made after installation

2. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.

3. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

4. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.

G. Accessories:

1. Inlet and Outlet: Flanged.

2. Companion Flanges: Rolled flanges for duct connections of same material as housing.

3. Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

4. Vibration Isolators:

   a. Type: Spring isolators.

   b. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

   c. Variable Speed Operation: Provide with motor as described above and ECM motor (single phase) or variable speed drive in accordance with section 23 29 23 – Variable Frequency Motor Controllers (three phase).

   d. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

1. Manufacturers: Cook, Greenheck, Penn Ventilator, Twin Cities, or Approved Equal.

2.2 IN-LINE CENTRIFUGAL FANS

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

1. Acme Engineering & Manufacturing Corporation.
2. Breidert Air Products.
3. Carnes Company.
4. Greenheck Fan Corporation.
5. Hartzell Fan Incorporated.
6. Loren Cook Company.
7. PennBarry.

B. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

E. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

F. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

2. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.

3. Companion Flanges: For inlet and outlet duct connections.

4. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.

5. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

6. Vibration Isolators:

   a. Type: Elastomeric hangers.
   b. Static Deflection: 1 inch .

2.2 ROOFTOP CENTRIFUGAL EXHAUST FANS

A. Unit Description: UL listed exhaust fan specifically designed for outdoor installation and service, shipped fully assembled and factory tested prior to shipment.

1. Housing:

   a. Spun 16 gauge minimum weather tight marine grade aluminum two piece upper housing, with reinforced rolled edges. Down-blast, or up-blast housing as scheduled.

      1) Fully welded aluminum curb cap

   b. Rubber grommeted internal wiring passages unless otherwise specified.

   c. Provide aluminum nameplate riveted to housing exterior with manufacturer, model, cfm, static pressure, and electrical characteristics all permanently engraved or stamped.

2. Impellers: Backward inclined, non-overloading, statically and dynamically balanced all aluminum construction, including hubs. Impeller shall overlap a spun aerodynamic inlet cone. Belt or direct drive as shown on Drawings.

3. Power Assemblies:

   a. Motor and drive isolated from discharge air stream in forced-air cooled compartment.

   b. Power Assembly mounted on minimum 14 gauge plated steel structure, supported on housing with rubber isolators loaded in combination shear and compression.

   c. Belt drive systems:

      1) Drive Sheaves: Cast iron, adjustable with machined grooves.

      2) Impeller Shaft: Anti-corrosion treated with re-lubricable pillow block style ball bearings rated for L-50 200,000 hr life at maximum cataloged operating speed under conditions of service.

      3) Drive Belts: premium notched belts, sized for 1.5 times motor horsepower. Provide spare belt, secured to dome of motor compartment.

d. Motors:

1) Refer to section 23 05 13 Common Electrical requirements for HVAC Components for additional information.

2) Constant Speed Operation: Open drip-proof type with sealed, permanently lubricated ball bearings; pre-wired through to disconnect switch mounted under fan cover with sufficient legs to break all leads to motor.

a) Motors, wiring, and disconnects serving fume hood exhaust fans and other potentially flammable exhaust streams shall be UL listed and in accordance with NEC for explosion proof construction.

3) Variable Speed Operation:

a) Three Phase: Open drip-proof type with sealed, permanently lubricated ball bearings; pre-wired through to disconnect switch mounted under fan cover with sufficient legs to break all leads to motor. Suitable for inverter duty operation with 10:1 variable torque speed range without damage. Provide with thermal overloads (RTD's, 2 per phase, embedded into the motor windings) for connection to VFD for motor thermal protection at low speed operation.

b) Single Phase: Electronically commutated motor (ECM) as manufactured by General Electric. Motor shall be of permanent magnet, brushless DC premium efficiency design with variable speed electronic controller capable of maintaining constant speed, torque, and/or cfm as required by service, capable of accepting 0-10vdc or 4-20mA speed control signal from building management system. Adjustable slow start and gradual speed changes, permanently lubricated ball bearings, and extra quiet operation are all included.

4. Accessories / options as scheduled:

a. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

b. Bird Screen: Removable, 1/2-inch mesh, aluminum or brass wire.

c. Factory fabricated insulated roof curb meeting the requirements above and of section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.

d. Fume / Kiln / Spray hood exhaust fans: Constructed of special corrosion-resistant materials with factory-applied anti-stick epoxy coating in color as selected by Architect. Configure for up-blast operation. Configuration shall include weather-proof factory wired junction box and disconnect switch mounted to the housing exterior, 18 inch high ventilated roof curb, floating hinge kit, and UL listed for the scheduled application.

e. Variable Speed Operation: Provide with motor as described above and ECM motor (single phase) or variable speed drive in accordance with section 23 29 23 – Variable Frequency Motor Controllers (three phase).

f. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

5. Manufacturers: Cook, Greenheck, Penn Ventilator, Twin Cities, or Approved Equal.

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 EXAMINATION

A. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

3.2 INSTALLATION

A. Install power ventilators level and plumb.
B. Support units using elastomeric mounts having a static deflection of 1 inch.
C. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. See Division 07 Section "Roof Accessories" for installation of roof curbs.
D. Support suspended units from structure using threaded steel rods and elastomeric hangers having a static deflection of 1 inch.
E. Install units with clearances for service and maintenance.
F. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.3 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

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

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 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.

3.5 ADJUSTING

A. Adjust damper linkages for proper damper operation.
B. Adjust belt tension.
C. Comply with requirements in Division 23 Section "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 23 34 00

SECTION 23 34 23 – VEHICLE ENGINE EXHAUST SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes Vehicle Engine Exhaust System components including:

1. Direct Drive Fans
2. Hose Storage Reels
3. Flexible Hose Assemblies

B. Products furnished but not Specified Under this Section

1. Hangers and supports for equipment: refer to Section 23 05 29 – Hangars and Supports for HVAC Piping and Equipment.
2. Motors and drive systems: refer to section 23 05 13 – Common Electrical Requirements for HVAC Equipment.
3. Ductwork: refer to Sections 23 31 00 – Ductwork and 23 33 00 – Air Duct Accessories.

1.3 SYSTEM DESCRIPTION

A. Design Requirements - Provide fans to fit intended use and location as indicated on Drawings and specifications and complying with following requirements:

1. Capacity, size and arrangement, static pressure, brake horsepower, component parts and accessories as scheduled and as necessary to obtain required results and allow for proper maintenance, equal to or better than the design make equipment.

2. Ratings based on Standard Test Code for Centrifugal Fans, adopted jointly by AMCA and ASHRAE.

3. Each size fan tested in manufacturer's laboratory under simulated installation conditions. Ratings based on tests, not on interpolated or extrapolated calculations.

4. Guaranteed full capacity delivery through duct systems installed under conditions specified.

5. Guaranteed sound power level ratings not exceeding ratings of specified equipment.

6. All equipment statically and dynamically balanced to acceptable tolerances with all weights permanently fastened.

1.4 SUBMITTALS

A. Procedural Requirements: Comply with requirements of SECTION 01 33 00 - Submittals and as modified below.

1. Specified Products: If product to be incorporated into Project is specified by name and product designation in Part 2 of product specification below as the basis of design equipment, includes all options qualities specified, and will be installed as specified in Part 3, then submit “As-Specified Verification Form” (attached to SECTION 01 33 00 - Submittals) in lieu of “Product Data” identified.

2. Equivalent Products or Substitutions: If product to be incorporated into Project is not the basis of design equipment as specified in Part 2 below, submit complete demonstrating compliance with all Product Data requirements specified.

B. Product Data: Submit detailed data and manufacturer’s cut sheets on all fans, hose reels, hose and fittings, controllers, and all other accessories specified including all pertinent dimensions, construction characteristics demonstrating compliance with specifications, operating data, and electrical characteristics.

C. Shop Drawings: Submit shop drawings showing to scale proposed installation including service access, coordination with adjacent construction, location, and size of all roof and wall openings.

D. Contract Closeout Submittals: Comply with requirements of SECTION 01 77 00, including submission of operating and maintenance instructions as item in "Operating and Maintenance Data" manual described in that section.

1.5 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. Motors and electrical accessories shall comply with NEMA 1.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. Mechanical Code of New York State.

PART 2 - PRODUCTS

2.1 VEHICLE EXHAUST SYSTEMS

A. Standard Packaged Systems: Provide complete factory assembled and tested package type vehicle exhaust systems, including direct centrifugal fan and factory assembled hose with accessories as scheduled and all as specified.

1. Provide materials and equipment which are standard products of an exhaust system manufacturer regularly engaged in the manufacture of the product, and that are essentially duplicates of items by that manufacturer which have been in satisfactory use for at least 2 years.

2. Mount on a welded steel wall bracket or as otherwise shown on drawings.

3. Provide with a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number.

4. Equipment shall be supported by a service organization that is capable of responding to service calls within twenty four hours.

B. Direct Drive Fans: The fan shall be a standard product of the system manufacturer.

1. The fan shall be single inlet, single width. Fan wheel shall be backward inclined, non-overloading type with single thickness blades. The wheel shall have a grey cast iron hub bored to match the motor shaft, with a machined keyway matching that in the motor shaft. The wheel shall be statically and dynamically balanced. The fan housing shall be fabricated of heavy gauge steel and be of all welded construction. The mating surfaces of the inlet cone and fan housing shall be caulked prior to assembly. The inlet cone shall be assembled to the fan housing using hex head cap screws bolted to threaded inserts welded to the interior of the housing. A rolled angle iron mounting flange, with bolt pattern matching the hose reel discharge, shall be welded to the fan inlet.

2. All surfaces of the fan shall be painted with an acid resistant polyester powder coating. The fan motor shall be of an industrial grade C face type, bolted directly to the housing, with horsepower and electrical characteristics as specified.

C. Hose Assembly: Provide system manufacturer’s factory assembled high temperature and abrasion resistant flexible engine exhaust hose assembly complete with end flanges, hose, and tailpipe adapter with each exhaust system.

1. The hose shall be fabricated of silicone coated glass fabric inner layer and neoprene coated polyester outer layer, clinched with an external galvanized steel helix. No adhesives may be used in the construction. The flexible hose is to be capable of withstanding temperatures of 600°F interior, and be both flame retardant and oil resistant.

2. A connecting flange shall be provided for bolt-up attachment to the hose storage reel.

3. Exhaust adapters and rotating cylinder attachment flanges shall be attached to the hose at the factory. Field assembly is not acceptable.

D. Control: Provide manufacturers standard wall-mounted fan start/stop and hose retractor controller. Location to be determined by Owner.

E. Manufacturers: Basis of design manufacturer is Car-Mon. Subject to compliance with requirements, manufacturers of complete assemblies offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Car-Mon Products, Inc, Elgin, IL, U.S.A: Type CMW fan and HTX hose.

2. National System of Garage Ventilation, Inc., Decatur, IL, U.S.A.
3. Ventaire, Inc., Burnsville, MN, U.S.A.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions (by Installer): Examine conditions under which vehicle exhaust systems are to be installed and notify Prime Contractor in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION

A. Install in accordance with manufacturer's specifications and recommendations and all applicable requirements of Division 1.
B. All fans shall be furnished with suitable vibration isolation, as described in SECTION 23 05 43 - Mechanical Sound, and Movement Control.
C. Confirm all locations, opening sizes and mounting arrangements in field and coordinate installation with work of other trades.
D. Install Vehicle exhaust fans level and plumb.
E. Install vehicle exhaust hose reel and fan using manufacturer’s mounting brackets. Attach to building steel in locations indicated.
F. Install units with clearances for service and maintenance.
G. Label fans according to requirements specified in Division 23 Section "Mechanical Identification."
H. Install reel controllers in convenient location of Owner’s choosing adjacent to each storage reel. Provide all control and power wiring between controller and cord reel.
I. Install fan controller in convenient but secure location of Owner’s choosing adjacent to fan. Interlock fan controller with building control system as indicated in Sequence of Operation.

3.3 CONNECTIONS

A. Duct installation and connection requirements are specified in the Division 23 Section on Air Ducts. Provide Class A sealed air and water-tight ductwork rated for plus or minus 12 inches water gauge.

B. Provide welded 300 series stainless steel ductwork from fan discharge connection through roof to termination point.

C. Install ducts adjacent to fans to allow ease of service and maintenance.

D. Ground equipment according to Division 26 Section "Grounding and Bonding."

E. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

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 pulleys and adjust belt tension, and install belt guards.

5. Adjust damper linkages for proper damper operation.

6. Verify lubrication for bearings and other moving parts.

7. Refer to Section 23 05 93 - Testing, Adjusting, And Balancing For Hvac, for testing, adjusting, and balancing procedures.

8. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

9. Remove and replace malfunctioning units and retest as specified above.

B. Demonstrate complete system to Owner’s personnel and train them in proper system operation and maintenance. Videotape training session with at least three segments:

C. One for student training as users of exhaust reels.

D. One for faculty training as users of both exhaust reels and fan system controls.

E. One for maintenance personnel training on system operation, maintenance, and troubleshooting.

END OF SECTION 23 34 23

SECTION 23 36 00 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Bypass, single-duct air terminal units.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

1.4 SUBMITTALS, GENERAL

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.5 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.

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 and vibration isolation.

1.6 CLOSEOUT SUBMITTALS

A. Field quality-control reports.

B. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Instructions for resetting minimum and maximum air volumes.
2. Instructions for adjusting software set points.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

PART 2 - PRODUCTS

2.1 SINGLE-DUCT AIR TERMINAL UNITS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Carnes.
2. Trane.
3. Titus.

B. Casing: 22 gauge galvanized steel.

1. Casing Lining: Adhesive attached, 1/2-inch- thick, coated, fibrous-glass duct liner complying with NFPA 90A, 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.

2. Air Inlet: Round stub connection for duct attachment.

3. Air Outlet: S-slip and drive connections.

4. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

5. Air Valve

a. The primary air inlet connection shall be 18-gage galvanized steel cylinder sized to fit standard round duct. A multiple-point, averaging flow sensing ring is provided with balancing taps for measuring +/-5% of unit cataloged airflow.

b. The damper blade shall be constructed of a closed-cell foam seal that is mechanically locked between two 22-gage galvanized steel disks. The damper blade assembly shall be connected to a cast zinc shaft supported by selflubricating bearings.

c. Cast shaft with damper position indicator.

d. The valve assembly shall include a mechanical stop to prevent over-stroking. At 4.0 in. wg, air valve leakage does not exceed 1% of cataloged airflow.

C. Electronic Controls: Control devices shall be compatible with temperature controls specified in Division 23 Section "Instrumentation and Control for HVAC" and shall have the following features:

1. Thermostat: Wall-mounted electronic type with the following features:

a. Auxiliary switch to energize heating control circuit.
b. Changeover thermistor to reverse action.

2.2 SOURCE QUALITY CONTROL

A. Factory Tests: Test assembled air terminal units according to AHRI 880.

1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, and AHRI certification seal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where air terminal units 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.
C. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

3.2 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.

3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "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.
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.

3.4 CONNECTIONS

A. Connect ducts to air terminal units according to Division 23 Section "Air Ducts." Coordinate duct installations and specialty arrangements with Drawings.

3.5 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.6 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. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Air terminal unit will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.7 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 23 36 00

SECTION 23 37 00 – AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Interior Outlets and Inlets:

a. Registers, grilles, and diffusers

2. Exterior Outlets and inlets:

a. Air louvers

1.3 SYSTEM DESCRIPTION

A. Design Requirements

1. Registers, Grilles, and Diffusers: Provide all supply, return and exhaust grilles, registers, and diffusers required for all systems.

2. Air Louvers: Provide AMCA-rated louvers for all fresh air intake and exhaust openings, except as otherwise shown or specified in Contract Documents. Cross- reference dimensions of each louver shown on heating drawings with those on the architectural drawings. Notify architect in writing of any discrepancies prior to submitting on louvers.

1.4 PERFORMANCE REQUIREMENTS

A. Interior Outlets and Inlets: Provide outlets and inlets with aspiration ability, temperature mixing, and velocity traverses and decay with distance, throw, pressure drop, and noise criteria ratings equal to or better than specified products.

1.5 SUBMITTALS

A. Comply with requirements of SECTION 01 33 00 - Submittals and as modified below.

B. Product Data: Submit manufacturer's product literature, technical specifications, performance data, installation instructions, and similar information required to demonstrate compliance with specified requirements. Annotate all selected options, cross referenced to specification and drawing designations. Include tabulated data for all proposed outlets and inlets, showing size, type, cfm, aspiration ability, water entrainment, temperature mixing, and velocity traverses and decay with distance, throw, pressure drop, noise criteria ratings and any other applicable data demonstrating performance equal to or better than specified products.

C. Shop Drawings: Submit shop drawings showing sizes, construction details, mounting details, capacity, and air flow characteristics for all equipment. Include complete tabulated schedules as indicated below for each of RGD, and Louvers.

1. Registers, Grilles, and Diffusers (RGD): Include complete tabulated schedule showing locations for each RGD, type, size, capacity as shown on Drawings, and performance data for each RGD furnished, including throw and noise criteria ratings. Indicate selections on data.

2. Air Louvers: Include complete tabulated schedule showing locations for each Louver, showing type, size, wall rough opening size, capacity as shown on Drawings, and performance data for each including pressure drop and water entrainment specifications. Include all this data on coordination drawings and special Mechanical Penetrations of General Construction Envelope coordination drawing.

D. Contract Closeout Submittals: Comply with requirements of SECTION 01 77 00, including submission of operating and maintenance instructions as item in "Operating and Maintenance Data" manual described in that section.

1.6 SEQUENCING AND SCHEDULING

A. Deliver Exterior Outlets and Inlets to project in sufficient time for installation in walls as wall construction progresses.

1. Coordinate unit selection to meet requirements of other equipment and installation details (automatic dampers, back draft dampers, etc.).
2. Verify all opening sizes, locations and mounting arrangements prior to installation.

PART 2 - PRODUCTS

2.1 REGISTERS, GRILLES, AND DIFFUSERS

A. General

1. Provide registers, grilles, and diffusers with border systems that are compatible with adjacent wall and ceiling systems, and that are specifically manufactured to fit into ceiling modules with accurate fit and adequate support. Refer to general construction drawings and specifications for details of adjacent systems.

2. All performance criteria equal to or better than design make as specified and tagged on drawings.

3. Provide factory baked white enamel finish for steel materials and clear or color anodizing for aluminum material as base bid standard finish unless otherwise specified or noted.

4. Provide products by one of the following:

   a. Krueger or equal.
   b. Titus or equal.
   c. Anemostat or equal.

B. Registers:

1. TYPE "R-A": 35° Fixed deflection wall return register; horizontal front vanes with 3/4" spacing between blades, rubber gasket to prevent streaking, optional opposed blade damper operable from face. Finish shall be #26 white, anodic acrylic paint. Design basis: Titus 350RL.

2. TYPE "R-B": Double deflection wall supply register; horizontal front blades with 3/4" spacing between blades, rubber gasket to prevent streaking, optional opposed blade damper operable from face. Finish shall be #26 white, anodic acrylic paint. Design basis: Titus 300RL.

C. Grilles

1. TYPE "G-A": Eggcrate return grille; 1/2 inch x1/2 inch x1inch deep squares; fabricated aluminum core; flat frame; white baked enamel finish to match ceiling. Neck size and accessories as noted on drawings. Provide frame to fit lay-in ceiling grid or hard ceiling as required. Design basis: Titus 50F.

D. Supply Diffusers:

1. TYPE "D-A": Ceiling air diffuser with stamped steel construction, stamped three ring removable core, 24 inch square face, 4 way pattern, integral round neck of size as noted on drawings. Anti smudge design to prevent streaking. Flush T-bar mount to fit lay-in ceiling grid, coordinate with G.C. Design basis: Titus TMSA.

2.2 AIR LOUVERS

A. Intake and Exhaust Louvers (Fixed Type)

1. Standard Construction Requirements:

   a. Factory constructed high performance drainable (frame, blades, and head as scheduled) aluminum louvers with storm resistant blades of AMCA rated performance equal to or better than the design make.

   b. Frame and blades constructed of extruded aluminum, alloy 6063-T5. Nominal wall thickness of 0.081 inches, depth to be 4 inches as noted on drawings.

c. Blade angle of 37-1/2 degrees, centered nominally at 5-3/32 inches for the 4 inch deep and at 5-29/32 inch for 4 inch deep louvers. Hidden vertical supports shall allow continuous line appearance up to 120 inches.

d. Stainless Steel 1/2 inch mesh x 0.063 inch bird screen secured in a removable frame with SS tamperproof fasteners, on interior face of louver. Finish same as louver.

e. Extended sills constructed of aluminum, alloy 6063 – T5 with a nominal wall thickness of 0.060 inches in a style selected by Architect.

f. Provide welded construction for all factory assembled louver components. Provide stainless steel fasteners for all field assembled components.

g. Size, type and location as shown on drawings.

h. Provide scheduled factory finish as detailed below.

1) Anodize: Electrolytically deposited color anodized finish complying with Aluminum Association code AA-C22A44. Finish shall be applied to 0.7 mils minimum thickness onto chemically etched and pretreated aluminum extrusion. Color to be selected by Architect.

i. Design basis: Ruskin ELF375DXH or engineer approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which air outlets and inlets are to be installed and notify a Architect in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in an acceptable manner.

1. Air Louvers: Coordinate unit selection to meet other equipment and installation details (automatic dampers, back draft dampers, etc.). Verify all opening sizes, locations and mounting arrangements prior to installation.

3.2 INSTALLATION

A. Install air outlets and inlets in strict accordance with manufacturer’s recommended installation instructions for applications shown on Drawings.

B. Registers, Grilles and Diffusers (RGD): Install all RGDs in accordance with manufacturer's installation instructions and SMACNA installation manual at locations indicated on Drawings.

1. Adjust each type of RGD as required to achieve even air distribution throughout occupied space, generally free of objectionable drafts and dead air pockets. Demonstrate adjustments of distribution to Owner and additionally adjust as requested by Owner's representative during or subsequent to initial adjustments. As RGD adjustment and Testing and Air Balancing work affect each other, make preliminary adjustment to all RGDs prior to balancing, and make final RGD adjustment during TAB work in cooperation with TAB agency. Refer to Section 23 05 93 – TESTING, ADJUSTING, AND BALANCING FOR HVAC for more detail.

2. Provide final balancing in accordance with SECTION 23 05 93.

3. Furnish to Owner, with receipt, 3 operating keys for each type of air outlet and inlet that requires them.

C. Air Louvers: Comply with manufacturer's specifications and recommendations for assembly and installation of air louver units, hardware, operators, and other components.

1. Set units plumb, level, and true to line, without warp or rack of frames. Anchor securely in place. Separate aluminum and other corrodible metal surfaces from sources of corrosion or electrolytic action at points of contact with other materials. Use stainless steel fasteners.

2. Make suitable provision for thermal expansion in assembly of groups of units.

3. Set head, jamb, and sill members in bed of compound as shown, or with joint fillers or gaskets as shown to provide weather tight construction.

4. Provide suitable gaskets or coating where dissimilar metals are in contact.

5. Clean aluminum surfaces promptly after installation of units. Remove excess glazing and sealant compounds, dirt, and other substances. Lubricate hardware and other moving parts.

END OF SECTION 23 37 00

SECTION 23 62 13 – UNITARY AIR CONDITIONING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Split System Heat Pumps.

B. Products Furnished but not Installed Under this Section

1. Associated refrigerant piping and condensate drain piping.

1.3 SYSTEM DESCRIPTION

A. Design Requirements

1. Cooling performance rated in accordance with AHRI Testing.

2. Unit efficiencies meet scheduled performance and exceed Energy Code Requirements.

3. Units listed and labeled by UL and ETL.

4. All refrigeration equipment and related installation provided to comply with Safety code for Mechanical Refrigeration ASHRAE Standard 15-1994 and ANSI Refrigeration Safety Code B 9.1.

1.4 SUBMITTALS

A. Comply with requirements of SECTION 01 33 00 - Submittals and as modified below.

B. Product Data: Provide manufacturer's specification data for each unit, showing operating weight, all sizes, dimensions, capacity, operating and performance characteristics, motor horsepower, and other pertinent data including color chart.

C. Contract Closeout Submittals: Comply with requirements of SECTION 01 77 00, including submission of operating and maintenance instructions as item in "Operating and Maintenance Data" manual described in that section.

PART 2 - PRODUCTS

2.1 DUCTLESS SPLIT HEAT/COOL AIR CONDITIONING UNIT

A. Unit Description: Unit to bear AHRI Certification Symbol and listed by ETL Testing Laboratories, Inc. consisting of outdoor unit which contains refrigerant compressor and can provide heating and cooling of spaces, indoor unit connected by insulated copper refrigerant tubing with flare type fittings. System equipped with factory-installed solid core filter drier, large capacity suction accumulator, low ambient controls, and other accessories as specified and as scheduled.

1. Refrigerant Run Capability: 130 feet of lift with maximum tubing length of 130 feet of interconnecting piping for up to 1.5 ton capacity unit, and 50 feet of lift with maximum tubing length of 164 feet for unit with greater than 1.5 ton capacity up to 3.5 ton capacity.

2. Refer to drawings for capacities and performance ratings.

B. Refrigerant: Sufficient R-410A refrigerant provided in outdoor unit to charge complete system.

C. Outdoor Condensing Unit: Outdoor with inverter driven compressors (Variable Frequency Drive) which provides efficient cooling and heating performance.

1. General data:

a. Factory assembled and pre-wired with all necessary electronic and refrigerant controls.

b. Refrigeration circuit consisting of a digital scroll compressor, motors, fans, condenser coil, electronic expansion valve, solenoid valves, 4 way valve, distribution headers, capillaries, filters, service isolation valves, oil separators, service ports, liquid receivers and accumulators.

c. Both liquid and suction lines must be individually insulated between the outdoor and indoor units on heat pump units. Liquid line insulation is not required on cooling only units.

d. The outdoor unit can be wired and piped with outdoor unit access from left, right, rear or bottom.

e. The sound pressure at rated conditions: maximum of 58 decibels dB(A) at 3 feet from the front of the unit. Provide with night operation mode capable of operating at further reduced noise.

f. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for re-programming.

g. The outdoor unit shall be modular in design and should allow for side-by-side installation with minimum spacing.

h. The following safety devices shall be included on the condensing unit; high pressure switch, control circuit fuses, crankcase heaters, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers, and sub-cooling feature. Oil recovery cycle shall be automatic occurring 1 hour after start of operation and then every 6 hours of operation.

i. The outdoor unit shall be capable of heating operation at 0°F dry bulb ambient temperature without additional low ambient controls.

2. Unit Cabinet:

a. The outdoor unit shall be completely weather proof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.

3. Fan:

a. The outdoor unit shall consist of one or two propeller type, direct-drive fan motors that have multiple speed operation via a DC inverter.
b. The outdoor unit fan motor shall have multiple speed operation of the DC inverter type, controlled to modulate as required to maintain head pressure.
c. The fan motor shall have internal thermal overload protection and permanently lubricated bearings and be mounted on rubber in shear isolators.
d. Provide a fan guard to prevent contact with moving parts, constructed of welded wire and plated or painted for corrosion resistance.

4. Outdoor Coil:

a. Manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
b. The coil shall be of a waffle louver fin and high heat exchanger, rifled bore tube design to ensure highly efficient performance.
c. The coils shall be complete with corrosion treatment of an acrylic resin type. The thickness of the coating must be between 2.0 to 3.0 microns.

5. Compressor:

a. The scroll compressor shall be variable speed (PWM inverter) controlled, changing speed to follow the variations in total cooling load as determined by the suction gas pressure as measured in the condensing unit.

b. The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC, hermetically sealed scroll type with a maximum speed of 6,480 rpm.

c. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.

d. The capacity control range shall be modulating from 14% to 100%.

e. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.

f. Oil separators shall be standard with the equipment together with an oil balancing circuit.

g. The compressor shall be mounted to avoid the transmission of vibration.

6. Low Ambient Kit

a. Low ambient kit shall consist of outdoor unit manufacturers standard hood-type assembly with damper control box, side-wind deflector and front wind deflector.

7. Electrical:

a. The power supply to the outdoor unit shall be in voltage and phasing as shown on the drawings, with a tolerance of +/- 10% from nominal indicated.

b. The control voltage between the indoor and outdoor unit shall be low voltage control wiring compatible with the energy management and control system as specified in section 23 09 00. The control wiring shall be a multiplex communication system, making it possible to connect multiple indoor units to one outdoor unit with one cable, thus simplifying the wiring operation.

D. Indoor Unit – Ceiling Cassette Unit

1. General: The indoor unit model shall be a ceiling cassette fan coil unit, operable with scheduled refrigerant, for installation into the ceiling cavity with an air panel grille. It shall be a four-way air distribution type, ivory white, impact resistant, and washable decoration panel. The supply air is distributed via motorized louvers which can be horizontally and vertically adjusted from 0° to 90°. Computerized control shall be used to maintain room temperature within 1°F. The indoor units sound pressure shall range from 28 dB(A) to 33 dB(A) at low speed measured at 5 feet below the unit.

2. Indoor Unit:

a. The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.

b. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.

c. Both refrigerant lines shall be insulated from the outdoor unit.

d. The 4-way supply air flow can be field modified to 3-way and 2-way airflow to accommodate vAHRIous installation configurations including corner installations.

e. Return air shall be through the concentric panel, which includes a resin net mold resistant filter.

f. The indoor units shall be equipped with an insulated corrosion proof condensate pan under the coil capturing and controlling all condensate.

g. Provide a condensate pump with a 21 inch lift located below the coil in the condensate pan, complete with a built in safety high level alarm and interlock.

h. The indoor units shall be equipped with a return air thermistor.

i. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.

j. The voltage range will be 253 volts maximum and 187 volts minimum.

3. Unit Cabinet:

a. The cabinet shall be space saving and shall be located into the ceiling.
b. Three auto-swing positions shall be available to choose, which include standard, draft prevention and ceiling stain prevention.
c. The airflow of the unit shall have the ability to shut down one or two sides allowing for simpler corner installation.
d. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

4. Fan:

a. The fan shall be direct-drive turbo fan type with statically and dynamically balanced impeller with high and low fan speeds available.
b. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range from 0.06 to 0.12 HP.
c. The air flow rate shall be available in high and low settings.
d. The fan motor shall be thermally protected.

5. Filter:

a. The return air shall be filtered by means of a washable long-life filter with mildew proof resin.

6. Coil:

a. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
b. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
c. The coil shall be a 2 row evaporator coil completely factory tested.
d. A thermistor will be located on the liquid and gas line.

7. Electrical:

    a. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
    b. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
    c. Transmission (control) wiring between the indoor and remote controller shall be a maximum distance of 1,640 feet.

8. Control:

    a. The unit shall have controls provided to perform input functions necessary to operate the system.

E. Controls:

1. Provide intelligent touch controller to control entire system. Provide gateway to seamlessly interface with EMCS via BACnet MS/TP or IP.
2. Provide Simplified wired remote controller for each space. All room controllers to wire to intelligent touch controller which can be monitored at the OWS.

F. Manufacturers:

1. Carrier / Toshiba
2. Daikin
3. Mitsubishi
4. Sanyo.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which unitary air conditioning equipment is to be installed and notify affected Contractors and Architect in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in an acceptable manner.

1. When conditions are confirmed to be acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to Architect written confirmation. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable.

3.2 INSTALLATION

A. Install in strict accordance with manufacturer’s recommendations and as follows.

B. Provide all required supports, attachment devices, vibration isolators, gasketing, sealants, and accessories needed to insure stable, quiet, leak free operation.

C. Run insulated condensate drain line to approved point of indirect waste disposal. Pitch drain line continuously in direction of flow. If gravity drain is not possible, provide condensate removal pump as specified, piped to nearest approved point of indirect waste disposal.

3.3 FACTORY START UP AND FIELD QUALITY CONTROL

A. Provide authorized factory representative to start-up unit, check following items, and furnish report:

1. Measure and check voltage of components.
2. Check removal of shipping bracing.
3. Proper connection of drains.
4. Check control circuitry, operation, and performance during all modes of operation.
5. Fan check (RPM, motor amps, rotation, belt tension, etc.).
6. All wiring circuits including condensate pan safety switch and lockout.
7. All accessory equipment operation, such as filters, controls, condensate drain, etc.

END OF SECTION 23 62 13

SECTION 23 63 00 – REFRIGERANT CONDENSING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Remote air-cooled condensing units.

1.3 SYSTEM DESCRIPTION

A. Design Requirements

1. Remote Air-Cooled Condensing Unit: Arranged for vertical airflow with fan design condensers performing as specified. Factory assembled, leak tested, evaluated, and charged with replacement holding charge. Provides maximum allowable fan outlet velocities and coil face velocities indicated in Contract Documents.

1.4 SUBMITTALS

A. Comply with requirements of SECTION 01 33 00 - Submittals and as modified below.

B. Product Data: Provide manufacturer's specifications data for each unit, showing operating weight, all sizes, dimensions, capacity, operating and performance characteristics, motor horsepower, and other pertinent data. Include manufacturer's installation instructions.

1. Remote Air-cooled Condensing Unit: Indicate fan outlet velocities and coil face velocities.

C. Shop Drawings: Show on shop drawings equipment, piping connections, valves, strainers, thermostatic valves, and piping schematic required for complete system.

1. Include refrigerant piping diagram.

D. Contract Closeout Submittals: Comply with requirements of SECTION 01 77 00, including submission of operating and maintenance instructions as item in "Operating and Maintenance Data" manual described in that section.

1.5 WARRANTY

A. Manufacturer's Warranty: Standard 1-year warranty covering entire unit with 5-year parts-only warranty covering compressor and entire refrigerant circuit.

PART 2 - PRODUCTS

2.1 REMOTE AIR-COOLED CONDENSING UNIT (7.5 TO 20 TONS CAPACITY)

A. Unit Description: Self-contained, packaged, factory-assembled and pre-wired units suitable for outdoor use consisting of cabinet, compressor(s), condensing coil and fan(s), integral sub-cooling circuit(s), filter drier(s), and controls. Refrigerant shall be R410A. Refer to Drawings for capacities and performance ratings.

B. Unit Construction:

1. Casing: 18 gauge zinc-coated galvanized steel frame and panels with weather resistant, baked enamel finish.
2. Exterior surfaces bonded and coated with baked enamel finish by a powder paint process capable of withstanding a minimum of 750 salt spray hours according to ASTM B117.
3. Cabinet screws that comply with ASTM B117 salt spray test for a minimum of 750 hours.
4. Permanently attached heavy-gage perimeter base rails with forklift slots and lifting holes.
5. Removable access panels to all internal components.
6. Separate access panel to controls.

C. Condenser Coil:

1. Constructed of seamless copper tubes mechanically expanded into rippled aluminum fins for permanent metal-to-metal contact and provided with full depth fin collars completely covering copper tube.

2. Draw through configuration.

3. Copper tubes attached to headers with heavy wall fittings for maximum resistance to piping strain and vibration due to discharge gas pulsation.

D. Fan and Fan Motors:

1. Fans: Direct drive low speed propeller type with maximum rotating speed of 1200 rpm and diameter not exceeding 28 inches.

2. Fan Guards: Heavy-gauge, closed meshed, steel wire, zinc plated and iridite-dipped; contoured for maximum rigidity.

3. Fan Motors: Weatherproof motors suitable for outdoor use, with permanently lubricated totally enclosed vAHRIable speed motor, with ball beAHRIngs and built-in thermal overload protection.

E. Controls:

1. All 24-volt control circuit, powered by a 24 volt transformer(s) and protected by a resettable breaker.

2. Conventional thermostat must provide operation for both condensing units and heat pumps without an “O” output from the thermostat.

3. Low voltage terminal strip for simple hook-up.

4. Compressor motor protection shuts down unit for motor over-current, over-temperature or low voltage conditions.

5. Safety lockouts provide reset capability at the space thermostat or base unit should any of the following standard safety devices trip and shut off compressor:

    a. Loss-of-charge/Low-pressure switch.
    b. High-pressure switch.
    c. Control board diagnostics and fault message display.
    d. Safety lockouts send a 24 volt signal to the control board's "X" terminal, allowing notification to the user via the thermostat fault light (if present).

F. Low ambient operating package allowing starting and operation at temperatures down to 0 deg. F., located in weatherproof enclosure, and including:

1. High pressure cut out.
2. Low pressure cut out.
3. Variable speed fan control module with head pressure feedback.
4. Compressor overload relays.
5. Liquid line temperature sensors.
6. Internal compressor winding high temperature thermostat
7. High-pressure fusible plug.
8. Oil failure cut out.
9. Five-minute anti short-cycle timer.
10. Liquid line solenoid valve installed at evaporator coil.

G. Compressors:

1. Hermetic scroll type, internally protected with high pressure relief and over temperature protection.
2. Two stage units operate in 50% capacity increments.
3. Suction gas cooled.
4. Voltage range of ±10% of unit nameplate voltage.
5. Neoprene isolators minimize sound transmission and vibration.
6. Belly-band crankcase heaters keep refrigerant from diluting sump oil.
7. Full charge of compressor oil

H. Accessories - All units provided with:

1. Hot Gas Bypass

2. Filter dryer
3. Liquid line solenoid valve
4. Sight glass
5. Suction and liquid line refrigerant service valves
6. Neoprene vibration isolators per manufactures recommendations
7. Non-Fused disconnect switch.

I. 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. Design Manufacturer: York, JCI.

2. Specified equivalents:

a. Daiken or equal.
b. Lennox or equal.
c. Trane or equal.

2.2 REMOTE AIR-COOLED CONDENSING UNIT (MORE THAN 20 TONS CAPACITY)

A. Unit Description: Self-contained, packaged, factory-assembled and pre-wired units suitable for outdoor use consisting of cabinet, compressor(s), condensing coil and fan(s), integral sub-cooling circuit(s), filter drier(s), and controls. Refrigerant shall be R410A.

B. Casing: 18 gauge zinc-coated galvanized steel frame and panels with weather resistant, baked enamel finish.

C. Condenser Coil: Constructed of seamless copper tubes mechanically expanded into rippled aluminum fins for permanent metal-to-metal contact and provided with full depth fin collars completely covering copper tube.

1. Copper tubes attached to headers with heavy wall fittings for maximum resistance to piping strain and vibration due to discharge gas pulsation.
2. Coils have working pressure of 450-psig with one 450-psig relief device circuit field-installed.
3. Coils factory leak-tested, dehydrated, evacuated, and sealed with holding charge of nitrogen.

D. Refrigerant Circuits: Provide multiple independent circuits as scheduled.

E. Fan and Fan Motors:

1. Fans: Direct drive propeller type with maximum rotating speed of 1200 rpm and maximum fan diameter not exceeding 28 inches.
2. Fan Guards: Heavy-gauge, closed meshed, steel wire, zinc plated and iridite-dipped; contoured for maximum rigidity.
3. Fan Motors: Weatherproof motors suitable for outdoor use, with permanently lubricated totally enclosed motor, with ball beAHRIngs and built-in thermal overload protection.

F. Controls: Low ambient operating package allowing starting and operation at temperatures down to 0deg. F., located in weatherproof enclosure, and including:

1. High pressure cut out.
2. Low pressure cut out.
3. Compressor overload relays.
4. Variable speed fan control module with head pressure feedback.
5. Internal compressor winding high temperature thermostat
6. Liquid line temperature sensors.
7. High-pressure fusible plug.
8. Oil failure cut out.
9. Five-minute anti-recycle timer.
10. Liquid line solenoid valve installed at evaporator coil.

G. Compressors:

1. Scroll-Type Compressors: Industrial grade, energy-efficient direct-drive 3600 RPM maximum speed scroll type, with suction gas cooled hermetic design motor with capacity modulation to below 30% capacity via vAHRIable speed driven or Copelend digital scroll technology, centrifugal oil pump with dirt separator, oil sight glass, and oil charging valve. Solid-state temperature sensor embedded in motor windings to protect against excessive winding temperatures.

2. Provide compressor with automatic capacity reduction equipment consisting of suction valve un-loaders using electric solenoid actuated lifting mechanism operated by oil pressure and providing for unloaded compressor start.

3. Motor designed for “across the line” starting and suitable for voltage utilization range of +/- 10 percent from nameplate voltage.

H. Accessories - All units provided with:

1. Hot Gas Bypass
2. Low Ambient Control to 0 deg. F.
3. Filter dryer
4. Liquid line solenoid valve
5. Sight glass
6. Refrigerant service valves
7. Spring isolators per manufactures recommendations

I. 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. Design Manufacturer: York, JCI.

2. Specified equivalents:

a. Daiken or equal
b. Lennox or equal.
c. Reznor or equal.
d. Trane or equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which refrigerant condensing units are to be installed in coordination with Installer of materials and components specified in this Section and notify affected Prime Contractors and Architect in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in an acceptable manner.

1. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to Architect written confirmation from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.

3.2 INSTALLATION

A. Install Remote Air-Cooled Condensing Units in strict accordance with manufacturer's recommendations as required providing a complete and properly operable system, and as follows.

1. Install roof mounted condensing units on existing equipment support rails. Provide pipe penetration curb for refrigerant piping and electrical penetrations of roofing.

B. Provide all refrigerant piping as specified in section 23 23 00 – Refrigerant Piping, and as additionally recommended by condensing unit manufacturer.

C. Provide all required supports, attachment devices, vibration isolators, gasketing, sealants, and accessories needed to insure stable, quiet, leak free operation.

3.3 FACTORY START UP AND FIELD QUALITY CONTROL

A. Provide authorized factory representative to start-up unit, check following items, and furnish report:

1. Proper connection of all power and ground wiring.

2. Measure and check voltage of components.

3. All wiring circuits.

4. Check removal of shipping bracing.

5. Check control circuitry, operation, and performance during all modes of operation.

6. Fan check (RPM, motor amps, rotation, belt tension, etc.).

7. Check all refrigerant piping, refrigerant charge, operating temperatures and pressures, superheat, sub-cooling, condition and location of specialties including isolation valves, charging ports, dryers, filters, etc.

8. All accessory equipment operation, such as filters, controls, etc.

END OF SECTION 23 63 00

SECTION 23 72 00 - AIR-TO-AIR ENERGY RECOVERY EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Packaged, dedicated outdoor air energy recovery unit (DOAS)

1.3 PERFORMANCE REQUIREMENTS

A. No condensate shall form anywhere on or around the complete unit that is not controlled by condensate pans and directed to drain though condensate piping provided as a part of this Contract.

1.4 SUBMITTALS, GENERAL

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For air-to-air energy recovery equipment. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Wiring Diagrams: For power, signal, and control wiring.

1.6 CLOSEOUT SUBMITTALS

A. Field quality-control reports.

B. Operation and Maintenance Data: For air-to-air energy recovery equipment to include in maintenance manuals.

1.7 QUALITY ASSURANCE

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

B. AHRI Compliance:

1. Capacity ratings for air-to-air energy recovery equipment shall comply with AHRI 1060, "Performance Rating of Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment."

2. Capacity ratings for air coils shall comply with AHRI 410, "Forced-Circulation Air-Cooling and Air-Heating Coils."

C. ASHRAE Compliance:

1. Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
2. Capacity ratings for air-to-air energy recovery equipment shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat Exchangers."

D. NRCA Compliance: Roof curbs for roof-mounted equipment shall be constructed according to recommendations of NRCA.

E. UL Compliance:

1. Packaged heat recovery ventilators shall comply with requirements in UL 1812, "Ducted Heat Recovery Ventilators"; or UL 1815, "Nonducted Heat Recovery Ventilators."
2. ETL listed and wired according to the NEC with UL listed power components.

F. Unit shall comply with NFPA 90A requirements for flame spread and smoke generation, including the unit insulation.

G. Air flow data shall be in accordance with AMCA 210 testing method.

1.8 COORDINATION

A. Coordinate layout and installation of air-to-air energy recovery equipment with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of air-to-air energy recovery equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Packaged Energy Recovery Units: One year.
2. Warranty Period for Fixed-Plate Total Heat Exchangers: 10 years.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Acceptance at Site

1. Inspect the factory packaging before opening and note any damage on the packing slip. Unpack and inspect the unit before acceptance. Dents or scratches of the casing of the unit, or substantial damage to the packing materials that may indicate internal damage to the unit, shall be cause for rejection of the unit.

B. Storage and Protection

1. After acceptance on site, until such time as the unit is being actively installed, package the unit in protective materials and stored in a protected location so as to protect the function and appearance of the unit in the as accepted condition.

PART 2 - PRODUCTS

2.1 PACKAGED ENERGY RECOVERY UNIT

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. RenewAire
2. Airxchange Inc.
3. American Energy Exchange, Inc.
4. AAON

B. Casing:

1. Construction: 2 inch double wall with injected foam insulation.

2. Exterior Casing Material: Painted exterior casing shall be capable of withstanding at least 2500-Hrs with no visible corrosive effects when tested in a salt spray and fog atmosphere with ASTM B117-95 test procedure.

3. Interior Casing Material: Unpainted 20-gauge G90 galvanized steel.

4. Lifting and Handling Provisions: Factory-installed shipping skids and lifting lugs.

5. Base Rails: G90 galvanized steel rails for mounting on roof curb or pad as indicated.

6. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.

    a. Service Doors:

        1) Access doors to filters and cores shall be hinged and gasketed.
        2) All other access doors shall be removable type with door handles.
        3) Material and construction of doors shall match material and construction of cabinet in which doors are installed.

7. Roof of Rooftop Units: Standing seam; sloped to drain water.

8. Outdoor units shall be specifically designed for outdoor rooftop application with a fully weatherproof cabinet

9. Outdoor unit base shall overhang the roof curb for water run-off.

10. Floor: Reinforced, metal surface; reinforced to limit deflection when walked on by service personnel. Insulation shall be below metal walking surface.

11. Unit nameplates shall be fixed on the unit.

12. Cabinet Insulation:

    a. Type: Injected, expanding polyurethane foam systems with no global warming potential (GWP), no ozone depletion potential (ODP) and no volatile organic compounds (VOCs) as the expansion agent.

    b. Insulation Thickness: 2 inch.

    c. The R-value of the insulation shall be R6.5 for 1 inch of insulation and R-13 for 2 inches of insulation.

    d. Insulation Adhesive: Comply with ASTM C 916, Type I.

13. Condenstae Drain Pans:

    a. Shape: Rectangular, with one (1) percent slope in at least two planes to direct water toward drain connection.

    b. Size: Large enough to collect condensate from cooling coils including coil piping connections, coil headers, and return bends.

        1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
        2) Depth: 2 inches deep

    c. Material: Stainless-steel.

    d. Drain Connection:

        1) Located on one end of pan, at lowest point of pan.

2) Terminated with threaded nipple.
3) Minimum Connection Size: 3/4 inch NPS.

14. Surfaces in Contact with Airstream: Comply with requirements in ASHRAE 62.1 for resistance to mold and erosion.

15. Roof Curb: Unit manufacturers full-perimeter curb of sheet metal, minimum 14 inches high, with wood nailer, neoprene sealing strip, and welded Z-bar flashing.

a. Comply with requirements in 'The NRCA Roofing Manual'.
b. Curbs are to be knock down construction providing full perimeter support, cross structure support and air seal for the unit.
c. Curb shall be minimum of 12” high with 2” rigid insulation.

C. Supply and Exhaust Fans

1. Fan Type: Direct Drive Type

2. Variable Flow Type: Electronically Commutated Motors

3. Plenum Fan Type: Single width, non-overloading, with backward-curved motorized impellers, with airfoil blades.

a. Fan Wheel Material: Plastic attached directly to motor shaft. Impeller made of high-strength composite material ZAmid in ultramarine blue.
b. Fan Balance: Precision balance fan at G6.3 (6.3mm/sec) per ISO 1940-1.

4. Motors:

a. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors.
b. EC fan motor to have a IP54 rating.
c. Enclosure: Totally enclosed.
d. Motor Bearings: L10 lifetime rated bearing life and shall exceed 30,000 hours.
e. EC Motor Efficiency: Super premium efficient per NEMA Standard.
f. EC Motor Service Factor: 1.00.

D. Cooling Coils

1. Capacity Ratings: Coil rated in accordance with AHRI 410 - Standard for Forced-Circulation Air-Cooling and Air-Heating Coils
2. Coil Casing Material: Galvanized steel.
3. Tube Material: Copper.
4. Tube Header Material: Copper.
5. Fin Material: Aluminum.
6. Fin and Tube Joints: Mechanical bond.
7. Leak Test: Coils shall be leak tested with air underwater.
8. Refrigerant Coil Suction and Distributor Header Materials: Seamless copper tube with brazed joints.

9. Provide adequate clearance for accessing, cleaning, servicing and maintaining the coil per coil manufacturer's recommendation.
10. Ensure that the coil can be removed and replaced in the field with ease.

E. Hot Water Heating Coils

1. Capacity Ratings: Coil rated in accordance with AHRI 410 - Standard for Forced-Circulation Air-Cooling and Air-Heating Coils
2. Coil Casing Material: Galvanized steel.
3. Tube Material: Copper.
4. Tube Header Material: Copper.
5. Fin Material: Aluminum.
6. Fin and Tube Joints: Mechanical bond.
7. Leak Test: Coils shall be leak tested with air underwater.
8. Provide adequate clearance for accessing, cleaning, servicing and maintaining the coil per coil manufacturer's recommendation.

F. Outdoor Intake Hood:

1. Type: Downturned and louvered intake hood
2. Materials: Match cabinet.
3. Bird Screen: Comply with requirements in ASHRAE 62.1.
4. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.
5. Inlet velocity at the outdoor air intake screen to be less than 400 fpm.
6. Comply with Outdoor Air Hood requirements of ASHRAE 62.1
7. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Electrical Requirements for HVAC Equipment."

G. Filters:

1. 2 inches thick, MERV 13.

H. Electrical Power Connections:

1. Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices shall provide a single-point field power connection to unit.
2. The units shall have an electrical connection box to connect all high and low voltage connections. The electrical shall be constructed to permit single-point high voltage power supply connections.
3. DOAS unit shall be equipped with a Unit Disconnect Switch.
4. Power Interface: Field power interface shall be UL 508 listed, nonfused disconnect switch.
5. Factory Wiring: Branch power circuit to each motor and motor control with means for disconnecting.
6. Transformer: Factory mounted with integral circuit breaker and sized with enough capacity to operate electrical load plus spare capacity.
7. Controls: Factory wired unit-mounted microprocessor controls, sensors and sequences of operations.

I. Controls:

1. Control sequence of operation is indicated on the Control Drawings.

2. Control Wiring: Factory wire connection for controls' power supply.

3. Control Devices: Sensors, transmitters, relays, switches, detectors, operators, actuators, and valves shall be manufacturer's standard items to accomplish indicated control functions.

4. Unit-Mounted Controller Display:

   a. Cooling/Off/Heating Controls: Control operational mode.

   b. Damper Position: Indicate open/closed position of the outdoor-air damper.

   c. Status Lights:

      1) Filter dirty.
      2) Fan operating.
      3) Cooling operating.
      4) Heating operating.
      5) Fan alarm.
      6) General alarm.
      7) Drain pan overflow.

   d. Digital Numeric Display:

      1) Outdoor airflow.
      2) Exhaust airflow.
      3) Outdoor dry-bulb temperature.
      4) Outdoor humidity.
      5) Exhaust temperature.
      6) Supply temperature.
      7) Space temperature.
      8) Return air temperature.
      9) Return air humidity.

5. Control Dampers:

   a. Damper Location: OA and EA dampers are factory installed and wired on the outside of the unit.

   b. Damper Leakage: The dampers for outside air and exhaust air to be low leak galvanized steel dampers for the commercial heating and air conditioning industry that meet most energy codes including California's Title 24, IECC 2015, and ASHRAE 90.1 requirements. The dampers to leak less than 4 cfm/sq. ft. at 1" w.c. (static pressure), and are AMCA licensed as a Class 1A damper at 1" w.c.

   c. Damper Rating: AMCA Class 1A rated dampers.

d. Damper Label: Bear the AMCA seal for both air leakage and performance.

e. Blade Configuration: Unless otherwise indicated, use parallel blade configuration for two-position control and equipment isolation service. For other applications, use an opposed-blade configuration.

f. Damper Frame Material: galvanized steel.

g. Blade Type: Non-insulated, single-thickness metal reinforced with multiple V-grooves or hollow-shaped airfoil.

h. Blade Material: Galvanized steel.

i. Blade Seals: Replaceable, continuous perimeter vinyl seals and jambs with stainless-steel compression-type seals.

6. Damper Actuators:

a. Factory-installed electric actuator for each damper assembly with one actuator for each damper assembly mounted to the damper frame.

b. Actuator capable of shutoff against fan pressure and able to operate the damper with sufficient reserve power to achieve smooth modulating action and proper speed of response at the velocity and pressure conditions to which the damper is subjected.

c. Maximum Operating Time: Open or close damper 90 degrees in 60 seconds.

d. Adjustable Stops: For both maximum and minimum positions.

e. Spring-return actuator to fail-safe; either closed or open as required by application.

f. Actuator Type: Direct coupled, designed for minimum 60,000 full-stroke cycles at rated torque.

g. Position feedback Signal: For remote monitoring of damper position.

h. Coupling: V-bolt and V-shaped, toothed cradle.

i. Circuitry: Electronic overload or digital rotation-sensing circuitry.

7. Refrigeration System Controls:

a. Unit-mounted enthalpy controller shall lock out refrigerant system when outdoor-air enthalpy is less than 28 Btu/lb of dry air or outdoor-air temperature is less than 60 deg F.

8. BMS Interface:

a. BACnet Factory Activation: Factory programmed and tested BACnet activation on the microprocessor controller that allows for communication to a BAS via BACnet.

b. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display unit status and alarms.

1) Hardwired Points:

a) Monitoring: On-off status, common trouble alarm.

b) Control: On-off operation, space temperature set-point adjustment, supply temperature set-point adjustment, space humidity set-point adjustment, space pressure set-point adjustment.

2) ASHRAE 135 (BACnet) communication interface with the BAS shall enable the BAS operator to remotely control and monitor the unit from an operator workstation. Control features and monitoring points displayed locally at unit control panel shall be available through the BAS.

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-to-air energy recovery equipment installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for electrical services to verify actual locations of connections before installation.

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

E. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

3.2 INSTALLATION

A. Install fixed-plate heat exchangers so supply and exhaust airstreams flow in opposite directions.

1. Install duct access doors in both supply and exhaust ducts, both upstream and downstream, for access to heat exchanger. Access doors and panels are specified in Division 23 Section "Air Duct Accessories."

B. Roof Curb: Install air-to-air energy recovery equipment on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 07 Section "Roof Accessories." Secure air-to-air energy recovery equipment to upper curb rail, and secure curb base to roof framing.

C. Install units with clearances for service and maintenance.

D. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

E. Pipe drains from units and drain pans to nearest roof drain; use same size as condensate drain connection, minimum ¾".

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Division 23 Section "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to unit to allow service and maintenance.

C. Connect piping to units mounted on vibration isolators with flexible connectors.

D. Connect cooling condensate drain pans with air seal trap at connection to drain pan and install cleanouts at changes in pipe direction.

E. Electrical Connections: Comply with applicable requirements in Division 26 Sections.

1. Install electrical devices furnished with units but not factory mounted.

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. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Adjust seals and purge.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Set initial temperature and humidity set points.
5. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

D. Air-to-air energy recovery equipment will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-to-air energy recovery units.

END OF SECTION 23 72 00

SECTION 23 73 13 - MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Multi-zone Air Handling Units.
2. Indoor Gas-Fired Makeup Air Unit

1.3 SUBMITTALS, GENERAL

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

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.

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. Source quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Field quality-control reports.
B. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
C. AHRI Certification: Air-handling units and their components shall be factory tested according to AHRI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by AHRI.
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.
G. Comply with American Gas Association Standards for gas fired equipment.

1.8 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 MULTI-ZONE AIR HANDLING UNITS

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. Annexaire
2. Custom Air Handling and Heat Transfer Package Solutions, CAHS.
3. Thybar

B. Unit Casing:

1. General Fabrication Requirements for Casings:

2. The unit housing shall be no-through metal with 2'' Composite and foam panel construction - interior and exterior. or an all-aluminum 4" Foam thermal break construction - interior and exterior. Thermal break construction using a gasket to insulate two panels is not an acceptable equivalent to a no-through metal constructed casing. No-through metal construction will be inherent to all the component construction in the assembly.

3. The unit housing shall be constructed from a frame, base and panel assembly. Unit shall be completely factory assembled and shipped in one piece as shown on drawings.

4. Base structure shall be fully welded G-90, painted exterior, and have integral lifting lugs which can be removed once the unit is installed.

5. The frame shall consist of anodized extruded aluminum profiles which incorporates a thermally broken construction; welded together for reinforcement and insulated for superior thermal performance.

6. All panels and access doors shall be double wall construction with R14 foam insulation for every 2" of construction. Any insulation incorporating CFCs or HCFCs in its construction is strictly prohibited from this application.

7. Composite or aluminum panels shall be provided for the entire unit construction, including but not limited to, walls, doors, floors, roof, interior partitions, and electrical compartment. Panels shall be non-load bearing type.

8. Unit casing will have no exterior condensation at interior AHU temperatures down to 42.5F while unit exterior conditions are maintained at 95 F dry bulb / 85 F wet bulb. The air handling unit manufacturer shall submit a copy of the test report demonstrating the general construction of the unit housing thermal performance. The test shall include placing the housing panels in a climate chamber and exposing the unit to the conditions mentioned previously. If the manufacturer does not have access to a Climate Chamber such equipment, an independent testing agent must be hired to transport the test unit to a qualified test facility and perform the test at the expense of the manufacturer. Inability to provide this option to the engineer will make the manufacturer ineligible to bid on this project.

9. The panels shall be tested in accordance with SMACNA and ASHRAE 111 to have a deflection of no more than L/1150 at 10'' (Exceeding AHRI casing deflection rating class CD1) and 1% leakage rate at 8" pressure and meet AHRI 1350 Casing Air Leakage rating Class 6.

10. Fire resistance of the panel will be in compliance with UL 94 rated at 5VA; and a flame spread / smoke development in compliance with UL 723 ASTM E84 Class 1 rating.

11. Access doors shall be provided to all major components to facilitate quick and easy access. Access doors will be made from the same material as the unit casing and shall incorporate thermal break construction. Fan access door(s) shall have premium type handles, with one handle interlinking multiple latches and threaded insert fastening handles for all remaining doors. If access doors do not open against unit operating pressure, provide safety latches that allow access doors to partially open after first handle movement and fully open after second handle movement. Hinges shall be Nylon hinge type designed to open 180 degrees. Removable panels provided for equipment pull out for coil.

C. Plug Fans

1. Direct driven plenum fans shall be installed with perimeter gasketed isolation.

2. Fans shall be direct drive radial centrifugal fans with free running impeller. Fans shall be compact, optimized and construction made of galvanized sheet steel with backward curved 7-blade high efficiency impeller, protected by an epoxy powder coating.

3. To reduce vibration, the impeller shall be balanced with hub to an admissible vibration severity of less than 2.8 mm/s in conformity with DIN ISO 14694 and proof shall be supplied for each individual impeller. Tests shall be made according to DIN ISO 1940 Part 1, quality of balancing G2.5/6.3.

4. The single inlet shall be mounted onto constant speed direct drive motor, equipped with an air flow optimized inlet cone from epoxy coated galvanized sheet steel.

5. Fans shall be completely certified as per ISO 5801 and in accordance to AMCA standards.

D. Dampers

1. Dampers shall be low leak type (Leakage Class 1A at 1 in. w.g. (0.25 kPa) static pressure differential).

2. Blades are maximum 6” deep extruded aluminum air-foil profiles. All blades are symmetrically pivoted. Galvanized dampers will not be acceptable.

3. Blade seals are extruded EPDM. Frame seals are extruded silicone. Seals are secured in an integral slot within the aluminum extrusions. Blade and frame seals are mechanically fastened to prevent shrinkage and movement over the life of the damper.

4. Face and bypass dampers shall be opposed blade type and installed in the compartments (as shown on the drawings) with linkage rod for actuators, unless otherwise noted.

5. Actuators shall be 24V, modulating, field installed.

E. Coils

1. Coils shall be factory installed in the unit.

2. Primary surface shall be round seamless 5/8" O.D. copper tube staggered in the direction of airflow. Secondary surface shall consist of rippled aluminum plate fins for higher capacity and structural strength. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates.

3. Coils shall be circuited for counter-flow heat transfer to provide maximum mean effective temperature difference for maximum heat transfer rates.

4. Headers shall have intruded tube holes to provide a large brazing surface for maximum strength and inherent flexibility.

5. Casing shall be constructed of continuous galvanized steel.

6. The complete coil shall be tested with 315 pounds air pressure under warm water and be suitable for operation at 250 psig working pressures. Maximum finned coil height shall be 60" and shall not exceed 500 FPM face velocity.

F. Electrical

1. The power and control center shall be integral to the unit housing and rated equivalent to NEMA 1.

2. All components shall be factory wired for single point power connection by the manufacturer of the unit. A non-fused safety disconnect switch shall be factory installed for ON/OFF servicing.

3. All electrical components contained in the internal panel shall be UL/CSA certified and labeled. The unit shall be complete with fuses, relays, terminals for main ON/OFF and step-down transformer.

4. An electrical pipe chase for power and control feeding shall be provided next to the control panel.

5. Each panel should have a separate access door with an approved locking device.

G. Filters

1. Pre-filter position, high capacity series MERV 13.

2. Media shall be 100% synthetic, mechanical media that does not support microbial growth.

3. Frame shall be a heavy duty, high strength, moisture resistant paperboard with a cross member design that increases filter rigidity and prevents breaching. Frame shall be recyclable.

4. Filters shall have an expanded metal support grid bonded to the air-exiting side of the filter to maintain pleat uniformity and prevent fluttering. Metal support grid shall be recyclable.

H. Control Package

1. The unit shall be delivered with factory installed control system. Under no circumstances shall control be provided by other than the manufacturer of the equipment. Field installed control package by the ATC will not be acceptable.

2. The control system shall consist of a microprocessor with 8-lines and 22-charaters built-in LCD display, allowing for full monitoring of all the unit equipment. Six push buttons allow for menu navigation and settings modification as required. Remote access ports also allow for potential program upgrade, operation log download and unit monitoring.

3. Refer to the Sequence of Operation and control schematic for detailed description of control logic and options.

4. Communication Interface Card: The microprocessor shall be capable of communicating with the following protocol language: BACnet MS/TP RS-485.

2.2 INDOOR GAS-FIRED MAKEUP AIR HANDLING UNIT

A. General:

1. Provide a packaged heating and make-up air unit with built-in power vent, separated combustion, 80% thermal efficiency gas furnace with fan, filters, control interface and suitable for suspension mounting.

2. Unit shall be design certified to ANSI and CSA standards.

B. Cabinet:

1. Single-wall blower and furnace cabinet arranged for make-up air application.
2. Unit shall be configured for rear outdoor air inlet and front outlet.
3. Unit shall include 100% outdoor air, 2-position damper.

C. Blower:

1. Unit shall include a centrifugal blower and filter rack with MERV13 pleated filters.
2. Motors shall be open-drip proof, and adjustable V-belt drive blower and meet EISA specifications for efficiency with factory mounted VSD controllable via EMCS.

D. Burner/Heating Controls

1. Unit shall be equipped for natural gas.
2. Burner shall be fully modulating.
3. Heat exchanger, burner and drip pan shall be constructed of 409 stainless steel.
4. Unit shall be equipped with 200 deg. F. firestat, discharge air low limit, and airflow proving switch.

E. Design basis: Reznor SSCBL series or engineer approved equal.

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 hydronic piping systems and electrical services to verify actual locations of connections before installation.
D. Proceed with installation only after unsatisfactory conditions have been corrected.
E. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

3.2 INSTALLATION

A. Arrange installation of units to provide access space around air-handling units for service and maintenance.

B. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

C. 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 Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air-handling unit to allow service and maintenance.

C. Hot-Water Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

D. Connect duct to air-handling units with flexible connections. Comply with requirements in Division 23 Section "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 and steam 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. 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 zone face and bypass dampers fully open and close for each zone.

6. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.

7. Comb coil fins for parallel orientation.

8. Verify that proper thermal-overload protection is installed for electric coils.

9. Install new, clean filters.

10. 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 linkages for proper damper operation.
B. Comply with requirements in Division 23 Section "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 AND TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

B. Training of the Owner’s operation and maintenance personnel is required in cooperation with the Commissioning Authority. Provide competent, factory-authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Commissioning Authority after submission and approval of formal training plans.

END OF SECTION 23 73 13

SECTION 23 74 00 - PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units). with the following components and accessories:

1. Direct-expansion cooling.
2. Economizer outdoor- and return-air damper section.

1.3 DEFINITIONS

A. DDC: Direct-digital controls.

B. ECM: Electrically commutated motor.

C. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

D. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

E. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

F. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

G. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

1.4 SUBMITTALS, GENERAL

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.5 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, 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.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.
B. Warranty: Executed special warranty specified in this Section.

1.7 QUALITY ASSURANCE

A. AHRI Compliance:

1. Comply with AHRI 210/240 and AHRI 340/360 for testing and rating energy efficiencies for RTUs.
2. Comply with AHRI 270 for testing and rating sound performance for RTUs.

B. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigeration system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
3. Comply with 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."

D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

E. UL Compliance: Comply with UL 1995.

F. 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. AAON, Inc.
2. Trane; American Standard Companies, Inc.
3. McQuay

2.2 CASING

A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.

1. Exterior Casing Thickness: 0.079 inch thick.

C. Inner Casing Fabrication Requirements:

1. Inside Casing: Galvanized steel, 0.028 inch thick.

D. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

1. Materials: ASTM C 1071, Type I.
2. Thickness: 1 inch.
3. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
4. Liner Adhesive: Comply with ASTM C 916, Type I.

E. Condensate Drain Pans: Formed sections of stainless-steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.1.

1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
2. Drain Connections: Threaded nipple.
3. Pan-Top Surface Coating: Corrosion-resistant compound.

F. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.3 FANS

A. Size / design for mid-life filter resistance equal to the average of the as specified clean filter resistance at the design flowrate and the filter manufacturer's recommended maximum (in need of changing) filter resistance at the design flow rate.

B. Belt-Driven Supply-Air Fans: Double width, forward curved or backward inclined, centrifugal; with permanently lubricated, motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

C. Exhaust fan shall be direct driven propeller type fan.

D. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.

E. Fan Motor: Comply with requirements in Division 23 Section "Common Electrical Requirements for HVAC Equipment."

2.4 COILS

A. Supply-Air Refrigerant Coil:

1. Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
3. Coil Split: Interlaced.
4. Condensate Drain Pan: Stainless steel formed with pitch and drain connections complying with ASHRAE 62.1.

B. Outdoor-Air Refrigerant Coil:

1. Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.

2.5 REFRIGERANT CIRCUIT COMPONENTS

A. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief.

B. Refrigeration Specialties:

1. Refrigerant: R-410A.
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant filter/dryer.
4. Manual-reset high-pressure safety switch.
5. Automatic-reset low-pressure safety switch.
6. Minimum off-time relay.
7. Automatic-reset compressor motor thermal overload.

8. Brass service valves installed in compressor suction and liquid lines.
9. Low-ambient kit high-pressure sensor.
10. Four-way reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.

2.6 AIR FILTRATION

A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Pleated: Minimum MERV 13

2.7 DAMPERS

A. Outdoor-Air Damper: Linked damper blades, for 0 to 100 percent outdoor air, with motorized damper filter.

B. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

1. Damper Motor: Modulating with adjustable minimum position.
2. Exhaust-Air Damper: Motorized, as required by ASHRAE/IESNA 90.1, with bird screen and hood.

2.8 ELECTRICAL POWER CONNECTION

A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.9 CONTROLS

A. Control equipment and sequence of operation are specified in Division 23 Section "Instrumentation and Control for HVAC" and on drawings.

2.10 ACCESSORIES

A. Low-ambient kit using condenser fans for operation down to 35 deg F.
B. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.
B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.
C. Examine existing roof support dunnage for suitable conditions where RTUs will be installed.
D. Proceed with installation only after unsatisfactory conditions have been corrected.
E. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

3.2 INSTALLATION

A. Unit Support: Install unit level on existing structural dunnage. Coordinate wall penetrations and flashing with wall construction.

3.3 CONNECTIONS

A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.
B. Install piping adjacent to RTUs to allow service and maintenance.
C. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts.

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. Report results in writing.

B. Perform tests and inspections and prepare test reports.

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. Report results in writing.

C. Tests and Inspections:

1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
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. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Inspect for visible damage to unit casing.

2. Inspect for visible damage to furnace combustion chamber.

3. Inspect for visible damage to compressor, coils, and fans.

4. Inspect internal insulation.

5. Verify that labels are clearly visible.

6. Verify that clearances have been provided for servicing.

7. Verify that controls are connected and operable.

8. Verify that filters are installed.

9. Clean condenser coil and inspect for construction debris.

10. Inspect operation of exhaust dampers.

11. Verify lubrication on fan and motor bearings.

12. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.

13. Start unit according to manufacturer's written instructions.

    a. Start refrigeration system.
    b. Do not operate below recommended low-ambient temperature.
    c. Complete startup sheets and attach copy with Contractor's startup report.

14. Inspect and record performance of interlocks and protective devices; verify sequences.

15. Operate unit for an initial period as recommended or required by manufacturer.

3.6 CLEANING AND ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions.

B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 23 74 00

SECTION 23 82 00 – TERMINAL HEATING AND COOLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following types of Terminal Heating and Cooling Equipment, associated accessories, and their installation:

1. Unit Ventilators (UV),
2. Fin Tube Radiation (FTR),
3. Unit Heaters (UH),
4. Air Coils (CC)

1.3 SUBMITTALS, GENERAL

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.4 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for each unit type and configuration.

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. Plans, elevations, sections, and details.
2. Details of anchorages and attachments to structure and to supported equipment.
3. Wiring Diagrams: Power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

B. Operation and Maintenance Data: For unit ventilators, fin tube radiation, unit heaters, and air coils to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

C. Warranty: Executed special warranty specified in this Section.

1.6 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. Comply with NFPA 70.

1.7 EXTRA MATERIALS

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. Unit Ventilator Filters: Furnish 3 spare filter(s) for each filter installed.

PART 2 - PRODUCTS

2.1 UNIT VENTILATORS

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

1. Carrier Corporation.
2. Daikin.
3. Trane.

B. Description: Factory-packaged and -tested units rated according to AHRI 840, ASHRAE 33, and UL 1995, including finished cabinet, dampers, filter, heating and cooling coil, drain pan, supply-air fan and motor in draw-through or blow-through configuration.

C. Provide Unit Ventilators constructed to operate quietly in an exposed classroom environment. Cabinet construction, fan speed and quality, and system insulation shall all combine to create units that operate with sound levels that do not exceed those shown below.

Unit Size	**Motor Speed**	**SOUND POWER DATA (db re: 10^{-12} watts)**						
Octave Band:		*2*	*3*	*4*	*5*	*6*	*7*	*8*
Center Frequency:		*125*	*250*	*500*	*1000*	*2000*	*4000*	*8000*
a. 750	High	57.4	51.8	52.5	52.6	51.2	46.9	35.2
b. 750	Medium	50.1	44.9	45.6	44.8	42.8	34.2	19.9
c. 750	Low	45.6	40.4	40.8	39.1	35.7	24.4	12.0
d. 1000	High	57.0	52.8	53.9	53.7	51.5	46.8	35.9
e. 1000	Medium	52.9	48.6	50.2	49.6	46.5	40.1	27.9
f. 1000	Low	49.4	45.4	47.0	45.5	42.0	33.6	20.7
g. 1250	High	62.4	55.2	55.7	55.3	54.4	49.7	38.5
h. 1250	Medium	59.3	52.1	52.5	51.7	50.4	44.0	31.8
i. 1250	Low	55.6	48.6	49.1	47.2	45.6	37.1	24.0

j. 1500	High	63.8	56.6	58.0	58.2	56.4	52.4	41.9
k. 1500	Medium	58.4	51.3	52.7	52.4	49.5	43.5	30.5
l. 1500	Low	54.8	47.6	49.4	47.5	44.2	36.2	21.5

D. Cabinets

1. Frames: jig welded of heavy gauge steel to insure proper durability, dimensions, and squareness.

2. Finish: sheet metal parts of G-90 galvanized steel to inhibit corrosion, exterior cabinet panels fabricated from 16-ga. Furniture grade galvanized steel, cleaned and phosphatized before applying a baked on polyester powder coat enamel finish. Finish color to be selected by Architect from manufacturer's standard colors.

3. Insulation: Minimum 1-inch thick, matte-finish, closed-cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.

   a. 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.

   b. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in NFPA 90.1 and ASHRAE 62.1.

4. Service Access:

   a. Opening or removing the unit front control and service panels shall not affect unit operation, allowing controls and damper linkage adjustments while the unit is running.

   b. Provide hex-head fasteners designed for repeated use to secure all removable panels.

E. Floor Units:

1. Provide with three separate removable front panels configured so that it is not necessary to remove the entire unit front cover or disturb the airflow to gain access to the service and control compartments.

2. Provide an integral closed rear pipe tunnel for convenient crossover of piping or electrical wiring in accordance with NEC.

3. Provide with supply discharge grille of continuous round edged steel bars with 10 to 15 degree vertical deflection and adjustable side deflection vanes beneath the discharge grille.

4. Return-Air Inlet: Front toe space where shown with no casework, draft stop deflector panel with rear side panel openings where shown with abutting casework or draft stop enclosure, or as otherwise scheduled.

5. End Panels: Provide where units are shown without UV manufacturer’s new abutting casework, in material and finish matching unit ventilator.

a. Provide formed steel end panels nominally 1” deep where no connecting casework obstructs side access, and where UVs are shown with new abutting millwork casework.

6. Provide leveling legs to compensate for uneven floor surfaces.

7. Provide adaptor back units (21-7/8") consisting of standard depth unit plus approximately five inch deep insulated false back outside air intake plenum wherever manufacturer’s standard size OA intake opening in general construction is not directly aligned with unit OA intake and unless standard depth units are specifically called for.

   a. Provide insulation on the rear of the basic unit same as the standard depth unit.

   b. Include full back panel with field cut flanged opening to match wall opening.

   c. Provide dual closed cell foam gasket at rear of the adaptor back as required to provide air tight seal round the wall opening and the unit perimeter when the unit is lagged to the wall.

   d. Insulation:

      1) Provide R-6 minimum, matte-finish closed-cell foam insulation, complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916. Insulate outside air duct on bottom, side, and top walls of adapter back and pipe tunnel as thermal break between outside air intake plenum and occupied space / return air / pipe space.

      2) Fire-Hazard Classification: Insulation and adhesive combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.

      3) Surfaces in contact with the airstream: Comply with requirements in ASHRAE 62.1.

   e. Provide with 2” step-down height to match lower window sill height as required. VIF.

8. Furnish color chart for selection by the Architect.

F. Coils:

1. Test and rate unit ventilator coils according to ASHRAE 33.

2. Provide hydronic coils of self-venting design with rows as required by scheduled capacity rated for a minimum working pressure of 200 psig at no less than 220 deg F. Elements of not less than 3/8" seamless copper tubes and return bends on staggered centers in the direction of air flow. Fins of continuous plate aluminum mechanically bonded to all tubes no closer than 0.1 inch. Provide with 7/8" silver brazed copper headers with minimum 4 pass serpentine design and NPT threaded connections as required to achieve a water pressure drop no greater than scheduled. Provide threaded drain plug at low point, and manual air vent at coil high point.

G. Dampers

1. Provide with separate room air, outdoor air, and coil face and bypass air dampers.

    a. Damper shaft extends through bearings to service compartment designed to accept electronic damper actuator.
    b. Bearings of high-performance polymer similar to delrin which does not require lubrication.
    c. Seals along edges of formed damper blade material fitted into channel with blended silicone rubber and mohair impregnated glass cloth, with mohair seals along all ends.

2. Room air damper: constructed of aluminum, counterbalanced against back pressure to close by wind pressure, thereby positively preventing outdoor air from blowing directly into the room.

3. Outdoor air damper: two-piece double wall torsionally rigid box beam construction with 1/2" thick, 1.5pcf density fiberglass sandwiched between welded 20-ga. galvanized steel blades. Provide additional closed cell foam insulation adhered to the interior and exterior of the outside air dampers and all other surfaces of the outside air chamber, minimum R value of 4.

4. Face and bypass damper: double wall torsionally rigid box beam aluminum construction with a dead air space.

5. Comply with ASHRAE/IESNA 90.1.

H. Indoor Fan and Motor Assembly

1. Direct drive multiple fan and motor assembly constructed to assure quiet, uniform air distribution, guaranteed to deliver the unit’s nominal advertised cfm at high speed.

2. All components of the fan/motor assembly including the motor mounting platform mounted on a chassis removable as a single subassembly from the front of the unit.

3. Fans wheels statically and dynamically balanced, constructed of welded galvanized steel or dark, high density, injection molded fiber reinforced polypropylene having high impact strength, chemical resistance and thermal stability. Fan housings constructed of welded galvanized steel, with deep spun bell-mouth entries.

4. Single full length large diameter hollow steel shaft on resiliently mounted precision shaft end sleeve type beAHRIngs. BeAHRIngs require oiling no more than annually, located outside of the moving air stream with no intermediate beAHRIngs allowed.

5. Motors designed specifically for extra quiet unit ventilator operation, 115 volts, single phase 60 Hz unless otherwise scheduled.

a. Automatic speed control motors: electronically commutated motor (ECM) as manufactured by General Electric. Motor shall be of permanent magnet, brushless DC premium efficiency design with vAHRIable speed electronic controller capable of maintaining constant speed, torque, and/or cfm as required by service, capable of accepting 0-10vdc or 4-20mA speed control signal from building management system. Adjustable slow start and gradual speed changes, permanently lubricated ball beAHRIngs, and extra quiet operation are all included.

I. Unit Electrical and Controls

1. Provide unit mounted integral disconnect and control boxes with ample room for installing and servicing controllers, control circuit fusing, room air fan speed terminal contacts for ECM motor control by DDC control system, speed selector switch as applicable, freeze-stat switch body, transformers, and fused 120vac duplex outlet. Arrange all electrical components for ease of serviceability.

2. Provide fan motor (as necessary) and controls voltage power transformers.

3. Additional control devices and operational sequences are specified in Division 23 Section "Instrumentation and Control for HVAC" and on the drawings.

J. Accessories

1. Filters: Minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

a. 1 inch thick mini-pleated cotton-polyester media MERV 13 filters have a rating based on ASHRAE Standard 52.2.

2.2 HOT-WATER BASEBOARD RADIATORS

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. Trane.
2. Slant/Fin.
3. Sterling Hydronics, a Mestek company.

B. Performance Ratings: Rate baseboard radiators according to Hydronics Institute's "I=B=R Testing and Rating Standard for Baseboard Radiation."
1. Refer to Finned Tube Radiation Schedule for performance.

C. Heating Elements: Copper tubing mechanically expanded into flanged collars of evenly spaced aluminum fins resting on polypropylene element glides. One end of tube shall be belled.

D. Enclosures: Minimum 18 gauge steel, removable front cover, minimum 20 gauge full back panel, wall and unit end caps and access door at valve locations.

E. Color: As selected by Architect.

2.3 GAS FIRED UNIT HEATERS

A. Description: Minimum 82%, high efficiency, separated-combustion, power vented, gas fired unit heater.

B. Fuel: Natural gas.

C. Heat exchanger: multi-cell, 4 pass serpentine style stainless steel. Heat exchanger tubes shall be press fabricated 409 stainless steel. All heat exchangers shall be fabricated with no welding or brazing. All heat exchanger cells shall be designed with an aerodynamic cross section to provide maximum airflow.

D. Burner: The units shall incorporate a single, one piece burner assembly with a single orifice. The burner shall have a continuous wound close pressed stainless steel ribbon separating the flame from the burner interior. All units shall have a single venturi tube and orifice supplying fuel to a one-piece burner housing. Each heat exchanger cell shall use balanced draft induction to maintain optimum flame control.

E. Controls shall include a two-stage gas valve; direct spark multi-try ignition with electronic flame supervision with timed lockout integrally controlled via a printed circuit control board. The control board shall also incorporate diagnostic lights, DIP switches for fan overrun settings, and a relay for fan only operation. All units shall be equipped with a safety limit switch. All controls shall be enclosed in the sealed control compartment to protect them from accidental damage, dust, and atmospheric corrosion.

F. Combination Venting and Intake: The unit shall have a factory-installed power venter device to draw combustion air from outside of the building. The outside air shall enter the unit through a factory-installed round inlet air terminal on the rear of the heater. The control compartment shall be sealed and the access door shall be gasketed to prevent dirt, lint, dust, or other contaminants present in the heated space from entering the unit. The control compartment door shall be equipped with a safety interlock switch to prevent operation when the door is open. The combustion air supply pipe and flue exhaust pipe shall be run in parallel from the heater to a factory supplied concentric adapter assembly, which allows for a single wall or roof penetration, to the vertical air inlet and vent terminal. The combustion air/venting system shall include a vibration isolated power venter motor and wheel assembly and a combustion air pressure switch. Unit Sizes 30-125 shall include a flame rollout switch.

G. Electrical: Operation shall be controlled by an integrated circuit board that includes LED diagnostic indicator lights. Supply voltage connections shall be made in a sealed junction box. 24-volt control connections shall be made on an externally mounted terminal strip with connections (W1, W2, R, and G). All internal wiring, both line and control voltages, shall be terminated by insulated terminal connectors to minimize shock hazard during service. Each unit shall be equipped for use with 115/1 volt power supply.

1. Provide unit with built-in disconnect switch.

H. Construction:

1. The cabinet shall be low profile with a pre-coat or powdercoat RAL 1001 white paint finish. Finish shall be a minimum 80 gloss on G30 galvanized steel.

2. The cabinet shall be constructed so that screws are not visible from the bottom, front, or sides, except for service panel and accessories. Unit construction shall incorporate a beveled front corner on control side for additional cabinet rigidity.

3. All units shall be manufactured with a tooled drawn supply air orifice on the rear panel to reduce fan inlet noise.

4. The unit shall be designed for suspension featuring 3/8”-16 female threads (hanger kits for 1” pipe) at both 2-point and 4-point locations with no additional adapter kits.

5. The cabinet shall be equipped with roll-formed horizontal louvers. Louvers shall be spring held and adjustable for directing airflow.

6. The cabinet shall be equipped with a full safety fan guard with no more than ½ inch grill spacing.

7. The motor and fan assembly shall be resiliently mounted to the cabinet to reduce vibration and noise. The unit shall be designed with a full opening service access panel complete with screw closure attachment and lifting handle for removal. Service panel shall be fully gasketed and equipped with a safety interlock switch.

8. All components in the gas train, all standard electrical controls, and the power venter shall be within the sealed service compartment.

    a. Minimum top clearance from combustibles shall be 1”.
    b. Minimum bottom clearance from combustibles shall be 1”.

2.4 ELECTRIC UNIT HEATERS

A. Construction:

1. 18 and 20 gauge steel.
2. Adjustable louvers to direct air flow.
3. High-limit temperature control with automatic reset.
4. Epoxy/polyester powder paint finish.

B. Fan:

1. Motor mounted in cold compartment.
2. Thermally protected.
3. Totally enclosed and factory lubricated ball beAHRIng motor.

C. Heating Element:

1. Stainless steel, tubular element.

D. Control:

1. Factory built-in thermostat.
2. Factory mounted disconnect switch.

2.5 COOLING COILS FOR AIR SYSTEMS

A. General:

1. Size: For face velocity and maximum pressure drops scheduled. If not scheduled, size to provide maximum of 500 fpm face velocity for cooling coils, or higher only if restricted by maximum coil size that can fit within existing units.

2. All coils to be computer optimized as to size and arrangement to meet requirements listed on drawings. Include computer selection sheets in submittal.

3. Certified in accordance with AHRI Standard 410.

B. Refrigerant Coils

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. Aerofin Corporation.
   b. Carrier Corporation.
   c. Coil Company, LLC.
   d. Heatcraft Refrigeration Products LLC; Heat Transfer Division.
   e. Lennox Industries Inc.
   f. Trane.
   g. USA Coil & Air.

2. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.

3. Minimum Working-Pressure Rating: 300 psig.

4. Source Quality Control: Factory tested to 450 psig.

5. Tubes: ASTM B 743 copper, minimum 0.016” thick.

6. Fins: Aluminum, minimum 0.010 inch thick.

7. Suction and Distributor Piping: ASTM B 88, Type L copper tube with brazed joints.

   a. Suction and liquid tubing from outdoor condensing unit to coil to be sized by equipment manufacturer.
   b. Provide 2 distributors and split coil circuits as recommended by equipment manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive equipment 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 unit installation.

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

D. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

E. Examine existing units to receive replacement refrigerant coils. Equipment schedules are intended as a general guide for performance characteristics. Field verify existing coil sizes to ensure proper installation in existing air handling equipment.

3.2 INSTALLATION

A. Install equipment in compliance with NFPA 90A.

B. Install equipment level and plumb.

C. Suspend motorized equipment from structure with threaded steel rods and minimum 1.0-inch static-deflection spring hangers.

D. Refer to Section 23 63 00 "Refrigerant Condensing Units" for condensing units matched to refrigerant cooling coils in air handling units.

E. Split replacement refrigerant coils require its own distributor nozzle, expansion valve and suction piping. Suction connections shall be located on the air entering side with suction connections at the bottom end of headers. Follow coil manufacturer's recommendations for installation and location of refrigerant control device and valves.

F. Mount unit ventilators centered on existing outdoor air louver.

G. Provide sheetmetal in-fill sections where gaps occur between the end of finished cabinetry and unit ventilator. In-fill sections shall be of the same gauge steel, profile and color as the unit ventilator. Refer to Architectural interior elevation drawings for locations.

3.3 FREEZE-PROTECTION

A. Take all precautions to prevent uncontrolled infiltration of outdoor air to coils and piping, including (but not necessarilly limited to) following preventative steps:

B. Provide sleeves, safing, insulation, caulking, etc..., as required to make neat and airtight connection to outside air intakes, with no uncontrolled infiltration permitted.

C. If walls are in such condition that it is impossible to plumb the units with the walls and get correct sealing through standard methods, notify the Owner and Architect of proposed solution, and modify methods as required. Units must seal tightly against the walls and prevent infiltration.

D. Insure that existing wall boxes are properly sealed and that no air is permitted to leak past them and are in good condition and ready to accept new work.

E. Adjust outdoor air dampers on the units to close tightly when in the unoccupied position (100% closed).

F. All openings in the outside air intake path between the intake louver and the outside air control damper which could permit the uncontrolled entrance of outdoor air shall be sealed and insulated. This includes but is not limited to unused holes (knockouts, etc.,), spaces around pipes and conduits, sealing wall sleeve to wall, sealing around intake louver, and other openings into piping and air compartments.

G. Insure that all freeze protection controls are in place and functional prior to freezing weather. During initial freezing weather, man job and continuously inspect for freeze concerns, provide report to Architect and Owner immediately and correct any discovered conditions which may result in freeze damage.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 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. Unless otherwise indicated, install shutoff valve and union or flange at each connection.

3. Connect piping to equipment using specialties as detailed on drawings, with at minimum isolation valves, unions, and P/T test ports supply and return, with control valve on return as specified.

4. Pipe cooling coil condensate through properly sized accessible p-trap to approved point of indirect waste discharge. Coordinate location of discharge with Plumbing Contractor, Owner and Architect in field.

B. Install refrigerant piping as required by Division 23 Section "Refrigerant Piping," and add refrigerant as required to compensate for length of piping.

C. Connect supply and return ducts to ducted equipment with flexible duct connectors specified in Section 23 31 00 "Ductwork". Comply with safety requirements in UL 1995 for duct connections.

D. Ground and wire equipment according to the stricter of manufacturer’s and Division 26 requirements.

3.5 FIELD QUALITY CONTROL

A. Ensure Manufacturers provide:

1. Thorough instruction of installing Contractor’s personnel in installation of units.
2. Instruction for Owner's personnel in operation and care of equipment.
3. Maintenance brochure.
4. Adjustment of air discharge pattern to suit each room as directed and approved.

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. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. After installing equipment, inspect for damage to finish. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

D. Remove and replace malfunctioning and damaged units and retest as specified above.

3.6 DEMONSTRATION

A. Provide service representative to train Owner's maintenance personnel to adjust, operate, and maintain units. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 23 82 00

SECTION 26 05 00 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section and to all of Division 26.

1.2 SUMMARY

A. Section Includes:

1. General requirements applicable to components and systems included in Electric Contract.

B. Products Installed but Not Furnished Under This Section

1. Make electrical connections to equipment shown on Drawings and furnished by other Contractors. Obtain approved wiring diagrams and location drawings for roughing in and final connections from Contractor furnishing equipment.

1.3 REFERENCES

A.	AIA	American Institute of Architects
B.	ADA	Americans with Disabilities Act
C.	AISC	American Institute of Steel Construction
D.	ANSI	American National Standards Institute
E.	ASTM	ASTM International
F.	IBC	International Building Code
G.	IEEE	Institute of Electrical and Electronics Engineers, Inc. (The)
H.	IES	Illuminating Engineering Society of North America
I.	NEC	National Electrical Code
J.	NEMA	National Electrical Manufacturers' Association
K.	NETA	International Electrical Testing Association
L.	NFPA	National Fire Protection Association
M.	UL	Underwriters' Laboratories, Inc.

1.4 DEFINITIONS

A. “Existing”: Equipment depicted on Drawings with an “E” designation denotes existing equipment to remain.

B. "Relocate": Equipment depicted on Drawings with an "RL" designation denotes existing equipment to relocate. Disconnect equipment, remove circuitry to a point beyond demolition and tag for reuse, store equipment for reuse and reinstall as specified in Contract Documents. Modify/extend circuitry to new equipment locations and reconnect. The Contractor is responsible for protecting equipment from damage during removal, storage and reinstallation.

C. "Replace": Equipment depicted on Drawings with an "R" designation denotes existing equipment to replace. Refer to relevant Project Manual Specification for additional information and requirements.

1.5 SYSTEM DESCRIPTIONS

A. Inspection of Existing Systems: Inspect each existing system scheduled for modification in presence of Authorized Owner's Representative and issue a deficiency report to Owner and Architect listing conditions found prior to any removals, relocations, or additions. Modified systems include (but are not limited to):

1. Power distribution
2. Lighting
3. Communications distribution
4. Public Address System
5. Fire Alarm System
6. Clock System

B. Design Requirements - Provide complete systems, properly tested, balanced, and ready for operation including necessary details, items and accessories although not expressly shown or specified, including (but not limited to):

1. Wiring and raceway for work specified in Project Manual and shown on Drawings.

2. Electrical devices and equipment for work specified in Project Manual and shown on Drawings.

3. Systems included, but not limited to:

    a. Electrical distribution
    b. Electrical connections
    c. Lighting
    d. Communications System
    e. Fire Alarm System

C. Electric Layouts: Arrange panels; disconnect switches, enclosed breakers, equipment, raceways, and similar components neatly, orderly and symmetrically. Provide 3/4-inch fire treated, gray painted plywood backboards for surface mounted panels, disconnect switches, enclosed breakers, and similar equipment. Arrangements shown on Drawings are diagrammatic only; provide and adjust raceways, wiring, and other components as required.

D. Power Interruptions and Scheduled Outages: Coordinate scheduling of all power interruptions and outages with Owner. Confirm with Owner prior to interruption of power, which building systems are considered critical and must remain operational during the interruption. If a scheduled power outage is to extend beyond one standard workday, provide temporary power to operate critical building systems (including, but not limited to fire alarm system, security system, building access control system, and building energy management control system).

1.6 SUBMITTALS

A. General Division 26 submittal requirements:

1. Comply with requirements of SECTION 01 33 00 – SUBMITTAL PROCEDURES and as modified below.

2. Product Data: Submit product data for items listed in individual technical section. Clearly identify manufacturer, pertinent design, function, materials, construction and performance data specifically addressing specification description and Contract Document requirements of item. Strike out products that are not applicable to item being submitted, where more than one product is indicated on manufacturer product literature.

   a. Cover Sheet: Attach cover sheet, identified in Section 01 33 00, to Product Data of each item submitted. Provide cover sheet for only one type of item with related accessories, equipment with related components. Do not combine unrelated items under the same cover sheet.

   b. Specified Equivalent Product Data: Submit manufacturer's product information including product literature, technical specifications and descriptions, performance data and, and similar items to demonstrate compatibility with Basis-of-Design Equipment as specified in the "Part 2 – Products" of each technical section.

3. Shop Drawings: Submit detailed drawings for electrical equipment layouts, showing exact sizes and locations for approval before beginning work.

   a. Do not proceed with installation of systems in each area until agreement is reached with all concerned on exact arrangements for each room or area, unless otherwise directed by Architect. If Contractor proceeds prior to resolving conflicts, Contractor shall modify installed Work as required to permit other systems to proceed with a coordinated installation.

   b. Specified Equivalent Drawings: Submit detailed drawings of proposed Specified Equivalents, indicating proposed installation of equipment and showing maintenance clearances, required service removal space other pertinent revisions to arrangement and configuration shown in Contract Documents.

4. Samples: On all submittals, indicate standard factory color and factory finish surfaces. Where more than one color is available, selection will be made by Architect from manufacturer's full range of colors. Electronically transmitted color samples are not acceptable.

1.7 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sleeves and sleeve seals. Include rated capacities, and furnished specialties and accessories.

1. Penetration firestopping materials.
2. Penetration firestopping assembly drawings.

1.8 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Codes and Standards: Comply with applicable Federal, State and local building and electrical codes, laws, ordinances, and regulations, and comply with applicable NFPA, National Electrical Code and utility company requirements and regulations. Provide Underwriters Laboratories Seal on all materials.

2. Permits and Inspections: Obtain approvals, tests, and inspections required by Architect, Engineer, local electrical inspector, agent or agency specified in Project Manual, or National, State, or local codes and ordinances.

   a. Schedule electrical inspection by an agency acceptable to the local authority having jurisdiction and submit final inspection certificate to Architect.
   b. Furnish materials and labor necessary for tests and pay costs associated with tests and inspections.
   c. Conduct tests under load for load balancing and where required by codes, regulations, ordinances, or technical Specification.

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

1.9 DELIVERY, STORAGE AND HANDLING

A. Storage and Protection:

1. Take precautions to store materials and products to protect finishes and not permit dust and dirt to penetrate equipment.
2. Replace equipment damaged beyond reasonable repair as required by Architect.
3. Refinish any equipment with marks, stains, scratches, dents, and other aesthetic damage that doesn't impede operation of equipment as required by Architect.

1.10 COORDINATION OF WORK

A. Existing Construction:

1. Unless otherwise specified, employ Contractor responsible for General Work for all cutting, patching, repairing and replacing of general work required for installation of systems and components included in Electric Work. Secure approval from Architect's representative before cutting.

2. Anchor Bolts: Deliver to Contractor responsible for General Work anchor bolts required for Electric Work construction that are to be installed in construction included in General Contract. Provide templates or holding fixtures as required to maintain proper accuracy.

3. Access Doors: Provide access doors shown on Drawings, or as required for access to pull boxes, junction boxes, relays and other electrical devices requiring periodic inspection, adjustment or maintenance, where located above or within inaccessible walls or ceilings, and including cutting and patching of adjacent walls and ceilings to match existing materials and finishes.

1.11 ALTERATION PROCEDURES

A. In locations where existing devices are indicated to be disconnected and removed and existing power circuit or communications cable is not scheduled to be reused:

1. Remove circuit conductors back to source.

2. Modify panel directory for that circuit.

3. Remove all existing exposed and unexposed accessible raceway.

4. Provide blank cover plates or wall infill (as indicated on plans) and as described below:

a. For single gang and multi-gang switch boxes in public or occupied spaces; stainless steel coverplates.

b. For single gang and multi-gang boxes in un-occupied spaces; stainless steel, galvanized steel or PVC coverplates.

c. For boxes larger than standard switch boxes in public or occupied spaces; remove existing box and provide wall infill, matching existing sub-surface and finished surface conditions. Paint wall to match surrounding finishes.

d. For boxes larger than standard switch boxes in un-occupied spaces; 18 gage galvanized sheet metal coverplate with machined edges. Prime and paint to match surrounding finish conditions.

5. Patch and paint existing walls where disturbed by the electrical work.

B. In locations where existing devices are to remain in place, ensure circuits feeding such devices remain operational. Modify existing circuits as required to allow new construction to occur and to maintain necessary circuitry to existing devices for complete and proper operation.

C. In locations where entire existing system is being removed or modified:

1. Refer to individual system specification sections for documentation and inspection requirements prior to any alteration work on any system.
2. Take all necessary measures to ensure that down time will not compromise safety.
3. Notify Owner, Architect and other Contractors not less than 2 weeks prior to interruptions in service.
4. Coordinate work schedule to minimize duration of system outage during hours when building is occupied.

PART 2 - PRODUCTS

2.1 PENETRATION FIRESTOPPING

A. Comply with requirements for sealants in fire rated penetrations specified in Section 07 84 13 “Penetration Firestopping”.

B. Submit Manufacturers Product Data Sheets for each type of product selected. Certify that Firestop Material is free of asbestos and lead paint, and complies with local regulations.

1. Certification by firestopping manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs) and are nontoxic to building occupants.

C. Submit system design listings, including illustrations from qualified testing and inspection agency that is applicable to each firestop configuration.

D. Submit a project specific Penetration Firestopping Schedule indicating where each firestop configuration will be used.

PART 3 - EXECUTION

3.1 CUTTING AND PATCHING

A. Do not cut waterproofed floors or walls for admission of any equipment or materials and do not pierce any structural members without written permission from Architect.

B. Furnish and install sleeves, inserts, panels, raceways, boxes, and similar infrastructure ahead of general construction work and maintain Contractor personnel at Site during installation of general construction work to be responsible for and to maintain these items in position.

C. Unless otherwise noted elsewhere in Contract Documents, bear expense of cutting, patching, repairing or replacing of work of other trades made necessary by any fault, error or tardiness on part of Electrical Contract or damage done by Electric Contract. Employ and pay Contractor whose work is involved.

3.2 DEMONSTRATION OF COMPLETE ELECTRICAL SYSTEMS

A. Thoroughly demonstrate and instruct Owner's designated representative in care and operation of electrical systems and equipment furnished and installed in Electric Contract.

1. Factory Representative: In addition to demonstration and instruction specified above, provide technically qualified factory representatives from manufacturers of major equipment, to train Owner's representatives in care and operation of applicable products as specified in applicable technical sections of Division 26.

2. Coordinate and schedule time and place of all training through the Architect at the Owner’s convenience.

3. Submit letters attesting to satisfactory completion of instructions, including date of completion of instruction, names of persons in attendance, and signature of Owner’s authorized representative.

4. Architect's representative must be present when Owner's representatives participate in instruction.

5. The following equipment and systems are included:

a. Fire Alarm System.

3.3 FIRESTOPPING

A. Install firestopping according to the requirements specified in Section 07 84 13 “Penetration Firestopping.”

B. Applied Fireproofing:

1. Coordinate the installation of hangers, supports and accessories from the structural steel with the fireproofing installation. Install all hangers and supports prior to installation of fireproofing.

2. Repair or replace existing fireproofing removed as a part of Electrical Work installation.

a. Employ the services of an approved fireproofing contractor to repair or replace the fireproofing by patching any areas that have been removed or damaged due to the installation of work after the completion of the fireproofing.

C. Repaired or replacement fireproofing shall match the fireproofing adjacent to the repaired area. All warranties shall be maintained.

END OF SECTION 26 05 00

SECTION 26 05 01 – HAZARDOUS MATERIAL DISPOSAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section and to all of Divisions 26.

1.2 SUMMARY

A. Section Includes:

1. Selective removal and subsequent off-site disposal of the following hazardous waste:

   a. PCB containing light ballasts.
   b. Mercury containing fluorescent light tubes.

2. Quality assurance requirements including personnel training and certification.

3. Requirements for transport and disposal of hazardous waste materials by legal and appropriate means.

1.3 REFERENCES

A. Regulatory Requirements

1. United States Environmental Protection Agency (EPA)

   a. 40 CFR 260 - Hazardous waste management system: General
   b. 40 CFR 261 - Identification and Listing of Hazardous Waste.
   c. 40 CFR 262 - Standards Applicable to Generators of Hazardous Waste.
   d. 40 CFR 263 - Standards Applicable to Transporters of Hazardous Waste
   e. 40 CFR 264 - Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
   f. 40 CFR 265 - Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
   g. 40 CFR 266 - Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities
   h. 40 CFR 268 - Land Disposal Restrictions
   i. 40 CFR 270 - EPA Administered Permit Programs: The Hazardous Waste Permit Program
   j. 40 CFR 761 - Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution In Commerce, and Use Prohibitions.

2. United States Department of Transportation (DOT)

   a. 49 CFR 171 - General Information, Regulations, and Definitions.
   b. 49 CFR 172 - Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements.
   c. 49 CFR 173 - Shippers - General Requirements for Shipments and Packaging.
   d. 49 CFR 174 - Carriage by Rail.
   e. 49 CFR 175 - Carriage by Aircraft.
   f. 49 CFR 176 - Carriage by Vessel.
   g. 49 CFR 177 - Carriage by Public Highway.
   h. 49 CFR 178 - Specifications for Packaging.
   i. 49 CFR 179 - Specifications for Tank Cars.
   j. 49 CFR 180 - Continuing Qualification for Maintenance of Packaging.

3. New York State Department of Environmental Conservation (DEC)

   a. 6 NYCRR 360 - Solid Waste Management Facilities
   b. 6 NYCRR 364 - Waste Transporter Permits
   c. 6 NYCRR 370 - Hazardous Waste Management System: General.
   d. 6 NYCRR 371 - Identification and Listing of Hazardous Wastes.
   e. 6 NYCRR 372 - Hazardous Waste Manifest System and Related Standards for Generators, Transporters and Facilities.
   f. 6 NYCRR 373-1 - Hazardous Waste Treatment, Storage and Disposal Facility Permitting Requirements.
   g. 6 NYCRR 373-2 - Final Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities.
   h. 6 NYCRR 373-3 - Interim Status Standards for Owners and Operators of Hazardous Waster Facilities.
   i. 6 NYCRR 376 - Land Disposal Restrictions.

1.4 HAZARDOUS WASTE GENERATOR STATUS

A. Owner is a Small Quantity Generator as defined by 6 NYCRR 371 and 40 CFR 26. Schedule removal, on-site storage, and transport as required to maintain Owner’s status as a Small Quantity Generator.

B. Owner is a Conditionally Exempt Small Quantity Generator as defined by 6 NYCRR 371 and 40 CFR 26. Schedule removals, on-site storage, and transport as required to maintain Owner’s status as a Conditionally Exempt Small Quantity Generator.

1.5 DEFINITIONS

A. Remove: Remove and legally dispose of items except those indicated to be reinstalled, salvaged, or to remain Owner's property.

1.6 SUBMITTALS

A. Comply with requirements of SECTION 01 33 00 – Submittal Procedures and as modified below.

B. Proposed Schedule: Submit schedule indicating proposed sequence of operations for removal and disposal to Owner's Representative for review prior to start of removal operations. Include coordination for shutoff, capping, and continuation of utility services as required, together with details for dust and noise control protection.

1. Provide detailed sequence of removals to ensure uninterrupted progress of Owner's on-site operations, including starting and ending dates for each activity.
2. Coordinate with Owner's continuing occupation of portions of existing building and with Owner's partial occupancy of completed new addition or structure, as applicable.
3. Include details for use of elevator and stairs and locations of temporary partitions and means of egress.

C. Transport and Disposal Data

1. Prior to removal, transport or disposal, submit copies of:

a. Valid Waste Transporter Permit, issued by New York State Department of Environmental Conservation.

b. Written communication from designated treatment, storage or disposal facility that it:

1) Is authorized to receive and dispose of waste products generated by this Project;
2) Has capacity to receive and dispose of waste products generated by this and;
3) Will provide or assure that ultimate disposal method indicated on manifest for particular hazardous waste(s) will be followed.

c. Instruction regarding requirements for distribution of waste manifest as completed at time of shipment.

2. Post Disposal Submittals

a. Completely executed waste manifest.

b. Documentation of Hazardous Waste Determination, consisting of:

1) Test results;
2) Waste analyses or
3) Other hazardous waste determination information.

c. Landfill Records: Submit landfill records indicating receipt and acceptance of hazardous waste(s) by landfill facility licensed to accept hazardous waste(s).

D. Quality Control Submittals

1. Qualifications Certification: Submit written certification or similar documentation signed by applicable subcontractor, Contractor and manufacturer (where applicable) indicating compliance with applicable "Qualifications" requirements specified below in "Quality Assurance" article.

1.7 QUALITY ASSURANCE

A. Qualifications

1. Hazardous Material Disposal Subcontractor: Engage experienced firm that has successfully completed hazardous material disposal similar to that indicated for this Project and provides training as required by USEPA, USDOT, NYSDEC and OSHA.

B. Pre-Disposal Conference - Prior to beginning hazardous material disposal, conduct conference at Site to review requirements and conditions for hazardous material disposal with attendance by at least the following:

1. Contractor's representative.
2. Hazardous material disposal subcontractor representative, if applicable.
3. Owner's representative.
4. Architect's representative.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Labeling and Packaging Materials: Provide labeling and packaging materials as required by 49 CFR 173 Shippers - General Requirements for Shipments and Packaging.

B. Hazardous Waste Disposal Vehicles: Provide vehicles for transporting hazardous waste possessing valid Industrial Waste Hauler Permit and equipped with appropriate placards affixed as prescribed by United States Department of Transportation regulations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions (by Hazardous Material Disposal subcontractor): Examine conditions under which hazardous material disposal is to be conducted in coordination with Hazardous Materials Disposal Installer and notify affected Contractors and Architect in writing of any conditions detrimental to proper and timely hazardous material disposal. Do not proceed with disposal until unsatisfactory conditions have been corrected in manner acceptable to Hazardous Material Disposal Installer.

1. When Hazardous Material Disposal Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to Architect written confirmation from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Hazardous Material Disposal Installer.

2. Survey existing conditions and coordinate with hazardous material disposal requirements indicated to determine extent of hazardous material disposal required.

3. Inventory and record condition of items to be removed and reinstalled and items to be removed and salvaged.

4. Survey condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during hazardous material disposal operations.

B. Perform additional surveys as hazardous material disposal progresses to detect hazards resulting from hazardous material disposal activities.

3.2 REMOVAL, PACKAGING, TRANSPORTATION AND DISPOSAL PROCEDURES

A. Removal: Remove light ballasts and fluorescent light tubes whole and intact. Do not release PCBs or mercury to the environment.

B. Packaging: Package, label, and mark all hazardous waste materials in accordance with applicable requirements of 49 CFR 173, 178 and 179.

C. Temporary On-Site Storage and Protection: Provide storage on site of hazardous materials removed from service and scheduled for disposal to prevent damage or vandalism.

D. Temporary On-Site Storage and Protection: Provide storage on site of hazardous materials removed from service and scheduled for disposal complying with requirements of 6 NYCRR 372.2 (a) (8). Do not exceed 180 days storage on site.

E. Hazardous Waste Determination: Provide analysis required by Treatment, Storage or Disposal facility to document hazardous waste determination.

F. Hazardous Waste Manifests

1. Maintain manifest from date of transport until date of disposal, destruction or recycling.

2. Return fully executed manifests to Owner within 60 days of date waste accepted by initial transporter.

3. Use following type of manifest as applicable:

a. If waste is to be disposed of in New York State or if waste is to be disposed of in state not requiring use of specific manifest form, use New York State Uniform Hazardous Waste Manifest;

b. If the waste is to be disposed of in state other than New York State and that state requires use of specific manifest form, use manifest required by state where waste is to be disposed in lieu of New York State Uniform Hazardous Waste Manifest.

4. Complete manifest and deliver to Owner for review and signature.

5. Retain copies of manifest required to remain with hazardous waste shipment and deliver remaining copies to Owner.

6. Advise Owner regarding required distribution of manifest, both verbally and in writing.

G. Disposal - Transport hazardous waste to treatment or disposal facility that:

1. Is permitted, licensed or registered by state to dispose of hazardous waste;

2. Has interim status to dispose of hazardous waste;

3. Is authorized to manage hazardous waste under Resource Conservation and Recovery Act (RCRA) or

4. Is facility which:

a. Beneficially uses or reuses, or legitimately recycles or reclaims its waste; or
b. Treats its waste prior to beneficial use or reuse, or legitimate recycling or reclamation.

3.3 ADJUSTING/CLEANING

A. At least weekly, remove from building site debris, rubbish, and other materials resulting from hazardous material disposal operations.

1. If additional hazardous materials are encountered during hazardous material disposal operations, comply with applicable regulations, laws, and ordinances concerning removal, handling, and protection against exposure or environmental pollution.

2. Burning of removed materials not permitted on Project Site.

3. Transport materials removed and legally dispose off-site.

B. Sweep building broom clean at end of each workday and on completion of hazardous material removal operations.

C. Upon completion of hazardous material removal, remove tools, equipment, and demolished materials from Site. Remove protections and leave interior areas broom clean. Change filters on air-handling equipment to remain.

END OF SECTION 26 05 01

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

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

1.3 SUBMITTALS, GENERAL

A. General: Submit all submittals required by this Section concurrently.

1.4 ACTION SUBMITTALS

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

1.5 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. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND 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. Alcan Products Corporation; Alcan Cable Division.
2. American Insulated Wire Corp.; a Leviton Company.
3. General Cable Corporation.

4. Senator Wire & Cable Company.
5. Southwire Company.

B. Single Conductors (600 Volt and Below): 600 volts rated, single conductor, 98 percent conductivity, stranded, annealed copper, sizes as shown, but not less than No. 12 AWG minimum size. Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN, XHHW.

D. Multiconductor Cable: (Type MC - Metal Clad): aluminum interlocking armor, 90 degree C, 600V rated conductors (75 degree C wet locations), stranded copper conductors, minimum size No. 12 AWG, insulated green equipment grounding conductor with anti-short bushings.

2.2 CONNECTORS AND SPLICES

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. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.
6. Ideal Industries/Buchanan

B. Splices and Terminations: Provide factory fabricated metal connectors of sizes, ratings, materials, types and classes as required for each service. Provide proper selection as determined by Installer to comply with installation requirements and NEC standards. Provide the following:

1. Conductors No. 8 AWG and smaller: Screw on, wing nut wire connectors with fixed square wire threads and wide throated skirt. UL 486C Listed.

2. Conductors No. 6 AWG to 3/0 AWG: Bolt on type or crimped type compression, seamless copper connectors using hand or hydraulic tool, color coded to wire size. Connector shall be electro-tin plated to resist electrolytic corrosion. UL 486A and UL 486B Listed.

3. Conductors No. 4/0 AWG and larger: Compression type solderless connector, long barrel seamless copper with minimum 2 pressure points per conductor. Fully compatible with industry standard crimping tool-die sets. Color coded to wire size and electro-tin plated to resist electrolytic corrosion. UL 486A Listed.

PART 3 - EXECUTION

3.1 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type XHHW, single conductors in raceway.

B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground**:** Type XHHW, single conductors in raceway.

E. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

F. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

G. Branch Circuits in Cable Tray: Metal-clad cable, Type MC.

H. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

I. Class 1 Control Circuits: Type THHN-THWN, in raceway.

J. Metal Clad Type "MC" Cable:

1. Install MC cable, parallel and perpendicular to surfaces or structural members following surface contours, where possible.

2. Do not use MC cable for home runs (from panel to first device in branch circuit).

3. Do not install exposed metal clad cable in any areas, including mechanical and electrical spaces.

4. Do not penetrate floor slabs with MC cable.

5. Metal clad cable may be used for switch, receptacle, light fixture, device and fixture branch circuit wiring above ceilings and in walls beyond corridor walls.

6. MC cable shall include a neutral, whether used or not, to a light switch location.

7. Above corridor ceilings, use MC cable for 6 foot light fixture whips.

8. Maintain a clearance of at least 6 inches from hot water and other high temperature pipes and telecommunications conduits, and at least 12 inches from unshielded telecommunications cables.

9. Support MC cable every 6 feet, and within 1 foot of every box, fitting, and cable termination. Do not support MC cable on hung ceilings or on ceiling support wires. The use of cable ties to support MC cable is prohibited.

10. Use MC cable in branch circuit wiring in movable metal partitions and movable gypsum partitions. Install conductors in accordance with partition manufacturer's recommendations.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

A. Wire and Cable Installation: Install all wire and cable in approved raceway with exit light circuits, emergency lighting circuits, and special systems wiring installed in separate raceways. Use UL approved lubricants for wire pulling. Tag all feeders, subfeeders, special system wiring and branch circuit wiring at each pull box, junction box, and gutter space indicating point of origin and termination. Install green grounding wire in all raceways for connection to equipment, motors, transformers, and similar equipment. Install low voltage cables as detailed in individual sections.

B. Splices and Terminations: Make all splices accessible. Insulate all splices, taps, and connections to insulation value of conductor. Follow all instructions and recommendations of splice material manufacturer. Terminate low voltage cables with termination blocks as described in individual sections.

1. Common Neutral Conductor: Do not use common neutral for multiple branch circuits.

C. Color Coding:

1. Color Code for Branch and Feeder Circuits: Install color coded insulated conductors for branch circuits as follows:

	L1	L2	L3	Neutral	Ground
For 60 Hz installations:					
208Y/120	Black	Red	Blue	White	Green
480Y/277	Brown	Orange	Yellow	Natural Gray	Green

2. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.

3. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

D. Pull all conductors together where more than one is being installed in raceway.

E. Do not exceed maximum pulling tension of wire being installed. Use pulling compound or lubricant, where necessary. Use compound that will not deteriorate conductor or insulation.

F. Use pulling means, including fish tape, cable or rope that cannot damage raceway or wire.

G. Replace wiring damaged during installation.

H. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

3.3 CONNECTIONS

A. Splices:

1. Dry Locations:

a. Conductors No. 8 AWG or Smaller: Use spring type pressure connectors or indent type pressure connectors with insulating jackets (except where special type splices are required).

b. Conductors No. 6 AWG or Larger: Use un-insulated indent type pressure connectors. Fill indentations with electrical filler tape and apply insulation tape to insulation equivalent of the conductor, or insulate with heat shrinkable splices.

c. Gutter Taps in Panelboards: Install gutter tap, fill indentations with electrical filler tape and apply insulation tape to insulation equivalent of the conductor, or insulate with gutter tap cover.

2. Damp Locations: As specified for dry locations, except apply moisture sealing tape over entire insulated connection (moisture sealing tape not required if heat shrinkable splices are used).

3. Wet Locations: Use un-insulated indent type pressure connectors and insulate with resin splice kits or heat shrinkable splices. Exception: Totally enclosed splices above ground protected in NEMA 3R, 4, 4x enclosures may be spliced as specified for damp locations.

B. Terminations:

1. Conductors No. 10 AWG or Smaller - Use terminals for:

a. Connecting control and signal wiring to terminal strips.
b. Connecting wiring to equipment designed for use with terminals.

2. Conductors No. 8 AWG or Larger - Use compression or mechanical type lugs for:

a. Connecting cables to flat bus bars.
b. Connecting cables to equipment designed for use with lugs.

3. For Conductor Sizes Larger than Terminal Capacity on Equipment: Reduce larger conductor to maximum conductor size that terminal can accommodate (reduced section not longer than one foot). Use compression or mechanical type connectors suitable for reducing connection.

C. Provide insulated green ground conductor for each branch and feeder circuit.

D. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.

E. All connections and terminations installed according to manufacturer's recommendations.

F. All bolted or screw-type terminations specifically torqued to setting specified by manufacturer.

3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.5 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

3.6 FIELD QUALITY CONTROL

A. Prior to energization, test cable and wire for continuity of circuitry and also for short circuits. Correct malfunctions when detected. Subsequent to wire and cable hook-ups, energize circuitry and demonstrate functioning in accordance with NETA testing requirements.

B. Provide resistance "Megger" test for power conductors rated at 50 amperes and above prior to energization. Replace and re-test defective conductors. The minimum resistance for 600 volt insulation rated cables is 100 megohms at a 1000 volt DC test voltage measured between all phases and between all phases and ground.

C. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice, connection and termination for each service entrance and power feeder conductor No. 2 AWG and larger. Remove box and equipment covers so splices, connectors and terminations are fully accessible to portable scanner. Correct deficiencies found during the scan.

D. Inspection and Test Reports: Prepare and submit a written report to record the following:

1. Procedures used for each test conducted.
2. Test results that complied with the Contract Documents.
3. Test results that did not comply with the Contract Documents and corrective action taken to achieve compliance.
4. Submit all test results to Architect & Owner's Representative prior to energization.

END OF SECTION 26 05 19

SECTION 26 05 23 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. UTP cabling.
2. Low-voltage control cabling.
3. Control-circuit conductors.
4. Identification products.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.

D. RCDD: Registered Communications Distribution Designer.

E. UTP: Unshielded twisted pair.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.
B. Source quality-control reports.
C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

PART 2 - PRODUCTS

2.1 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.

2.2 PERFORMANCE REQUIREMENTS

A. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262 by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

1. Flame Travel Distance: 60 inches or less.
2. Peak Optical Smoke Density: 0.5 or less.
3. Average Optical Smoke Density: 0.15 or less.

B. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

C. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

2.3 BACKBOARDS

A. Description: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels in Section 06 10 00 "Rough Carpentry."
B. Painting: Paint plywood on all sides and edges with flat black alkyd paint. Comply with requirements in Section 09 91 23 "Interior Painting."

2.4 UTP CABLE

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. ADC.
2. Alpha Wire Company; a division of Belden Inc.
3. Belden Inc.
4. CommScope, Inc.
5. Draka Cableteq USA.

6. Genesis Cable Products; Honeywell International, Inc.
7. Mohawk; a division of Belden Inc.
8. Nexans; Berk-Tek Products.
9. Siemon Company (The).
10. Superior Essex Inc.
11. SYSTIMAX Solutions; a CommScope, Inc. brand.
12. 3M.
13. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. Description: 100-ohm, four-pair UTP, 24-pair UTP, formed into four-pair binder groups with no overall jacket.

1. Comply with ICEA S-90-661 for mechanical properties of Category 5e cables.

2. Comply with ICEA S-102-700 for mechanical properties of Category 6 cables.

3. Comply with TIA-568-C.1 for performance specifications.

4. Comply with TIA-568-C.2, Category 6.

5. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with NEMA WC 66, UL 444 and NFPA 70 for the following types:

a. Communications, Plenum Rated: Type CMP complying with UL 1685 or Type CMP in listed plenum communications raceway.
b. Communications, Riser Rated: Type CMR complying with UL 1666 and ICEA S-103-701.
c. Communications, General Purpose: Type CM or Type CMG; or Type CM, Type CMG, Type CMP, or Type CMR in listed communications raceways.

2.5 UTP CABLE HARDWARE

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. ADC.
2. American Technology Systems Industries, Inc.
3. Belden Inc.
4. Dynacom Inc.
5. Hubbell Incorporated.
6. Leviton Commercial Networks Division.
7. Molex Premise Networks; a division of Molex, Inc.
8. Panduit Corp.
9. Siemon Company (The).
10. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-C.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

E. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair UTP cable indicated.

F. Jacks and Jack Assemblies: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-C.1.

G. Patch Cords: Factory-made, four-pair cables in 36-inch 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.

H. Faceplates:

1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 26 27 26 "Wiring Devices."

2. Metal Faceplate: Stainless steel, complying with requirements in Section 26 27 26 "Wiring Devices."

3. For use with snap-in jacks accommodating any combination of UTP, optical-fiber, and coaxial work area cords.

a. Flush-mounted jacks, positioning the cord at a 45-degree angle.

I. Legend:

1. Factory labeled by silk-screening or engraving for stainless steel faceplates.
2. Machine printed, in the field, using adhesive-tape label.
3. Snap-in, clear-label covers and machine-printed paper inserts.

2.6 LOW-VOLTAGE CONTROL CABLE

A. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. One pair, twisted, No. 18 AWG, stranded (19x30) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.

4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. One pair, twisted, No. 18 AWG, stranded (19x30) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

2.7 CONTROL-CIRCUIT CONDUCTORS

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. Encore Wire Corporation.
2. General Cable Technologies Corporation.
3. Southwire Company.

B. Class 1 Control Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway, complying with UL 44.

C. Class 2 Control Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway, complying with UL 44.

D. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway, complying with UL 44.

E. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.

1. Smoke control signaling and control circuits.

2.8 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.
B. Factory test UTP cables according to TIA-568-C.2.
C. Cable will be considered defective if it does not pass tests and inspections.
D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Test cables on receipt at Project site.

1. Test each pair of UTP cable for open and short circuits.

3.2 INSTALLATION OF RACEWAYS AND BOXES

A. Comply with requirements in Section 26 05 33 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.

1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

2. Outlet boxes for optical-fiber cables shall be no smaller than 4 inches square by 2-1/8 inches deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.

3. Flexible metal conduit shall not be used.

B. Comply with TIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.

C. Install manufactured conduit sweeps and long-radius elbows if possible.

D. Raceway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.

2. Install cable trays to route cables if conduits cannot be located in these positions.

3. Secure conduits to backboard if entering the room from overhead.

4. Extend conduits 3 inches above finished floor.

5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

E. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1 and NFPA 70.

B. General Requirements for Cabling:

1. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems" and Ch. 6, "Optical Fiber Structured Cabling Systems."

2. Terminate all conductors and optical fibers; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.

3. Cables may not be spliced.

4. 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.

5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems" and Ch. 6, "Optical Fiber Structured Cabling Systems." Install lacing bars and distribution spools.

6. 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.

7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.

8. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems" and Ch. 6, "Optical Fiber Structured Cabling Systems." Monitor cable pull tensions.

9. Support: Do not allow cables to lay on removable ceiling tiles.

10. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.

C. UTP Cable Installation:

1. Comply with TIA-568-C.2.
2. Install termination hardware as specified in Section 271500 "Communications Horizontal Cabling" unless otherwise indicated.
3. Do not untwist UTP cables more than 1/2 inch at the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:

1. Install wiring in raceways. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 30 inches apart.

3. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

F. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches.

4. 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:

   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches.

6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified for future use with a tag.

3.5 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits; No 14 AWG.
2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

3.6 FIRESTOPPING

A. Comply with requirements in Section 07 84 13 "Penetration Firestopping."
B. Comply with TIA-569-B, Annex A, "Firestopping."
C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.7 GROUNDING

A. For data communication wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.
B. For low-voltage control wiring and cabling, comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.8 IDENTIFICATION

A. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

B. Identify data and communications system components, wiring, and cabling according to TIA-606-A; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.

3.9 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 test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Visually inspect UTP cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test UTP cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not after cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

D. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 26 05 23

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes: Grounding and bonding systems and equipment.

1.3 SUBMITTALS

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

1.4 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. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: No. 6, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 inch thick by 2 inches wide by 8 inches long, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. fiberglass reinforced polyester, impulse tested at 5000 V.

2.2 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless, Non-reversible compression or exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad, sectional type; 10 feet by 3/4 inch in diameter.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install stranded conductors for all sizes unless otherwise indicated.

B. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

C. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.

2. Lighting circuits.

3. Receptacle circuits.

4. Single-phase motor and appliance branch circuits.

5. Three-phase motor and appliance branch circuits.

6. Flexible raceway runs.

7. Armored and metal-clad cable runs.

8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.

C. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.

2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

3.4 LABELING

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.

B. Install labels at the telecommunications bonding conductor and grounding terminal bar and at the grounding electrode conductor where exposed.

1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.5 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.

a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.

b. Perform tests by fall-of-potential method according to IEEE 81.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

B. Grounding system will be considered defective if it does not pass tests and inspections.

C. Prepare and submit all test and inspection reports.

D. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity to 1000 kVA: 5 ohms.
2. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.

E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.
B. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.
2. Trapeze hangers. Include Product Data for components.
3. Steel slotted channel systems. Include Product Data for components.
4. Equipment supports.

1.6 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are, shown on details on Drawings.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. 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:

a. Allied Tube & Conduit.
b. Cooper B-Line, Inc.; a division of Cooper Industries.
c. ERICO International Corporation.
d. GS Metals Corp.
e. Thomas & Betts Corporation.
f. Unistrut; Tyco International, Ltd.
g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.

4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.

5. U-Channel Strut Systems: Provide 16 gauge steel U-channel strut system for supporting electrical equipment of types and sizes indicated with 9/16-inch diameter holes at 8 inches on center on top surface, with standard galvanized or PVC finish and following fittings that mate and match with U-channel:

a. Fixture hangers.
b. Channel hangers
c. End caps
d. Beam clamps
e. Wiring stud.
f. Thin-wall raceway clamps.
g. Rigid conduit clamps.
h. Raceway hangers.
i. U-bolts.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

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

    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:

        1) Hilti Inc.
        2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        3) MKT Fastening, LLC.
        4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

    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:

        1) Cooper B-Line, Inc.; a division of Cooper Industries.
        2) Empire Tool and Manufacturing Co., Inc.
        3) Hilti Inc.
        4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

6. Toggle Bolts: All-steel springhead type.

7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

2.3 MANUFACTURED SUPPORTING DEVICES

A. General: Provide supporting devices, complying with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation, and as specified in this Section. Where more than one type of device meets indicated requirements, select device according to Contractor's option.

1. Fasteners:

a. Standard Bolts and Nuts: ASTM A 307, Grade A, regular hexagon head.
b. Lag Bolts: FS FF-B-561, square head type.
c. Machine Screws: FS FF-S-92, cadmium plated steel.
d. Machine Bolts: FS FF-B-584 heads; FF-N-836 nuts.
e. Wood Screws: FS FF-S-111 flat head carbon steel.
f. Plain Washers: FS FF-W-92, round, general assembly grade carbon steel.
g. Lock Washers: FS FF-W-84, helical spring type carbon steel.
h. Toggle Bolts: Tumble-wing type; FS FF-B-588, type, class and style as required to sustain load.
i. Stainless Steel Fasteners: Type 302 for interior Work; Type 316 for exterior Work.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

E. Install hangers, supports, clamps and attachments to support raceway properly from building structure. Arrange for grouping of parallel runs of horizontal raceways to be supported together on trapeze type hangers where possible.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Fasteners

1. Materials:

   a. Dry Locations: Use cadmium or zinc coated anchors and fasteners.
   b. Damp and Wet Locations: Use hot dipped galvanized or stainless steel anchors and fasteners.
   c. Corrosive Atmospheres or Other Extreme Environmental Conditions: Use fasteners made of materials suitable for conditions.

2. Types (unless otherwise specified or indicated):

   a. Use cast-in-place concrete inserts in fresh concrete construction for direct pull-out loads such as shelf angles or fabricated metal items and supports attached to concrete slab ceilings.

   b. Use anchoring devices to fasten items to solid masonry and concrete when anchor is not subjected to pull out loads, or vibration in shear loads.

   c. Use toggle bolts to fasten items to hollow masonry and stud partitions.

E. Attachment Devices

1. Make attachments to structural steel or steel bar joists wherever possible. Provide intermediate structural steel members where required by support spacing.

2. Make attachments to steel bar joists at panel points of joists.

3. Do not drill holes in main structural steel members.

4. Use "C" beam clamps for attachment to steel beams

5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.

6. To Light Steel: Sheet metal screws.

7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate

8. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

F. Raceway Support

1. Use pipe straps and specified method of attachment where raceway is installed proximate to surface of masonry construction.

2. Use hangers secured to surface with specified method of attachment where raceway is suspended from the surface.

3. Use "C" beam clamps and hangers where raceway is supported from steel beams.

4. Use channel support system supported from structural steel for multiple parallel raceway runs.

5. Where raceways are installed above ceiling, do not rest raceway directly on runner bars, T-bars, etc.

   a. Raceway Sizes 2-1/2 Inches and Smaller: Support raceway from ceiling supports or from construction above ceiling.
   b. Raceway Sizes Over 2-1/2 Inches: Support raceway from beams, joists, or trusses above ceiling.

G. Light Fixture Support

1. Do not support fixtures from ceilings or ceiling supports unless specified or indicated on Drawings.

   a. Comply with NEC, Article 410.16 – Means of Support.
   b. Support fixtures with hanger rods attached to beams, joists, or trusses–of largest standard diameter-that fits in mounting holes of fixture.
   c. Where approved, channel supports may span and rest upon lower chord of trusses and be used to support lighting fixtures.
   d. Where approved, channel supports may span and be attached to underside of beams, joists, or trusses and be used to support lighting fixtures.

2. Use 2 nuts and 2 washers on lower end of each hanger rod to hold and adjust fixture (one nut and washer above top of fixture housing, one nut and washer below top of fixture housing).

    a. Where adequately supported outlet box is specified to support fixture or be used as one point of support, support box so that box may be adjusted to bring face of outlet box even with surface of ceiling.

3. Ceiling Mounted Lighting Fixtures: Provide at least following number of supports with additional supports when recommended by fixture manufacturer or shown on Drawings.

    a. Support individual fluorescent fixtures less than 2 feet long at 2 points.

    b. Support continuous row fluorescent fixtures less than 2 feet wide at points equal to number of fixtures plus one. Uniformly distribute points of support over row of fixtures.

    c. Support individual fluorescent fixtures 2 feet or wider at 4 corners.

    d. Support continuous row fluorescent fixtures 2 feet or wider at points equal to twice number of fixtures plus 2. Uniformly distribute points of support over row of fixtures.

    e. Use adequately supported outlet box as one point of support for fixtures weighing less than 50 pounds.

    f. Support recessed mounted fluorescent fixtures and incandescent fixtures directly from suspension system of suspended acoustical ceilings and securely fasten fixtures to framing members of ceiling using lock clips, wirelashing or leveling supports. Support each fixture weighing more than 50 pounds (including lamps) independent of suspended ceiling grid.

4. Wall Mounted Lighting Fixtures: Provide at least following number of supports with additional supports when recommended by fixture manufacturer or shown on Drawings.

    a. Support individual fluorescent fixtures 2 feet long or less at 2 points.
    b. Support individual fluorescent fixtures over 2 feet long at 3 points.
    c. Support continuous row fluorescent fixtures at points equal to twice number of fixtures. Uniformly distribute points of support.
    d. Adequately supported outlet box may be used as one point of support for fixtures weighing less than 50 pounds

H. Channel Support System: Channel supports may be used, as approved, to accommodate mounting of equipment with following material and finish.

1. Dry Locations: 16-gage steel channel support system with standard finish.
2. Damp and Wet Locations: 16-gage steel channel support system with hot dipped galvanized or PVC finish

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 5 – Metal Fabrications for site fabricated metal supports.
B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions for approved equipment but not less 4 inches larger in both directions than the supported unit. Anchors will be a minimum of 10 bolt diameters from the edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are shown on construction details on Drawings.

C. Anchor equipment to concrete base:

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

2. Install anchor bolts to elevations required for proper attachment to supported equipment.

3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

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 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.

END OF SECTION 26 05 29

SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.
B. ENT: Electrical nonmetallic tubing.
C. EPDM: Ethylene-propylene-diene terpolymer rubber.
D. FMC: Flexible metal conduit.
E. RMC: Rigid metal conduit
F. LFMC: Liquidtight flexible metal conduit.
G. LFNC: Liquidtight flexible nonmetallic conduit.
H. NBR: Acrylonitrile-butadiene rubber.
I. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets, custom enclosures, cabinets, handholes and boxes.

1.5 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. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

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:

1. AFC Cable Systems, Inc.
2. Alflex Inc.

3. Allied Tube & Conduit; a Tyco International Ltd. Co.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. Electri-Flex Co.
6. O-Z Gedney; a unit of General Signal.
7. Wheatland Tube Company.

B. Rigid Metal Conduit (RMC): Rigid, hot dipped galvanized steel with galvanized threaded malleable iron fittings and bushings with insulated throat (galvanized steel). ANSI C80.1.

C. Electrical Metallic Tubing (EMT): Metallic galvanized steel tube with galvanized steel compression or setscrew type fittings and bushings with insulated throat (galvanized steel). ANSI C80.3.

D. Flexible Metal Conduit (FMC): Flexible, interlocked galvanized zinc-coated steel metal strip with galvanized screw-in type steel fittings.

E. Liquid Tight Flexible Metal Conduit (LFMC) : Liquid-tight flexible metal raceway with single, flexible, continuous, interlocked and double-wrapped steel core galvanized inside and outside, coated with liquid tight jacket of flexible polyvinyl chloride (PVC).

F. Joint Compound for Rigid Steel Conduit: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

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:

1. AFC Cable Systems, Inc.
2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. Arnco Corporation.
4. CANTEX Inc.
5. CertainTeed Corp.; Pipe & Plastics Group.
6. Condux International, Inc.
7. ElecSYS, Inc.
8. Electri-Flex Co.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT/Cole-Flex.
11. RACO; a Hubbell Company.
12. Thomas & Betts Corporation.

B. RNC: NEMA TC 2, Type EPC-40-PVC**,** with matching fittings by same manufacturer as the conduit complying with NEMA TC# and UL 514B.

C. LFNC: UL 1660.

D. Fittings for LFNC: UL 514B.

2.3 METAL WIREWAYS

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:

1. Cooper B-Line, Inc.
2. Hoffman.
3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, 12, 3R, as indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type or as indicated with manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.

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:

a. Hubbell, Inc.
b. Thomas & Betts Corporation.
c. Walker Systems, Inc.; Wiremold Company (The).
d. Wiremold Company (The); Electrical Sales Division.

B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors.

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:

a. Butler Manufacturing Company; Walker Division.
b. Enduro Systems, Inc.; Composite Products Division.
c. Hubbell Incorporated; Wiring Device-Kellems Division.
d. Lamson & Sessions; Carlon Electrical Products.
e. Panduit Corp.
f. Walker Systems, Inc.; Wiremold Company (The).
g. Wiremold Company (The); Electrical Sales Division.

2.5 BOXES, ENCLOSURES, AND CABINETS

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:

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
3. Erickson Electrical Equipment Company.
4. Hoffman.
5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
6. O-Z/Gedney; a unit of General Signal.
7. RACO; a Hubbell Company.
8. Robroy Industries, Inc.; Enclosure Division.
9. Scott Fetzer Co.; Adalet Division.
10. Spring City Electrical Manufacturing Company.
11. Thomas & Betts Corporation.
12. Walker Systems, Inc.; Wiremold Company (The).
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

B. Outlet Boxes

1. Materials

a. Recessed Applications and Exposed Applications in Unfinished Spaces: Galvanized, stamped steel.

b. Boxes in stud walls shall be 4" square, 2 1/8" deep boxes with raised covers for power circuits. Provide "Far-Side" box support to keep box alignment parallel with wall face.

c. Boxes in masonry walls shall be 3 ½" deep masonry boxes, single or multigang as required

d. Exposed Applications: In finished spaces requiring exposed applications, provide boxes to match surface raceway system. In situations where surface mount conduits are allowed, condulet style boxes shall be used. Where surface mount devices are provided as components of specific systems, provide surface mount box from same manufacturer to match device.

e. Concrete and Wall in Wet Locations: Heavy duty cast aluminum, thermoset protective silver grey finish, with threaded mounting posts.

f. Weatherproof Outlet Boxes: Corrosion-resistant cast metal weatherproof outlet wiring boxes of appropriate type, shape, size and depth, with threaded conduit ends and cast metal face plates with cover suitably configured for each application~~,~~ and including face plate gaskets and corrosion resistant fasteners. Do not compromise outlet weatherproof integrity when attachment plug is inserted.

g. Junction and Pull Boxes: Galvanized code gauge sheet steel boxes with screw-on covers, of appropriate type, shape and size suitable for box location and installation with welded seams and equipped with stainless steel nuts, bolts, screws and washers.

2. Size: As required for number and size of raceways and conductors. Depth to suit wall depth and device installed.

3. Covers: Design and style for each type, outlet, junction box, etc.; NEMA rated for each location.

C. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic.

D. Cabinets:

1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Raceway Installation: Securely support raceway from building construction, separately from outlet boxes and junction boxes. Secure to masonry surfaces with expansion anchors. Use galvanized hanger rods, inserts and hangers. Conceal all raceway runs except in mechanical rooms, storage room ceilings, and areas above suspended ceilings. Run exposed raceway neatly, parallel and level, to ceilings, walls and floors. Make necessary offsets and bends to comply with construction. Install expansion fittings at all building expansion joints. Support all raceways with clamps per National Electric Code

1. RMC Installation: Use RMC in concrete slabs, below concrete slabs, below grade, damp locations, exterior locations and in hazardous locations. Where exposed leaving concrete slabs, extend minimum 6 inches above and below slabs. Use RMC elbows when penetrating concrete slab from PVC raceway below or in slabs.

2. RNC: Use for underground applications, in slabs, and below slabs. Provide rigid raceway when extending through slabs. Make solvent-cemented joints in accordance with recommendations of manufacturer.

3. EMT: Use EMT for non-hazardous, dry locations above grade. As a minimum, use EMT in corridor ceilings, for home runs and in all unoccupied exposed interior areas. Surface mounted EMT shall not be used in finished areas without written permission from the Architect or Owner.

4. FMC: Use flexible metal conduit for final connections to motors, step-down transformers, vibrating machines, etc. Terminate with clamp type connectors and anti-short bushing. Maximum length of three feet.

5. LFMC: Use a maximum of two feet of liquid tight flexible conduit for connection of motors and for other electrical equipment where subject to movement and vibration and also where subjected to one or more of the following conditions

    a. Exterior location.
    b. Moist or humid atmosphere where condensate can be expected to accumulate.
    c. Corrosive atmosphere.
    d. Subjected to water spray.
    e. Subjected to dripping oil, grease or water

6. LFNC: Use a maximum of three feet of liquid tight flexible nonmetallic conduit for connection to video cameras and other electrical equipment with extreme bending requirements and also where subjected to one or more of the following conditions:

    a. Exterior location.
    b. Corrosive atmosphere.

7. All non-metallic or flexible conduit shall contain a separate grounding conductor in addition to the circuit conductors.

8. Do not secure branch circuit wiring to ceiling support wires. Provide independent support wires dedicated only to electrical raceways.

9. Use roughing-in dimensions of electrically operated units furnished by supplier. Set conduit and boxes for connection to units only after receiving dimensions and after checking location with other trades.

10. Provide nylon pull cord in empty raceways. Test empty raceways with ball mandrel. Clear any raceway that rejects ball mandrel. Restore raceway and surrounding surfaces to original condition.

11. Fasten raceway terminations in sheet metal enclosures by 2 locknuts and terminate with bushing. Install locknuts inside and outside of enclosure.

12. Do not cross pipe shafts or ventilating duct openings with raceways.

13. Keep raceways at least 6 inches from parallel runs of flues, hot water pipes or other sources of heat. Wherever possible, install horizontal raceway runs above water and steam piping.

B. Concealed Raceways

1. Paint raceway threads in metallic raceways installed underground, in floors below grade, or outside with corrosion-inhibiting compound before assembling couplings. Draw coupling and raceway sufficiently tight to ensure water tightness.

2. For floors-on-grade, install raceways under concrete slabs.

3. Install underground raceways minimum of 18 inches below finished grade.

4. Provide raceway in furniture and any other cavity to effectively create a raceway system from the ceiling space to the outlet.

C. Raceways in Concrete Slabs: Do not embed pipes other than electrical raceway in structural concrete and provide steel sleeves for raceway passing through concrete. Obtain Architect's approval for any variation from following requirements unless shown on Drawings. Request Architect's approval in writing accompanied by suitable sketch.

1. Place raceways between bottom reinforcing steel and top reinforcing steel.
2. Place raceways either parallel or at 90 degrees to main reinforcing steel.
3. Place nearly parallel raceways apart at least six times O.D. of raceway used.
4. Restrict O.D. of raceway in solid slabs to 1/4 of slab thickness with raceway placed in middle of that thickness.
5. Do not use raceway coating, except galvanizing or equivalent coating.
6. Do not cut or displace any reinforcement.

D. Install raceways to avoid damage or penetration of structural members. Avoid horizontal or cross runs in building partitions or sidewalls.

E. For raceway larger than 2 inches, provide minimum 2 inches between raceways vertically penetrating elevated concrete slabs. Provide fire-stopping and spray-on fireproofing at locations where raceways penetrate surface of floor slab that is part of fire rating required for construction.

F. Exposed Raceways

1. Install exposed raceway in unfinished spaces, crawl spaces, pipe spaces, or in areas with existing exposed raceway. In areas where walls/ceilings are to be painted, exposed raceways shall be painted to match.

2. Install exposed raceways and extensions from concealed raceway systems neatly, parallel with, or at right angles to walls of building.

3. Do not run raceway through walls with plaster finish or through masonry walls or floors. Install pipe sleeves for raceway runs through these areas.

4. Install exposed raceway to avoid interfering with ceiling inserts, lights or ventilation ducts or outlets.

5. Support exposed raceways using hangers, clamps or clips. Support raceways on each side of bends and space not more than 6 ft. O.C. for 1-inch raceway and not more than 8 ft. O.C. for 1-1/4-inch raceway.

6. Provide exposed raceways for outlets on waterproof walls and set anchors supporting raceway in waterproof cement.

7. Support multiple raceway runs on trapeze style assemblies. Do not support raceway or cable from pipe, ductwork, or other raceway systems.

8. Apply exposed raceways requirements specified above to raceways installed in space above hung ceilings and in crawl spaces.

9. Do not install raceway directly on floor.

G. Minimum Raceway Size: 1/2-inch

H. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Provide locknuts for securing raceway to metal enclosure with sharp edge for digging into metal and ridged outside circumference for proper fastening.

2. Provide bushings for terminating raceways smaller than 1-1/4 inches with flared bottom and ribbed sides with smooth upper edges to prevent injury to cable insulation.

3. Install insulated type bushings for terminating raceways 1-1/4 inches and larger with flared bottom and ribbed sides and with upper edge with phenolic insulating ring molded into bushing.

4. Provide screw-type grounding terminal for standard or insulated type bushing.

5. Provide miscellaneous fittings such as reducers, chase nipples, 3-piece unions, split couplings and plugs specifically designed for their particular application.

I. Surface Raceways: Use surface raceways in finished spaces to conceal new cabling that cannot be installed above accessible ceiling or within walls. Use surface raceway only when raceway type and routing are approved by Architect and Owner's representative. Securely support from building construction and secure to masonry surfaces with expansion anchors. Mount at heights at locations shown on Drawings; obtain approval from Architect and Owner's representative for all routing not indicated on Drawings. Do not run surface raceway through walls with plaster finish or through masonry walls or floors. Install pipe sleeve with junction boxes or adapter fittings for raceway runs through these areas. In existing construction, run raceway along top of baseboards, taking care to avoid telephone and other signal wiring around doorframes and other openings. Run raceway on ceiling or walls perpendicular to or parallel with walls and floors.

J. Fittings and Accessories Installation

1. Use zinc electroplate or hot dipped galvanized steel fittings and accessories in conjunction with ferrous raceways in dry and damp locations.

2. Use hot dipped galvanized fittings and accessories in conjunction with ferrous raceways in wet locations.

3. Use caps or plugs to seal ends of raceways until cable is installed (to exclude foreign material).

4. Use expansion fittings where raceways cross expansion joints.

5. Use deflection fittings where raceways cross expansion joints that move in more than one plane.

6. Use 2 locknuts and insulated bushing (plastic bushing on 1/2-inch raceway and 3/4-inch raceway) on end of each raceway entering sheet metal cabinet or box in dry or damp locations. Terminate raceway ends within cabinet/box at same level.

7. Use watertight hub on end of each raceway entering cabinets or boxes (in wet locations) not constructed with integral threaded hubs.

8. Specific Applications:

    a. Rigid Metal Raceway: Use threaded fittings and accessories. Use 3-piece raceway coupling where raceway cannot be rotated.
    b. Flexible Metal Raceway: Use flexible metal raceway connectors.
    c. Liquid Tight Flexible Metal Raceway: Use “seal-tite” connectors.
    d. Rigid Nonmetallic Raceway, Metal Surface Raceway, and Wireways: Use manufacturer's standard fittings and accessories.

9. Raceways for Future Use (Spare Raceways and Empty Raceways): Draw fish tape through raceways in Architect’s presence to demonstrate that raceway is clear of obstructions. Leave pulling-in line in each spare and empty raceway.

10. Raceway Installation in Special Areas

    a. Raceways Exposed to Different Temperatures: Where portions of interior raceway system are exposed to widely different temperatures, seal interior and exterior of raceway to prevent circulation of air from warmer to colder section through raceway installation.

    b. Refrigerated Rooms: Install raceway body or junction box in raceway system on warm side of refrigerated room. After cables are installed, seal raceway interior at raceway body or junction box.

    c. Heated Areas to Unheated Areas: After cables are installed, seal raceway interior at nearest raceway body, outlet or junction box in heated area adjoining unheated area.

3.2 EXISTING RACEWAYS

A. Conditions for Re-Use of Existing Raceways:

1. Existing raceway is adequately sized for new cables.
2. Remove existing cables.
3. Demonstrate to Architect that existing raceway is clear of obstructions and in good condition.
4. Install insulated bushings to replace damaged or missing bushings. Replace non-insulated bushings with insulated bushings on raceway sizes 1 inch and larger.

3.3 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2, except where requirements on drawings or in this article are stricter.

3.4 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33

SECTION 26 05 44 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Sleeves for raceway penetrations of walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 “Penetration Firestopping”.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

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

a. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Metraflex Company (The).
d. Pipeline Seal and Insulator, Inc.
e. Proco Products, Inc.

2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Carbon steel.

4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

2.4 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

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

3. 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."

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 07 92 00 "Joint Sealants."

b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used.

5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

C. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

D. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel or cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

E. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

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

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls.
B. Using grout, seal the space around outside of sleeve-seal fittings.

3.4 SLEEVE INSTALLATION FOR FIRE RATED ASSEMBLY PARTITIONS

A. Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

B. Maintain indicated fire rating of walls, partitions, ceilings and floors at raceway penetrations. Install sleeves and sleeve seals with appropriate firestop materials. Comply with Division 07 Section “Penetration Firestopping”.

END OF SECTION 26 05 44

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification for conductors.
3. Warning labels and signs.
4. Instruction signs.
5. Equipment identification labels.
6. Miscellaneous identification products.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1.
B. Comply with NFPA 70.
C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
D. Comply with ANSI Z535.4 for safety signs and labels.
E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

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

C. Coordinate installation of identifying devices with location of access panels and doors.

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

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

F. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch with stamped legend, punched for use with self-locking cable tie fastener.

G. Write-On Tags: Polyester tag, 0.015 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.2 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

F. Write-On Tags: Polyester tag, 0.015 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.3 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 7 by 10 inches.

D. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 10 by 14 inches.

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES.

2.4 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.5 EQUIPMENT IDENTIFICATION LABELS

A. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.
B. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.
C. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.6 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black.

C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

I. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways and Cables within Buildings: Identify raceways and the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Emergency Power.
2. Exit lights
3. Power.

B. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.

    a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.

    b. Colors for 208/120-V Circuits:

        1) Phase A: Black.
        2) Phase B: Red.
        3) Phase C: Blue.

    c. Colors for 480/277-V Circuits:

        1) Phase A: Brown.
        2) Phase B: Orange.
        3) Phase C: Yellow.

    d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

C. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

D. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.

E. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

F. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Install underground-line warning tape for both direct-buried cables and cables in raceway.

G. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

H. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels:

1. Comply with 29 CFR 1910.145.

2. Identify system voltage with black letters on an orange background.

3. Apply to exterior of door, cover, or other access.

4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:

a. Power transfer switches.
b. Controls with external control power connections.

I. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

J. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch high letters for emergency instructions at equipment used for power transfer.

K. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.

b. Outdoor Equipment: Engraved, laminated acrylic or melamine label, Stenciled legend 4 inches high.

c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

   a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive, engraved, laminated acrylic or melamine label.

   b. Enclosures and electrical cabinets.

   c. Access doors and panels for concealed electrical items.

   d. Switchgear.

   e. Switchboards.

   f. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.

   g. Emergency system boxes and enclosures.

   h. Enclosed switches.

   i. Enclosed circuit breakers.

   j. Enclosed controllers.

   k. Variable-speed controllers.

   l. Push-button stations.

   m. Power transfer equipment.

   n. Contactors.

   o. Power-generating units.

   p. Monitoring and control equipment.

END OF SECTION 26 05 53

SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Indoor occupancy sensors.
2. Lighting contactors.
3. Emergency shunt relays.

B. Related Requirements:

1. Section 26 27 26 "Wiring Devices" for wall-box dimmers and manual light switches.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show installation details for occupancy and light-level sensors.

1. Interconnection diagrams showing field-installed wiring.
2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 INDOOR OCCUPANCY SENSORS

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. Bryant Electric.
2. Cooper Industries, Inc.
3. Hubbell Building Automation, Inc.
4. Leviton Manufacturing Co., Inc.
5. Lightolier Controls.
6. Lithonia Lighting; Acuity Brands Lighting, Inc.
7. Lutron Electronics Co., Inc.
8. NSi Industries LLC; Tork Products.
9. RAB Lighting.
10. Sensor Switch, Inc.
11. Square D.
12. Watt Stopper.

B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.

4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.

5. Mounting:

   a. Sensor: Suitable for mounting in any position on a standard outlet box.
   b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.

7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.

C. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.

2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.

3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

2.2 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

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. Bryant Electric.
2. Cooper Industries, Inc.
3. Hubbell Building Automation, Inc.
4. Leviton Manufacturing Co., Inc.
5. Lightolier Controls.
6. Lithonia Lighting; Acuity Brands Lighting, Inc.
7. Lutron Electronics Co., Inc.
8. NSi Industries LLC; Tork Products.
9. RAB Lighting.
10. Sensor Switch, Inc.
11. Square D.
12. Watt Stopper.

B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.

C. Wall-Switch Sensor:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 2100 sq. ft.

2. Sensing Technology: Dual technology - PIR and ultrasonic.

3. Switch Type: SP, field selectable automatic "on," or manual "on" automatic "off."

4. Voltage: Match the circuit voltage.

5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.

6. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

2.3 EMERGENCY SHUNT RELAY

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. Philips Bodine GTD20A

B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 1008. The device shall include relay switching circuitry, a test switch, a normal power indicator light and an alternate power indicator light contained in one enclosure. The unit shall be UL listed for field installation in indoor or damp locations and shall be warranted for a full five years from purchase date.

1. Coil Rating: 120 or 277 V.
2. Contact Rating: 20 A.

2.4 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

A. Wiring Method: Comply with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.
B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
D. Splices, Taps, and Terminations: Make connections only in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Section 26 05 53 "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

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

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Lighting control devices will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 26 09 23

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

A. SVR: Suppressed voltage rating.
B. TVSS: Transient voltage surge suppressor.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.

2. Detail enclosure types and details for types other than NEMA 250, Type 1.

3. Detail bus configuration, current, and voltage ratings.

4. Short-circuit current rating of panelboards and overcurrent protective devices.

5. Include evidence of NRTL listing for series rating of installed devices.

6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

7. Include wiring diagrams for power, signal, and control wiring.

8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

C. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 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. Keys: Two spares for each type of panelboard cabinet lock.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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. Comply with NEMA PB 1.

F. Comply with NFPA 70.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards.
B. Handle and prepare panelboards for installation according to NECA 407.

1.10 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

   a. Ambient Temperature: Not exceeding minus 22 deg F to plus 104 deg F .
   b. Altitude: Not exceeding 1600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 1600 feet.

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

1. Notify Architect no fewer than 5 days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Architect's written permission.
3. Comply with NFPA 70E.

1.11 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.12 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

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

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces at project location.

B. Enclosures: Flush- and surface-mounted cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.

3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.

4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.

5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.

6. Finishes:

   a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.

   b. Back Boxes: Galvanized steel.

   c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

7. Directory Card: Inside panelboard door, mounted in transparent card holder.

C. Incoming Mains Location: Top.

D. Phase, Neutral, and Ground Buses:

1. Material: Tin-plated aluminum.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

E. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Compression type.
3. Ground Lugs and Bus-Configured Terminators: Compression type.
4. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.

B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

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

1. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
2. Siemens Energy & Automation, Inc.
3. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: As shown on drawings.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

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

1. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
2. Siemens Energy & Automation, Inc.
3. Square D; a brand of Schneider Electric.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments.
   d. Ground-fault pickup level, time delay, and I^2t response.

4. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

5. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

a. Standard frame sizes, trip ratings, and number of poles.

b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.

c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

2.5 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NECA 407.
B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panelboards and accessories according to NECA 407.

B. Comply with mounting and anchoring requirements specified in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."

C. Mount top of trim 90 inches above finished floor unless otherwise indicated.

D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

E. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

F. Install filler plates in unused spaces.

G. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

H. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

I. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 26 05 53 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.4 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. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

E. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

F. Panelboards will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly and lubricate as recommended by manufacturer.

B. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.

2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.

3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.

4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

END OF SECTION 26 24 16

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Weather-resistant receptacles.
3. Snap switches.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.
B. GFCI: Ground-fault circuit interrupter.
C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
D. RFI: Radio-frequency interference.
E. TVSS: Transient voltage surge suppressor.
F. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Shop Drawings: List of legends and description of materials and process used for premarked wall plates.

1.6 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand (Pass & Seymour).

B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

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

B. Comply with NFPA 70.

C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranded building wire.
2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

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. Cooper; 5351 (single), CR5362 (duplex).
b. Hubbell; HBL5351 (single), HBL5352 (duplex).
c. Leviton; 5891 (single), 5352 (duplex).
d. Pass & Seymour; 5361 (single), 5362 (duplex).

2.4 GFCI RECEPTACLES

A. General Description:

1. Straight blade, feed and non-feed-through type.
2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 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. Cooper; VGF20.
b. Hubbell; GFR5352L.
c. Pass & Seymour; 2095.
d. Leviton; 7590.

2.5 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 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. Single Pole:

1) Cooper; AH1221.
2) Hubbell; HBL1221.
3) Leviton; 1221-2.
4) Pass & Seymour; CSB20AC1.

b. Two Pole:

1) Cooper; AH1222.
2) Hubbell; HBL1222.
3) Leviton; 1222-2.
4) Pass & Seymour; CSB20AC2.

c. Three Way:

1) Cooper; AH1223.
2) Hubbell; HBL1223.
3) Leviton; 1223-2.
4) Pass & Seymour; CSB20AC3.

d. Four Way:

1) Cooper; AH1224.
2) Hubbell; HBL1224.
3) Leviton; 1224-2.
4) Pass & Seymour; CSB20AC4.

C. Key-Operated Switches, 120/277 V, 20 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. Cooper; AH1221L.
b. Hubbell; HBL1221L.
c. Leviton; 1221-2L.
d. Pass & Seymour; PS20AC1-L.

2. Description: Single pole, with factory-supplied key in lieu of switch handle.

D. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors.

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. Cooper; 1995.
b. Hubbell; HBL1557.
c. Leviton; 1257.
d. Pass & Seymour; 1251.

E. Key-Operated, Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

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. Cooper; 1995L.
b. Hubbell; HBL1557L.
c. Leviton; 1257L.
d. Pass & Seymour; 1251L.

2.6 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: 0.035-inch- (1-mm-) thick, satin-finished, Type 302 stainless steel.

3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

C. Cover Plates:

1. Stainless Steel Cover Plates: Type 302 or 304, satin finish, 0.040 inch thick, accurately die cut, protected with release paper. Flush mounting plates shall be beveled with smooth rolled outer edge. Surface mounting plates shall be beveled and pressure formed for smooth edge to fit box. Single and combination plates as required to match types and sizes of specified wiring devices.

2. Weatherproof Cover Plates: Receptacles in wet locations shall be installed with a hinged outlet cover/enclosure clearly marked “Suitable For Wet Locations While in Use” and “UL Listed”. There must be a gasket between the enclosure and the mounting surface, and between the hinged cover and the mounting plate/base to assure proper seal. The installation shall be in compliance with NEC Article 410-57(b). Specification Grade die cast aluminum (copper free alloy 360)as manufactured by Hubbell Corp. (or approved equal).

D. Material for unfinished spaces: Galvanized steel.

2.7 FINISHES

A. Device Color:

1. Wiring Devices Connected to Normal Power System: To match existing.
2. Wiring Devices Connected to Emergency Power System: Red.

B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.

2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.

3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.

4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.

2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.

3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

4. Existing Conductors:

a. Cut back and pigtail, or replace all damaged conductors.
b. Straighten conductors that remain and remove corrosion and foreign matter.
c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.

2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.

3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.

4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.

5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.

6. Use a torque screwdriver when a torque is recommended or required by manufacturer.

7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.

8. Tighten unused terminal screws on the device.

9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical. Group adjacent switches under single, multigang wall plates.

3.2 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

A. Comply with Section 26 05 53 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.

2. Percent Voltage Drop under 15-A Load: A value of 5 percent or higher is unacceptable.

3. Ground Impedance: Values of up to 2 ohms are acceptable.

4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.

5. Using the test plug, verify that the device and its outlet box are securely mounted.

6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

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

D. Prepare test and inspection reports.

END OF SECTION 26 27 26

SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.
B. NO: Normally open.
C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Include evidence of NRTL listing for series rating of installed devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

B. Shop Drawings: For enclosed switches, include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
C. Comply with NFPA 70.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
2. Altitude: Not exceeding 6600 feet (2010 m).

1.8 COORDINATION

A. Coordinate layout and installation of switches, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Double Throw, 240 or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.
7. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240 and 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Double Throw, 240 and 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
4. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 ENCLOSURES

A. Enclosed Switches: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.
3. Kitchen Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4X stainless steel.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
6. Hazardous Areas as Indicated on Drawings: NEMA 250.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches for compliance with installation tolerances and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install individual wall-mounted switches with tops at uniform height unless otherwise indicated.
B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
C. Install fuses in fusible devices.
D. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

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

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch. Remove front panels so joints and connections are accessible to portable scanner.

b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch 11 months after date of Substantial Completion.

c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

END OF SECTION 26 28 16

SECTION 26 51 00 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Interior lighting fixtures.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.

B. Related Sections:

1. Section 26 09 23 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

2. Section 26 27 26 "Wiring Devices" for switch wall-boxes.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.
B. CRI: Color-rendering index.
C. HID: High-intensity discharge.
D. LER: Luminaire efficacy rating.
E. Lumen: Measured output of lamp and luminaire, or both.
F. Luminaire: Complete lighting fixture, including driver housing if provided.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.

2. Emergency lighting units including battery and charger.

3. Energy-efficiency data.

4. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.

5. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for driver lifetime and accessories identical to those indicated for the lighting fixture as applied in this Project.

    a. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Shop Drawings: For nonstandard or custom lighting fixtures. 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. Samples: May be requested for each lighting fixture indicated in the Lighting Fixture Schedule. Each Sample shall include the following:

1. Luminaires.
2. Cords and plugs.
3. Pendant support system.
4. Installation instructions.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) 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. Lighting fixtures.

2. Suspended ceiling components.

3. Structural members to which suspension systems for lighting fixtures will be attached.

4. Other items in finished ceiling including the following:

    a. Air outlets and inlets.
    b. Smoke and fire detectors.
    c. Occupancy sensors.
    d. Access panels.

5. Perimeter moldings.

B. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.

C. Product Certificates: For driver unit(s) for variable level or bi-level and dimmer-controlled fixtures, from manufacturer.

D. Field quality-control reports.

E. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

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

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 QUALITY ASSURANCE

A. All luminaires and drivers submitted shall be on the Consortium for Energy Efficiency (CEE) High Performance List or meet CEE High Performance Specifications.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

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.

D. Comply with NFPA 70.

E. FM Global Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

F. Mockups: Provide interior lighting fixtures for room or module mockups, complete with power and control connections.

1. Obtain Architect's approval of fixtures for mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.9 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: Five years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining years.

2. Warranty Period for Emergency and Self-Powered Exit Sign Batteries: Five years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining years.

1.10 EXTRA MATERIALS

A. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
B. Plastic Diffusers and Lenses: One for every 50 of each type and rating installed. Furnish at least one of each type.
C. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, product(s) indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. LED Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

F. Diffusers and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

a. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
b. UV stabilized.

2. Glass: Annealed crystal glass unless otherwise indicated.

G. Factory-Applied Labels: Comply with UL 1598. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following characteristics:

a. "USE ONLY" and include specific lamp type.
b. CCT and CRI for all luminaires.

2.3 LED LIGHTING

A. Bulb shape complying with ANSI C79.1.
B. Lamps dimmable from 100 percent to 1 percent of maximum light output.
C. Internal driver.
D. Nominal Operating Voltage: 120 to 277 volts.
E. In-line Fusing: On the primary for each luminaire.
F. Internal battery pack for emergency lighting when indicated.

2.4 EMERGENCY LED POWER UNIT

A. Internal Type: Self-contained driver, modular, battery-inverter unit, factory mounted within lighting fixture. Comply with UL 924.

1. Emergency Connection: Operate LED’s continuously at a reduced lumen output. Connect unswitched and switched circuit to battery-inverter unit.

2. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.

a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

3. Battery: Sealed, maintenance-free, nickel-cadmium type.

4. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.

2.5 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.

2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

a. Battery: Sealed, maintenance-free, nickel-cadmium type.

b. Charger: Fully automatic, solid-state type with sealed transfer relay.

c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

3. Master/Remote Sign Configurations:

a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in battery for power connection to remote unit.

b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

C. Self-Luminous Signs: Powered by tritium gas, with universal bracket for flush-ceiling, wall, or end mounting. Signs shall be guaranteed by manufacturer to maintain the minimum brightness requirements in UL 924 for 10 years.

D. Self-Luminous Signs: Using strontium oxide aluminate compound to store ambient light and release the stored energy when the light is removed. Provide with universal bracket for flush-ceiling, wall, or end mounting.

2.6 EMERGENCY LIGHTING UNITS

A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.

1. Battery: Sealed, maintenance-free, lead-acid type.

2. Charger: Fully automatic, solid-state type with sealed transfer relay.

3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.

7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.

8. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

2.7 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.
F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

2.8 LIGHT FIXTURE SCHEDULE

A. Refer to Light Fixture Schedule on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures:

1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
2. Install lamps in each luminaire.

B. Location:

1. Evenly proportioned in room except adjusted to conform to ceiling pattern as described below and except where otherwise shown or dimensioned.
2. Edges of fixtures parallel with walls.

C. Plaster Frames:

1. Provide for all recessed fixtures in plaster & gypsum board type ceilings.
2. Install in cooperation with General Contractor.

D. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.

E. Mounting:

1. Install all fixtures to hang true to vertical, free from finger marks, flaws, scratches, dents or other imperfections

2. Take care when hanging fixtures to not deface in any way, ceilings or walls.

3. Install continuous rows of fixtures in straight line; all fixtures at same level. Do not rotate fixtures about longitudinal axis with respect to one another.

4. Mount surface fixtures tight to surface without distorting it.

5. Provide proper mounting equipment and trim for recessed fixtures to adapt them to the ceiling or wall construction and to prevent light leaks around trim.

6. Provide special means for supporting fixtures as hereinafter specified, as shown on Drawings, or as required. Provide supports for each fixture capable of supporting 4 times fixture weight. Similar to rod hangers and clamps manufactured by Caddy Co.

7. Do not support outlet boxes by conduit.

8. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches from lighting fixture corners.

9. Support all lay-in and troffer light fixtures (1 x 4, or 2 x 2 and larger) at all four corners with fixture support clips, Caddy #515 (or approved equal). For seismic protection, provide a #8 ceiling system support wire on all four corners of each fixture.

10. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.

11. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.

12. Conduit and threaded rod hangers not permitted in finished spaces.

F. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.
5. Hang all stem mounted fixtures level with self-aligning hangers in canopies.
6. Gymnasium high-bay lighting fixtures shall be mounted so that fixture lens is at same elevation as bottom chord of roof truss, unless noted otherwise on drawings.

G. Mechanical Coordination:

1. Coordinate location of all hangers in rooms without ceilings with duct work, plumbing piping, sprinkler piping, etc.

2. Coordinate location of all hangers in rooms without ceilings with duct work, plumbing piping, sprinkler piping, etc.

3. Make all necessary offsets and extensions so that stems and fixtures avoid beams, pipes, ducts, etc.

4. Do not install in fan, storage, and equipment rooms until after all other mechanical work is in place.

5. Where fixtures are located below heating, ventilating, and air conditioning units, and/or ductwork and piping, provide trapeze hangers around obstruction and suspend fixture from trapeze hanger.

H. Architectural Coordination:

1. Locate all hangers at intersections of joints or at centers of blocks in rooms with acoustical tile or other patterned type of ceiling materials.

2. Space continuous row fixtures to conform with corresponding joint intersections.

3. Coordinate all ceiling layouts with general contractor and ceiling subcontractor and obtain architect's approval before proceeding.

4. Coordinate all ceiling layouts with general contractor and ceiling subcontractor and obtain architect's approval before proceeding.

5. Contractor responsible for electrical work: Verify ceiling construction and report in writing any discrepancies between ceiling type and fixture type before releasing fixtures for manufacture.

6. Coordinate all under cabinet lights with Architect before roughing.

I. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

1. Wire the emergency lighting units to the unswitched lighting circuit supplying the space served by the emergency lighting unit.

3.2 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Verify that self-luminous exit signs are installed according to their listing and the requirements in NFPA 101.

C. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

D. Remove and replace with new, all broken glassware, plastic or fixtures damaged before final acceptance at no additional expense to Owner.

E. No allowance made for breakage or theft before final acceptance.

F. Immediately prior to occupancy, damp clean all diffusers, glassware, fixture trims, reflectors, lamps, and replace burned- out lamps.

3.4 STARTUP SERVICE

A. Verify all luminaires function in conjunction with lighting control system and perform as intended.

1. Illumination is adequate and measured satisfactorily.
2. Dimming performs satisfactorily in accordance with specification.
3. 1 Hour of training of Owner includes technical information about luminaires and is completed in conjunction with lighting control specification.

3.5 UTILITY REBATES

A. Provide Owner with all receipts for the light fixtures, luminaires, etc. eligible for current utility rebate programs at completion of Contract, allowing Owner to apply for rebates and schedule utility company inspections. Provide copy to Architect for record.

END OF SECTION 26 51 00

SECTION 26 56 00 – LED EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
2. Luminaire supports.
3. Luminaire-mounted photoelectric relays.
4. Poles and accessories.

B. Related Requirements:

1. Section 26 09 23 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

2. Section 26 51 00 "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.
B. CRI: Color rendering index.
C. Fixture: See "Luminaire."
D. IP: International Protection or Ingress Protection Rating.
E. Lumen: Measured output of lamp and luminaire, or both.
F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, applied as stated in AASHTO LTS-4-M.

B. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-4-M Ice Load Map.

C. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.

1. Basic wind speed for calculating wind load for poles 50 feet high or less is 90 mph.

a. Wind Importance Factor: 1.0.
b. Minimum Design Life: 25 years.
c. Velocity Conversion Factors: 1.0.

1.5 ACTION SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.

2. Details of attaching luminaires and accessories.

3. Details of installation and construction.

4. Luminaire materials.

5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, drivers, and accessories.

a. Testing Agency Certified Data: For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

b. Manufacturer Certified Data: Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

6. Photoelectric relays.

7. LED Drivers, including energy-efficiency data.

8. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.

9. Materials, dimensions, and finishes of poles.

10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.

11. Anchor bolts for poles.

12. Manufactured pole foundations.

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. Anchor-bolt templates keyed to specific poles and certified by manufacturer.

3. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.

4. Wiring Diagrams: For power, signal, and control wiring.

C. Samples: For products designated for sample submission in the Exterior Lighting Device Schedule. Each Sample shall include lamps and drivers.

1.6 INFORMATIONAL SUBMITTALS

A. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a professional engineer.

B. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.

C. Field quality-control reports.

D. Warranty: Sample of special warranty.

1.7 CLOSEOUT SUBMITTALS

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

1.8 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. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: One for every 10 of each type and rating installed. Furnish at least one of each type.
2. Diffusers and Lenses: One for every 10 of each type and rating installed. Furnish at least one of each type.
3. Globes and Guards: One for every 10 of each type and rating installed. Furnish at least one of each type.

1.9 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by 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, accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.

C. Provide luminaires from a single manufacturer for each luminaire type.

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. Comply with IEEE C2, "National Electrical Safety Code."

F. Comply with NFPA 70.

G. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

H. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces of luminaires by applying a strippable, temporary protective covering prior to shipping.
B. Package aluminum poles for shipping according to ASTM B 660.
C. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
D. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation. Handle poles with web fabric straps.
E. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.11 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.
B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.12 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
3. Warranty Period for Color Retention: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product indicated on Drawings.

2.2 LUMINAIRE REQUIREMENTS

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

1. LER Tests Incandescent Fixtures: Where LER is specified, test according to NEMA LE 5A.
2. LER Tests Fluorescent Fixtures: Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
3. LER Tests HID Fixtures: Where LER is specified, test according to NEMA LE 5B.

B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. UL Compliance: Comply with UL 1598.

D. CRI of 80. CCT of 3000 K.

E. L70 lamp life of 50,000 hours.

F. Lamps dimmable from 100 percent to 1 percent of maximum light output.

G. Internal driver.

H. Nominal Operating Voltage: 120 V ac/208 V ac.

I. In-line Fusing: Separate in-line fuse for each luminaire.

J. Lamp Rating: Lamp marked for outdoor use.

K. Source Limitations: Obtain luminaires from single source from a single manufacturer.

L. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

M. Metal Parts: Free of burrs and sharp corners and edges.

N. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.

O. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

P. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect driver when door opens.

Q. Exposed Hardware Material: Stainless steel.

R. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

S. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

T. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

U. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

V. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

W. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning", or SSPC-SP 8, "Pickling."

2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

   a. Color: As selected from manufacturer's standard catalog of colors.
   b. Color: Match Architect's sample of manufacturer's standard color.
   c. Color: As selected by Architect from manufacturer's full range.

X. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.

3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

Y. Photoelectric Sensor Controller

1. Mounted to luminaire location or integral to luminaire.
2. UL Listed by UL Standard 773A.

2.3 MATERIALS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Sheet Metal Components: Corrosion-resistant aluminum. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.

D. Diffusers and Globes:

1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Lens Thickness: At least 0.250 inch minimum unless otherwise indicated.

E. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

F. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

G. Housings:

1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
2. Provide filter/breather for enclosed luminaires.

H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

a. "USE ONLY" and include specific lamp type.
b. Lamp diameter, shape, size, wattage and coating.
c. CCT and CRI for all luminaires.

2.4 FINISHES

A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.

3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

4. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.

    a. Color: Dark bronze, unless otherwise noted.

D. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.

2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

    a. Color: As selected from manufacturer's standard catalog of colors.
    b. Color: Match Architect's sample of manufacturer's standard color.
    c. Color: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicate structural supports.

1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Adjust luminaires that require field adjustment or aiming.

3.2 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch-wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch below top of concrete slab.

C. Raise and set poles using web fabric slings (not chain or cable).

3.3 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Section 26 05 33 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.4 GROUNDING

A. Ground metal poles and support structures according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole unless otherwise indicated.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground nonmetallic poles and support structures according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole.
2. Install grounding conductor and conductor protector.

C. Ground metallic components of pole accessories and foundations.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):

   a. IES LM-5.
   b. IES LM-50.
   c. IES LM-52.
   d. IES LM-64.
   e. IES LM-72.

2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

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

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 26 56 00

SECTION 26 58 10 – FOOTBALL/LACROSSE SCOREBOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section and to all of Divisions 26.

1.2 SECTION INCLUDES

A. Single-sided LED Football/Lacrosse scoreboard.
B. Single-sided LED Delay of Game clocks

1.3 REFERENCES

A. Standard for Electric Signs, UL 48.
B. Standard for CSA C22.2 #207.
C. Federal Communications Commission Regulation Part 15.
D. National Electric Code.

1.4 SUBMITTALS

A. Product data: Submit manufacturer’s product illustrations, data and literature that fully describe the scoreboards and accessories proposed for installation.
B. Shop drawings: Submit mechanical and electrical drawings.
C. Maintenance data: Submit manufacturer’s installation, operation, and maintenance manuals.

1.5 DELIVERY, STORAGE AND HANDLING

A. Product delivered on site.
B. Scoreboard and equipment to be housed in a clean, dry environment.

1.6 PROJECT CONDITIONS

A. Environmental limitations: Do not install scoreboard equipment until mounting structure is secure and concrete has ample time to cure.
B. Field measurements: Verify position and elevation of structure and its layout for scoreboard equipment. Verify dimensions by field measurements.
C. Verify mounting structure is capable of supporting the scoreboard's weight and windload in addition to the auxiliary equipment.
D. Installation may proceed within acceptable weather conditions.

1.7 QUALITY ASSURANCE

A. For outdoor use.
B. Source Limitations: Obtain each type of scoring or related equipment through one source from a single manufacturer.
C. ETL listed to UL 48.
D. NEC compliant.
E. FCC compliant.
F. ETLC listed to CSA 22.2 #207.

1.8 WARRANTY

A. Provide 5 years of no cost parts exchange including standard shipping on electronics parts and radios due to manufacturing defects.
B. Provide toll-free service coordination.
C. Provide technical phone support during Daktronics business hours.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Daktronics, Inc., 201 Daktronics Drive, P.O. Box 5128, Brookings, SD 57006-5128.

B. Subject to compliance with requirements and properties of the product listed, products from other manufacturers will be considered if submitted prior to bid in accordance with the stipulations in the Instructions to Bidders.

2.2 PRODUCT

A. Daktronics FB-2021 single-sided football scoreboard displays period time to 99:59, HOME and GUEST scores to 99, and DOWN/TO GO/BALL ON/QTR (quarter) information. T.O.L. (time outs left) to nine are optional. Arrows indicate possession. During the last minute of the period, the clock displays time to 1/10 of a second.

B. Daktronics TI-2015 segment timer displays the segment number, which can be set to start flashing when a preset limit (warning time) is reached. An audible horn sounds at the end of segments. The timer can also be configured to count up or down from any preset number from 0 to 99 or used as a speed of pitch display for baseball.

2.3 SCOREBOARD

A. General information

1. Dimensions: 8'-0" high, 25'-0" wide, 0'-8" deep.
2. Base weight: 820 lb with vinyl captions – options may increase weight.
3. Base power requirement: 600 W with vinyl captions – options may increase wattage.
4. Color: provide over 150 colors to choose from.

B. Construction

1. Alcoa aluminum alloy 5052 for excellent corrosion resistance.
2. Scoreboard back, face, and perimeter: 0.063" thick.
3. Scoreboard top and bottom: 0.125" thick.

C. Digits & Indicators

1. LED color: Red.
2. Clock digits: 30" high.
3. HOME, GUEST, DOWN, TO GO, BALL ON, and QTR digits: 24"high.
4. Seven bar segments per digit.
5. PanaView® LED digit technology.
6. All digits and indicators are sealed front and back with weather-tight silicone gel.

D. Captions

1. Vinyl applied directly to scoreboard face.
2. HOME and GUEST captions: 15" high.
3. DOWN, TO GO, BALL ON, and QTR captions: 12" high.
4. Color: standard white or others available upon request.

E. Additional Equipment

1. Vinyl striping applied around the clock and scoreboard face.
2. Programmable Team Name Message Centers (TNMCs) – add 120 lb and 270 W.
3. Electronic captions – add 160 lbs and 670 W.
4. Two 18" T.O.L. digits with two 12" captions.
5. LED Colon.
6. Horn.

2.4 DELAY OF GAME CLOCKS

A. General information

1. Dimensions: 2'-4" high, 3'-4" wide, 0'-8" deep.
2. Weight: 36 lb.
3. Power requirement: 300 W.
4. Color: semi-gloss black.

B. Construction

1. Alcoa aluminum alloy 5052 for excellent corrosion resistance.
2. Display back, face, and perimeter: 0.063" thick.

C. Digits

1. LED color: Red.
2. Clock digits: 24" high.
3. Seven bar segments per digit.

4. PanaView® LED digit technology.
5. All digits are sealed front and back with weather-tight silicone gel.

D. Horn

1. Vibrating horn mounted inside the scoreboard cabinet behind face.
2. Sounds automatically when period clock counts down to zero.
3. Sounds manually as directed by operator.

E. Additional Equipment

1. Individual digit protective screens

2.5 SCORING CONSOLE

A. Console is an All Sport® 5000 controller.

B. Scores multiple sports using changeable keyboard inserts.

C. Controls multiple scoreboards and displays, including other All Sport 5000 controlled displays currently owned by customer.

D. Recalls clock, score, and period information if power is lost.

E. Console capable of automatically calculating and displaying DOWN & TO GO for each play.

F. Runs Time of Day and Segment Timer modes.

G. Console includes:

1. Rugged aluminum enclosure to house electronics.
2. Sealed membrane water-resistant keyboard.
3. 32-character LCD to verify entries and recall information currently displayed.
4. Power cord that plugs into a standard grounded outlet; 6 watts max.
5. Control cable to connect to the control receptacle junction box (wired system only).
6. Hand-held switch for main clock start/stop and horn.
7. Soft-sided carrying case.

H. Additional Equipment

1. 2.4 GHz spread spectrum radio system with frequency hopping technology and 64 non-interfering channels; system includes a transmitter installed inside the console and a receiver installed inside the scoreboard(s)

2. Hard carrying case

3. Battery pack

2.6 SPONSOR/IDENTIFICATION PANEL

A. Non-backlit logo/sponsor panels: 2’-0” high, 25’-0” wide.

1. Construction

a. Signage cabinetry and metal parts shall be made of durable, lightweight aluminum
b. All sheet metal parts shall be constructed of 0.050"aluminum with an alloy content of 5052-H34 minimum.
c. All painted surfaces shall be primed and painted using automotive industrial finish or better.

2. Sign decoration

a. Sign decoration shall be constructed using self-adhesive vinyl materials with a minimum of a 3-year outdoor warranty
b. Digitally produced graphics shall be 3M Scotchprint® or equivalent

2.7 DECORATIVE TRUSS WORK

A. Bidder shall provide decorative truss accent mounted on top of the scoring system.

B. Dimensions: up to 4’-0” high, 25’-0” wide.

C. Construction: 3” square structural grade aluminum tubing with an alloy composition of 6061-T6.

D. Color: over 150 colors to choose from

1. Display includes aluminum channel letters that spell the school name and mascot.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that mounting structure is ready to receive scoreboard. Verify that placement of conduit and junction boxes are as specified and indicated in plans and shop drawings. Verify concrete has cured adequately according to specifications.

3.2 INSTALLATION

A. All power and control cables to scoreboards and displays will be routed in conduit. Power to the scoreboards/displays as well as raceways shown on electrical plans by the Electrical Contractor. Scoreboard control wiring including conduit will be the responsibility of the contractor assigned the scoreboard equipment.

B. Install scoreboards and exterior displays to beams in location detailed and in accordance with manufacturer's instructions. Verify unit is plumb and level.

3.3 INSTALLATION – CONTROL CENTER

A. Provide boxes, cover plates and jacks in locations per plans.

B. Test connect control unit to all jacks and check for proper operation of control unit, scoreboard and all features. Leave control unit in carrying case and other loose accessories with owner's designated representative.

C. Verify earth ground does not exceed 15 ohms.

END OF SECTION 26 58 10

SECTION 27 05 00 – COMMON WORK RESULTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. General requirements applicable to components and systems included in Electric Contract.

B. Products Installed but Not Furnished Under This Section

1. Make electrical connections to equipment shown on Drawings and furnished by other Contractors. Obtain approved wiring diagrams and location drawings for roughing in and final connections from Contractor furnishing equipment.

1.3 REFERENCES

A.	AIA	American Institute of Architects
B.	ADA	Americans with Disabilities Act
C.	AISC	American Institute of Steel Construction
D.	ANSI	American National Standards Institute
E.	ASTM	American Society for Testing and Materials International
F.	IBC	International Building Code
G.	IEEE	Institute of Electrical and Electronics Engineers, Inc. (The)
H.	IES	Illuminating Engineering Society of North America
I.	NEC	National Electrical Code
J.	NEMA	National Electrical Manufacturers' Association
K.	NETA	International Electrical Testing Association
L.	NFPA	National Fire Protection Association
M.	UL	Underwriters' Laboratories, Inc.

1.4 DEFINITIONS

A. “Existing”: Equipment depicted on Drawings with an “E” designation denotes existing equipment to remain.

B. "Move": Equipment depicted on Drawings with an "M" designation denotes existing equipment to relocate. Disconnect equipment, remove circuitry to a point beyond demolition and tag for reuse, store equipment for reuse and reinstall as specified in Contract Documents. Modify/extend circuitry to new equipment locations and reconnect. The Contractor is responsible for protecting equipment from damage during removal, storage and reinstallation.

C. "Replace": Equipment depicted on Drawings with an "R" designation denotes existing equipment to replace. Refer to relevant Project Manual Specification for additional information and requirements.

1.5 SYSTEM DESCRIPTIONS

A. Inspection of Existing Systems: Inspect each existing system scheduled for modification in presence of Authorized Owner's Representative and issue a deficiency report to Owner and Architect listing conditions found prior to any removals, relocations, or additions. Modified systems include (but are not limited to):

1. Computer Network Cabling System.
2. IP Security System

B. Design Requirements - Provide complete systems, properly tested, balanced, and ready for operation including necessary details, items and accessories although not expressly shown or specified, including (but not limited to):

1. Wiring and raceway for work specified in Project Manual and shown on Drawings.

2. Electrical devices and equipment for work specified in Project Manual and shown on Drawings.

3. Systems included, but not limited to:

a. Computer Network Cabling System.
b. IP Security System

1.6 SUBMITTALS

A. General Division 27 submittal requirements:

1. Product Data: Submit product data for items listed in individual technical section. Clearly identify manufacturer, pertinent design, function, materials, construction and performance data specifically addressing specification description and Contract Document requirements of item. Strike out products that are not applicable to item being submitted, where more than one product is indicated on manufacturer product literature.

2. Shop Drawings: Submit detailed drawings for electrical equipment layouts, showing exact sizes and locations for approval before beginning work.

1.7 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Codes and Standards: Comply with applicable Federal, State and local building and electrical codes, laws, ordinances, and regulations, and comply with applicable NFPA, National Electrical Code and utility company requirements and regulations. Provide Underwriters Laboratories Seal on all materials.

2. Permits and Inspections: Obtain approvals, tests, and inspections required by Architect, Engineer, local electrical inspector, agent or agency specified in Project Manual, or National, State, or local codes and ordinances.

   a. Schedule electrical inspection by an agency acceptable to the local authority having jurisdiction and submit final inspection certificate to Architect.
   b. Furnish materials and labor necessary for tests and pay costs associated with tests and inspections.
   c. Conduct tests under load for load balancing and where required by codes, regulations, ordinances, or technical Specification.

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

1.8 DELIVERY, STORAGE AND HANDLING

A. Storage and Protection:

1. Take precautions to store materials and products to protect finishes and not permit dust and dirt to penetrate equipment.
2. Replace equipment damaged beyond reasonable repair as required by Architect.
3. Refinish any equipment with marks, stains, scratches, dents, and other aesthetic damage that doesn't impede operation of equipment as required by Architect.

1.9 COORDINATION OF WORK

A. Existing Construction:

1. Unless otherwise specified, employ Contractor responsible for General Work for all cutting, patching, repairing and replacing of general work required for installation of systems and components included in Electric Work. Secure approval from Architect's representative before cutting.

2. Anchor Bolts: Deliver to Contractor responsible for General Work anchor bolts required for Electric Work construction that are to be installed in construction included in General Contract. Provide templates or holding fixtures as required to maintain proper accuracy.

3. Access Doors: Provide access doors shown on Drawings, or as required for access to pull boxes, junction boxes, relays and other electrical devices requiring periodic inspection, adjustment or maintenance, where located above or within inaccessible walls or ceilings, and including cutting and patching of adjacent walls and ceilings to match existing materials and finishes.

1.10 ALTERATION PROCEDURES

A. In locations where existing devices are indicated to be disconnected and removed and existing power circuit or communications cable is not scheduled to be reused:

1. Provide blank cover plates or wall infill (as indicated on plans) and as described below:

a. For single gang and multi-gang switch boxes in public or occupied spaces; stainless steel coverplates.

b. For single gang and multi-gang boxes in un-occupied spaces; stainless steel, galvanized steel or PVC coverplates.

c. For boxes larger than standard switch boxes in public or occupied spaces; remove existing box and provide wall infill, matching existing sub-surface and finished surface conditions. Paint wall to match surrounding finishes.

d. For boxes larger than standard switch boxes in un-occupied spaces; 18 gage galvanized sheet metal coverplate with machined edges. Prime and paint to match surrounding finish conditions.

2. Patch and paint existing walls where disturbed by the electrical work.

B. In locations where existing devices are to remain in place, ensure circuits feeding such devices remain operational. Modify existing circuits as required to allow new construction to occur and to maintain necessary circuitry to existing devices for complete and proper operation.

C. In locations where entire existing system is being removed or modified:

1. Refer to individual system specification sections for documentation and inspection requirements prior to any alteration work on any system.
2. Take all necessary measures to ensure that down time will not compromise safety.
3. Notify Owner, Architect and other Contractors not less than 2 weeks prior to interruptions in service.
4. Coordinate work schedule to minimize duration of system outage during hours when building is occupied.

PART 2 - PRODUCTS

2.1 PENETRATION FIRESTOPPING

A. Comply with requirements for sealants in fire rated penetrations specified in Section 07 84 13 “Penetration Firestopping”.

B. Submit Manufacturers Product Data Sheets for each type of product selected. Certify that Firestop Material is free of asbestos and lead paint, and complies with local regulations.

1. Certification by firestopping manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs) and are nontoxic to building occupants.

C. Submit system design listings, including illustrations from qualified testing and inspection agency that is applicable to each firestop configuration.

D. Submit a project specific Penetration Firestopping Schedule indicating where each firestop configuration will be used.

PART 3 - EXECUTION

3.1 CUTTING AND PATCHING

A. Do not cut waterproofed floors or walls for admission of any equipment or materials and do not pierce any structural members without written permission from Architect.

B. Furnish and install sleeves, inserts, panels, raceways, boxes, and similar infrastructure., ahead of general construction work and maintain Contractor personnel at Site during installation of general construction work to be responsible for and to maintain these items in position.

C. Unless otherwise noted elsewhere in Contract Documents, bear expense of cutting, patching, repairing or replacing of work of other trades made necessary by any fault, error or tardiness on part of Electrical Contract or damage done by Electric Contract. Employ and pay Contractor whose work is involved.

3.2 DEMONSTRATION OF COMPLETE ELECTRICAL SYSTEMS

A. Thoroughly demonstrate and instruct Owner's designated representative in care and operation of electrical systems and equipment furnished and installed in Electric Contract.

1. System Operator: Maintain competent operator at building for at least 2 days in 2 consecutive weeks after Owner takes occupancy of major parts of building to operate systems and equipment in presence of Owner's representative.

2. Factory Representative: In addition to demonstration and instruction specified above, provide technically qualified factory representatives from manufacturers of major equipment, to train Owner's representatives in care and operation of applicable products as specified in applicable technical sections of Division 26.

3. Coordinate and schedule time and place of all training through the Architect at the Owner’s convenience.

4. Submit letters attesting to satisfactory completion of instructions, including date of completion of instruction, names of persons in attendance, and signature of Owner’s authorized representative.

5. The following equipment and systems are included:

    a. Computer Network Cabling Systems.
    b. IP Security System.

3.3 FIRESTOPPING

A. Install firestopping according to the requirements specified in Section 07 84 13 “Penetration Firestopping.”

B. Applied Fireproofing:

1. Coordinate the installation of hangers, supports and accessories from the structural steel with the fireproofing installation. Install all hangers and supports prior to installation of fireproofing.

2. Repair or replace existing fireproofing removed as a part of Electrical Work installation.

    a. Employ the services of an approved fireproofing contractor to repair or replace the fireproofing by patching any areas that have been removed or damaged due to the installation of work after the completion of the fireproofing.

C. Repaired or replacement fireproofing shall match the fireproofing adjacent to the repaired area. All warranties shall be maintained.

END OF SECTION 27 05 00

SECTION 27 05 26 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes: Grounding and bonding systems and equipment.

1.3 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. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

2.2 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install stranded conductors for all sizes unless otherwise indicated.

B. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.

C. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.

1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch grounding bus.

3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

3.4 LABELING

A. Comply with requirements in Division 27 Section "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.

3.5 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

END OF SECTION 27 05 26

SECTION 27 05 28 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Innerduct.
4. Cable trays.
5. Surface pathways.
6. Boxes, and enclosures.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.
B. ENT: Electrical nonmetallic tubing.
C. EPDM: Ethylene-propylene-diene terpolymer rubber.
D. FMC: Flexible metal conduit.
E. RMC: Rigid metal conduit.
F. LFMC: Liquidtight flexible metal conduit.
G. LFNC: Liquidtight flexible nonmetallic conduit.
H. NBR: Acrylonitrile-butadiene rubber.
I. RNC: Rigid nonmetallic conduit.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of pathway groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Seismic Qualification Certificates: For pathway racks, enclosures, cabinets, equipment racks and their mounting provisions, including those for internal components, from manufacturer.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Manufacturers: Products that may be incorporated into the Work include, but are not limited to, the following:

1. AFC Cable Systems, Inc.
2. Alflex Inc. Allied Tube & Conduit; a Tyco International Ltd. Co.
3. Anamet Electrical, Inc.
4. Electri-Flex Co.

B. Rigid Metal Conduit (RMC): Rigid, hot dipped, galvanized steel with galvanized threaded malleable iron fittings and bushings with insulated throat (galvanized steel). ANSI C80.1.

1. Electrical Metallic Tubing (EMT): and bushings with insulated throat (galvanized steel). ANSI C80.3. Provide space saver EMT conduit connectors, in compression or set screw type as called for in the detailed drawings for: cable tray, raceway entrance end fittings, and backbox connections for communication cabling – to maximize the cable bend radius, cross-sectional area and cable fill ratios.

2. Acceptable manufacturers: Cooper Crouse-Hinds, Space-Saver Series (use Basis-of-Design paragraph for this type of specifying—see me re format)

C. Flexible Metal Conduit (FMC): Zinc-coated steel, flexible, galvanized, interlocked metal strip with galvanized screw-in type steel fittings.

D. Liquid Tight Flexible Metal Conduit (LFMC) : Liquid-tight flexible metal raceway with single, flexible, continuous, interlocked and double-wrapped steel core galvanized inside and outside, coated with liquid tight jacket of flexible polyvinyl chloride (PVC).

E. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

1. Fittings for RMC: Galvanized threaded malleable iron fittings and bushings with insulated throats (galvanized steel).
2. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.

F. Joint Compound for Rigid Steel Conduit: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Manufacturers: Products that may be incorporated into the Work include, but are not limited to, the following:

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit; a Tyco International Ltd. Co.

3. Anamet Electrical, Inc.
4. Arnco Corporation.
5. CANTEX Inc.
6. CertainTeed Corp.
7. Condux International, Inc.

B. General Requirements for Nonmetallic Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

2.3 INNERDUCT

A. Construct of a PVC Riser rated or plenum rated plastic as required.

B. For riser installations, ~~shall~~ meet NEC 770-53 requirements.

C. Shall be either 0.75”, 1" or 1.25" in diameter as called for on the Drawings or as directed by Owner. White or orange in color.

D. Maximum flame rating of UL 910.

E. Design Make: Pyramid Industries, Inc., # IN RHF100T (with pull rope)

F. Acceptable Manufacturers:

1. Endot
2. Carlon Dura-Line
3. Arnco

2.4 SPLIT INNER DUCT

A. Shall be constructed of a pliable PVC Riser rated or plenum rated plastic as required.

B. For riser installations, shall meet NEC 770-53 requirements.

C. Shall be 1 1/2" to 2” in diameter, so as to fit over smaller diameter inner duct with some overlap, and allow ready access in pass-thru closets, pull boxes, and manholes, or any where there is a break, opening or missing section in the smaller innerduct.

D. Shall be orange or grey in color.

E. Shall have a maximum flame rating of UL 910.

F. Design Make: Carlon Core Duct , color to be determined by Owner and general availability.

G. Acceptable Manufacturers:

1. Endot

2. Dura-Line
3. Arnco
4. Pyramid Industries

2.5 METAL WIREWAYS AND CABLE TRAYS

A. Cable Trays:

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. Cablofil Inc.
    b. Cooper B-Line, Inc.
    c. Cope - Tyco/Allied Tube & Conduit.
    d. Mono-Systems, Inc.
    e. Square D; a brand of Schneider Electric.

2. Cable Tray Material: Metal, suitable for indoors, and protected against corrosion by hot-dip galvanizing, complying with ASTM A 123/A 123M, Grade 0.55, not less than 0.002165 inches thick.

    a. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

    b. Comply with TIA-569-B.

    c. Basket Cable Trays: 6 inches wide and 2 inches deep . Wire mesh spacing shall not exceed 2 by 4 inches.

    d. Trough Cable Trays: Nominally 6 inches wide.

    e. Ladder Cable Trays: Nominally 18 inches wide, and a rung spacing of 12 inches.

    f. Channel Cable Trays: One-piece construction, nominally 4 inches wide. Slot spacing shall not exceed 4-1/2 inches o.c.

    g. Solid-Bottom Cable Trays: One-piece construction, nominally 12 inches wide. Provide without solid covers.

B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

C. Wireway Covers: Hinged type unless otherwise indicated.

D. Finish: Manufacturer's standard enamel finish.

2.6 SURFACE PATHWAYS

A. General Requirements for Surface Pathways:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

B. Surface Metal Pathways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.

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

a. Mono-Systems, Inc.
b. Niedax-Kleinhuis USA, Inc.
c. Panduit Corp.
d. Wiremold / Legrand.

C. Surface Nonmetallic Pathways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL-94 V-0 requirements for self-extinguishing characteristics.

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

a. Mono-Systems, Inc.
b. Niedax-Kleinhuis USA, Inc.
c. Panduit Corp.
d. Wiremold / Legrand.

D. Tele-Power Poles:

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

a. Mono-Systems, Inc.
b. Panduit Corp.
c. Wiremold / Legrand.

2. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

A. Indoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.

2. Exposed, Not Subject to Severe Physical Damage: EMT.

3. Exposed and Subject to Severe Physical Damage: GRC. Pathway locations include the following:

a. Loading dock.
b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
c. Mechanical rooms.
d. Gymnasiums

3.2 INSTALLATION

A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

B. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

C. Complete pathway installation before starting conductor installation.

D. Arrange stub-ups so curved portions of bends are not visible above finished slab.

E. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.

F. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

G. Support conduit within 12 inches of enclosures to which attached.

H. Stub-ups to Above Recessed Ceilings:

1. Use EMT for pathways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

I. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.

J. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

K. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

L. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

M. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

N. Surface Pathways:

1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.

2. Install surface pathway with a minimum 2-inch radius control at bend points.

3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

O. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:

1. 1-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet .

2. 1.25-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.

3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

P. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway sealing fittings according to NFPA 70.

Q. Install devices to seal pathway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service pathway enters a building or structure.
3. Where otherwise required by NFPA 70.

R. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 27 Section "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.4 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 27 05 28

SECTION 27 05 33 - RACEWAY AND BOXES FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.
B. ENT: Electrical nonmetallic tubing.
C. EPDM: Ethylene-propylene-diene terpolymer rubber.
D. FMC: Flexible metal conduit.
E. RMC: Rigid metal conduit
F. LFMC: Liquidtight flexible metal conduit.
G. LFNC: Liquidtight flexible nonmetallic conduit.
H. NBR: Acrylonitrile-butadiene rubber.
I. RNC: Rigid nonmetallic conduit.

1.4 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. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

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:

1. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Allied Tube & Conduit; a Tyco International Ltd. Co.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. Electri-Flex Co.

6. O-Z Gedney; a unit of General Signal.
7. Wheatland Tube Company.

B. Rigid Metal Conduit (RMC): Rigid, hot dipped galvanized steel with galvanized threaded malleable iron fittings and bushings with insulated throat (galvanized steel). ANSI C80.1.

C. Electrical Metallic Tubing (EMT): Metallic galvanized steel tube with galvanized steel compression or setscrew type fittings and bushings with insulated throat (galvanized steel). ANSI C80.3.

D. Flexible Metal Conduit (FMC): Flexible, interlocked galvanized zinc-coated steel metal strip with galvanized screw-in type steel fittings.

E. Liquid Tight Flexible Metal Conduit (LFMC) : Liquid-tight flexible metal raceway with single, flexible, continuous, interlocked and double-wrapped steel core galvanized inside and outside, coated with liquid tight jacket of flexible polyvinyl chloride (PVC).

F. Joint Compound for Rigid Steel Conduit: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

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:

1. AFC Cable Systems, Inc.
2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. Arnco Corporation.
4. CANTEX Inc.
5. CertainTeed Corp.; Pipe & Plastics Group.
6. Condux International, Inc.
7. ElecSYS, Inc.
8. Electri-Flex Co.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT/Cole-Flex.
11. RACO; a Hubbell Company.
12. Thomas & Betts Corporation.

B. RNC: NEMA TC 2, Type EPC-40-PVC**,** with matching fittings by same manufacturer as the conduit complying with NEMA TC# and UL 514B.

C. LFNC: UL 1660.

D. Fittings for LFNC: UL 514B.

2.3 METAL WIREWAYS

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:

1. Cooper B-Line, Inc.
2. Hoffman.
3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, 12, 3R, as indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type or as indicated with manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.

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:

a. Hubbell, Inc.
b. Thomas & Betts Corporation.
c. Walker Systems, Inc.; Wiremold Company (The).
d. Wiremold Company (The); Electrical Sales Division.

B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors.

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:

a. Butler Manufacturing Company; Walker Division.
b. Enduro Systems, Inc.; Composite Products Division.
c. Hubbell Incorporated; Wiring Device-Kellems Division.
d. Lamson & Sessions; Carlon Electrical Products.
e. Panduit Corp.
f. Walker Systems, Inc.; Wiremold Company (The).
g. Wiremold Company (The); Electrical Sales Division.

2.5 BOXES, ENCLOSURES, AND CABINETS

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:

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
3. Erickson Electrical Equipment Company.
4. Hoffman.
5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
6. O-Z/Gedney; a unit of General Signal.
7. RACO; a Hubbell Company.
8. Robroy Industries, Inc.; Enclosure Division.
9. Scott Fetzer Co.; Adalet Division.
10. Spring City Electrical Manufacturing Company.
11. Thomas & Betts Corporation.
12. Walker Systems, Inc.; Wiremold Company (The).
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

B. Outlet Boxes

1. Materials

a. Recessed Applications and Exposed Applications in Unfinished Spaces: Galvanized, stamped steel.

b. Boxes in stud walls shall be 4" square, 2 1/8" deep boxes with raised covers for power circuits. Provide "Far-Side" box support to keep box alignment parallel with wall face.

c. Boxes in masonry walls shall be 3 ½" deep masonry boxes, single or multigang as required

d. Exposed Applications: In finished spaces requiring exposed applications, provide boxes to match surface raceway system. In situations where surface mount conduits are allowed, condulet style boxes shall be used. Where surface mount devices are provided as components of specific systems, provide surface mount box from same manufacturer to match device.

e. Concrete and Wall in Wet Locations: Heavy duty cast aluminum, thermoset protective silver grey finish, with threaded mounting posts.

f. Weatherproof Outlet Boxes: Corrosion-resistant cast metal weatherproof outlet wiring boxes of appropriate type, shape, size and depth, with threaded conduit ends and cast metal face plates with cover suitably configured for each application~~,~~ and including face plate gaskets and corrosion resistant fasteners. Do not compromise outlet weatherproof integrity when attachment plug is inserted.

g. Junction and Pull Boxes: Galvanized code gauge sheet steel boxes with screw-on covers, of appropriate type, shape and size suitable for box location and installation with welded seams and equipped with stainless steel nuts, bolts, screws and washers.

2. Size: As required for number and size of raceways and conductors. Depth to suit wall depth and device installed.

3. Covers: Design and style for each type, outlet, junction box, etc.; NEMA rated for each location.

C. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic.

D. Cabinets:

1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Raceway Installation: Securely support raceway from building construction, separately from outlet boxes and junction boxes. Secure to masonry surfaces with expansion anchors. Use galvanized hanger rods, inserts and hangers. Conceal all raceway runs except in mechanical rooms, storage room ceilings, and areas above suspended ceilings. Run exposed raceway neatly, parallel and level, to ceilings, walls and floors. Make necessary offsets and bends to comply with construction. Install expansion fittings at all building expansion joints. Support all raceways with clamps per National Electric Code

1. RMC Installation: Use RMC in concrete slabs, below concrete slabs, below grade, damp locations, exterior locations and in hazardous locations. Where exposed leaving concrete slabs, extend minimum 6 inches above and below slabs. Use RMC elbows when penetrating concrete slab from PVC raceway below or in slabs.

2. RNC: Use for underground applications, in slabs, and below slabs. Provide rigid raceway when extending through slabs. Make solvent-cemented joints in accordance with recommendations of manufacturer.

3. EMT: Use EMT for non-hazardous, dry locations above grade. As a minimum, use EMT in corridor ceilings, for home runs and in all unoccupied exposed interior areas. Surface mounted EMT shall not be used in finished areas without written permission from the Architect or Owner.

4. FMC: Use flexible metal conduit for final connections to motors, step-down transformers, vibrating machines, etc. Terminate with clamp type connectors and anti-short bushing. Maximum length of three feet.

5. LFMC: Use a maximum of two feet of liquid tight flexible conduit for connection of motors and for other electrical equipment where subject to movement and vibration and also where subjected to one or more of the following conditions

    a. Exterior location.
    b. Moist or humid atmosphere where condensate can be expected to accumulate.
    c. Corrosive atmosphere.
    d. Subjected to water spray.
    e. Subjected to dripping oil, grease or water

6. LFNC: Use a maximum of three feet of liquid tight flexible nonmetallic conduit for connection to video cameras and other electrical equipment with extreme bending requirements and also where subjected to one or more of the following conditions:

    a. Exterior location.
    b. Corrosive atmosphere.

7. All non-metallic or flexible conduit shall contain a separate grounding conductor in addition to the circuit conductors.

8. Do not secure branch circuit wiring to ceiling support wires. Provide independent support wires dedicated only to electrical raceways.

9. Use roughing-in dimensions of electrically operated units furnished by supplier. Set conduit and boxes for connection to units only after receiving dimensions and after checking location with other trades.

10. Provide nylon pull cord in empty raceways. Test empty raceways with ball mandrel. Clear any raceway that rejects ball mandrel. Restore raceway and surrounding surfaces to original condition.

11. Fasten raceway terminations in sheet metal enclosures by 2 locknuts and terminate with bushing. Install locknuts inside and outside of enclosure.

12. Do not cross pipe shafts or ventilating duct openings with raceways.

13. Keep raceways at least 6 inches from parallel runs of flues, hot water pipes or other sources of heat. Wherever possible, install horizontal raceway runs above water and steam piping.

B. Concealed Raceways

1. Paint raceway threads in metallic raceways installed underground, in floors below grade, or outside with corrosion-inhibiting compound before assembling couplings. Draw coupling and raceway sufficiently tight to ensure water tightness.

2. For floors-on-grade, install raceways under concrete slabs.

3. Install underground raceways minimum of 18 inches below finished grade.

4. Provide raceway in furniture and any other cavity to effectively create a raceway system from the ceiling space to the outlet.

C. Raceways in Concrete Slabs: Do not embed pipes other than electrical raceway in structural concrete and provide steel sleeves for raceway passing through concrete. Obtain Architect's approval for any variation from following requirements unless shown on Drawings. Request Architect's approval in writing accompanied by suitable sketch.

1. Place raceways between bottom reinforcing steel and top reinforcing steel.
2. Place raceways either parallel or at 90 degrees to main reinforcing steel.
3. Place nearly parallel raceways apart at least six times O.D. of raceway used.
4. Restrict O.D. of raceway in solid slabs to 1/4 of slab thickness with raceway placed in middle of that thickness.
5. Do not use raceway coating, except galvanizing or equivalent coating.
6. Do not cut or displace any reinforcement.

D. Install raceways to avoid damage or penetration of structural members. Avoid horizontal or cross runs in building partitions or sidewalls.

E. For raceway larger than 2 inches, provide minimum 2 inches between raceways vertically penetrating elevated concrete slabs. Provide fire-stopping and spray-on fireproofing at locations where raceways penetrate surface of floor slab that is part of fire rating required for construction.

F. Exposed Raceways

1. Install exposed raceway in unfinished spaces, crawl spaces, pipe spaces, or in areas with existing exposed raceway. In areas where walls/ceilings are to be painted, exposed raceways shall be painted to match.

2. Install exposed raceways and extensions from concealed raceway systems neatly, parallel with, or at right angles to walls of building.

3. Do not run raceway through walls with plaster finish or through masonry walls or floors. Install pipe sleeves for raceway runs through these areas.

4. Install exposed raceway to avoid interfering with ceiling inserts, lights or ventilation ducts or outlets.

5. Support exposed raceways using hangers, clamps or clips. Support raceways on each side of bends and space not more than 6 ft. O.C. for 1-inch raceway and not more than 8 ft. O.C. for 1-1/4-inch raceway.

6. Provide exposed raceways for outlets on waterproof walls and set anchors supporting raceway in waterproof cement.

7. Support multiple raceway runs on trapeze style assemblies. Do not support raceway or cable from pipe, ductwork, or other raceway systems.

8. Apply exposed raceways requirements specified above to raceways installed in space above hung ceilings and in crawl spaces.

9. Do not install raceway directly on floor.

G. Minimum Raceway Size: 1/2-inch (16-mm)

H. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Provide locknuts for securing raceway to metal enclosure with sharp edge for digging into metal and ridged outside circumference for proper fastening.

2. Provide bushings for terminating raceways smaller than 1-1/4 inches with flared bottom and ribbed sides with smooth upper edges to prevent injury to cable insulation.

3. Install insulated type bushings for terminating raceways 1-1/4 inches and larger with flared bottom and ribbed sides and with upper edge with phenolic insulating ring molded into bushing.

4. Provide screw-type grounding terminal for standard or insulated type bushing.

5. Provide miscellaneous fittings such as reducers, chase nipples, 3-piece unions, split couplings and plugs specifically designed for their particular application.

I. Surface Raceways: Use surface raceways in finished spaces to conceal new cabling that cannot be installed above accessible ceiling or within walls. Use surface raceway only when raceway type and routing are approved by Architect and Owner's representative. Securely support from building construction and secure to masonry surfaces with expansion anchors. Mount at heights at locations shown on Drawings; obtain approval from Architect and Owner's representative for all routing not indicated on Drawings. Do not run surface raceway through walls with plaster finish or through masonry walls or floors. Install pipe sleeve with junction boxes or adapter fittings for raceway runs through these areas. In existing construction, run raceway along top of baseboards, taking care to avoid telephone and other signal wiring around doorframes and other openings. Run raceway on ceiling or walls perpendicular to or parallel with walls and floors.

J. Fittings and Accessories Installation

1. Use zinc electroplate or hot dipped galvanized steel fittings and accessories in conjunction with ferrous raceways in dry and damp locations.

2. Use hot dipped galvanized fittings and accessories in conjunction with ferrous raceways in wet locations.

3. Use caps or plugs to seal ends of raceways until cable is installed (to exclude foreign material).

4. Use expansion fittings where raceways cross expansion joints.

5. Use deflection fittings where raceways cross expansion joints that move in more than one plane.

6. Use 2 locknuts and insulated bushing (plastic bushing on 1/2-inch raceway and 3/4-inch raceway) on end of each raceway entering sheet metal cabinet or box in dry or damp locations. Terminate raceway ends within cabinet/box at same level.

7. Use watertight hub on end of each raceway entering cabinets or boxes (in wet locations) not constructed with integral threaded hubs.

8. Specific Applications:

    a. Rigid Metal Raceway: Use threaded fittings and accessories. Use 3-piece raceway coupling where raceway cannot be rotated.
    b. Flexible Metal Raceway: Use flexible metal raceway connectors.
    c. Liquid Tight Flexible Metal Raceway: Use “seal-tite” connectors.
    d. Rigid Nonmetallic Raceway, Metal Surface Raceway, and Wireways: Use manufacturer's standard fittings and accessories.

9. Raceways for Future Use (Spare Raceways and Empty Raceways): Draw fish tape through raceways in Architect’s presence to demonstrate that raceway is clear of obstructions. Leave pulling-in line in each spare and empty raceway.

10. Raceway Installation in Special Areas

    a. Raceways Exposed to Different Temperatures: Where portions of interior raceway system are exposed to widely different temperatures, seal interior and exterior of raceway to prevent circulation of air from warmer to colder section through raceway installation.

    b. Refrigerated Rooms: Install raceway body or junction box in raceway system on warm side of refrigerated room. After cables are installed, seal raceway interior at raceway body or junction box.

    c. Heated Areas to Unheated Areas: After cables are installed, seal raceway interior at nearest raceway body, outlet or junction box in heated area adjoining unheated area.

3.2 EXISTING RACEWAYS

A. Conditions for Re-Use of Existing Raceways:

1. Existing raceway is adequately sized for new cables.

2. Remove existing cables.
3. Demonstrate to Architect that existing raceway is clear of obstructions and in good condition.
4. Install insulated bushings to replace damaged or missing bushings. Replace non-insulated bushings with insulated bushings on raceway sizes 1 inch and larger.

3.3 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on drawings or in this article are stricter.

3.4 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 27 04 33

SECTION 27 05 44 - SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Sleeves for raceway penetrations of walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 “Penetration Firestopping”.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

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

a. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Metraflex Company (The).
d. Pipeline Seal and Insulator, Inc.
e. Proco Products, Inc.

2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Carbon steel.

4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

2.4 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

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

3. 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."

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.

b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used.

5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.

C. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

D. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel or cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

E. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

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

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls.
B. Using grout, seal the space around outside of sleeve-seal fittings.

3.4 SLEEVE INSTALLATION FOR FIRE RATED ASSEMBLY PARTITIONS

A. Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

B. Maintain indicated fire rating of walls, partitions, ceilings and floors at raceway penetrations. Install sleeves and sleeve seals with appropriate firestop materials. Comply with Division 07 Section “Penetration Firestopping”.

END OF SECTION 27 05 44

SECTION 27 11 00 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Telecommunications mounting elements.
2. Backboards.
3. Telecommunications equipment racks and cabinets.
4. Grounding.

B. Related Requirements:

1. Section 27 15 00 "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.
B. LAN: Local area network.
C. RCDD: Registered Communications Distribution Designer.

1.4 SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. 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. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.

3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

PART 2 - PRODUCTS

2.1 BACKBOARDS

A. Backboards: Plywood, 3/4 by 48 by 96 inches

2.2 EQUIPMENT FRAMES

A. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:

1. Emerson Network Power Connectivity Solutions.
2. Hubbell Premise Wiring.
3. Leviton Commercial Networks Division.
4. Middle Atlantic Products, Inc.
5. Ortronics, Inc.
6. Panduit Corp.
7. Siemon Co. (The).

B. General Frame Requirements:

1. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.

2. Module Dimension: Width compatible with EIA 310-D standard, 19-inch panel mounting.

3. Finish: Manufacturer's standard, baked-polyester powder coat.

C. Floor-Mounted Racks: Modular-type, steel construction.

1. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
2. Baked-polyester powder coat finish.

D. Modular Freestanding Cabinets:

1. Removable and lockable side panels.
2. Hinged and lockable front and rear doors.
3. Adjustable feet for leveling.
4. Screened ventilation openings in the roof and rear door.
5. Cable access provisions in the roof and base.

6. Grounding bus bar.
7. Rack-mounted, 550-cfm fan with filter.
8. Power strip.
9. Baked-polyester powder coat finish.
10. All cabinets keyed alike.

E. Cable Management for Equipment Frames:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

2.3 POWER STRIPS

A. Power Strips: Comply with UL 1363.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Rack mounting.
3. Six 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
4. LED indicator lights for power and protection status.
5. LED indicator lights for reverse polarity and open outlet ground.
6. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
7. Rocker-type on-off switch, illuminated when in on position.
8. Peak Single-Impulse Surge Current Rating: 26 kA per phase.
9. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all three modes shall be not more than 330 V.

2.4 GROUNDING

A. Comply with requirements in Section 27 05 26 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Telecommunications Main Bus Bar:

1. Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide with 9/32-inch holes spaced 1-1/8 inches apart.
3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

C. Comply with J-STD-607-A.

2.5 LABELING

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.

C. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

D. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.

1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.

2. Record agreements reached in meetings and distribute them to other participants.

3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.

4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

3.2 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."
B. Comply with TIA-569-B, Annex A, "Firestopping."
C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.3 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inchclearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.4 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
B. Paint backboards as required. For fire-resistant plywood, do not paint over manufacturer's label.

END OF SECTION 27 11 00

SECTION 27 15 00 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. UTP Plenum Rated cabling.
2. Cable connecting hardware, and patch panels.
3. Telecommunications outlet/connectors.
4. Cabling system identification products.
5. Cable management system.

1.3 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. EMI: Electromagnetic interference.
D. IDC: Insulation displacement connector.
E. LAN: Local area network.
F. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.
G. RCDD: Registered Communications Distribution Designer.
H. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of telecommunications cabling with Owner's telecommunications and LAN equipment and service suppliers.
B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

1.5 SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.

2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.

3. Cabling administration drawings and printouts.

4. Wiring diagrams to show typical wiring schematics, including the following:

   a. Patch panels.
   b. Patch cords.

5. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
2. 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.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cables to determine the continuity of the strand end to end. Use or optical loss test set.

2. Test optical fiber cables while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; including the loss value of each. Retain test data and include the record in maintenance data.

3. Test each pair of UTP cable for open and short circuits.

PART 2 - PRODUCTS

2.1 HORIZONTAL CABLING DESCRIPTION

A. 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. TIA/EIA-568-B.1 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.
2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
3. Bridged taps and splices shall not be installed in the horizontal cabling.
4. Splitters shall not be installed as part of the optical fiber cabling.

B. A work area is approximately 100 sq. ft., and includes the components that extend from the telecommunications outlet/connectors to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

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. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
C. Grounding: Comply with J-STD-607-A.

2.3 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements in Section 061000 "Rough Carpentry" for plywood backing panels.

2.4 UTP CABLE

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

1. Berk-Tek; a Nexans company.
2. CommScope, Inc.
3. SYSTIMAX Solutions; a CommScope, Inc. brand.

B. Description: Provide Plenum Rated horizontal copper cable, UTP, 100 ohm in accordance with TIA-568-C.2, UL 444, ANSI/NEMA WC 66, ICEA S-90-661. Provide four each individually twisted pair, minimum size 24 AWG conductors, Category 6, with a thermoplastic jacket color to be selected by owner for various cabling end point devices. Cable shall be imprinted with manufacturers name or identifier, flammability rating, gauge of conductor, transmission performance rating (category designation) and length marking at regular intervals in accordance with ICEA S-90-661. All Cable provided shall be plenum rated cabling in accordance with NFPA 70. Substitution of a higher rated cable shall be permitted in accordance with NFPA 70.

2.5 UTP CABLE HARDWARE

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. Hubbell Premise Wiring.
2. Leviton Commercial Networks Division.
3. Panduit Corp.
4. Siemon Co. (The).

B. 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.

C. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair UTP cable indicated.

D. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

E. Patch Cords: Provide thirty factory-made, four-pair cables in 36-inch and 72-inch (1 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 6A performance. Patch cords shall have latch guards to protect against snagging.

2.6 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-B.1.

B. Workstation Outlets: Two-port-connector assemblies mounted in single faceplate.

1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."

2. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.

a. Flush mounting jacks, positioning the cord at a 45-degree angle.

3. Legend: Machine printed, in the field, using adhesive-tape label.

2.7 GROUNDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.
B. Comply with J-STD-607-A.

2.8 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 Section 260553 "Identification for Electrical Systems."

2.9 CABLE MANAGEMENT SYSTEM

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. iTRACS Corporation, Inc.
2. TelSoft Solutions.

B. Description: Computer-based cable management system, with integrated database capabilities.

C. Document physical characteristics by recording the network, TIA/EIA details, and connections between equipment and cable.

D. Information shall be presented in database view.

E. System shall interface with the following testing and recording devices:

1. Direct upload tests from circuit testing instrument into the personal computer.
2. Direct download circuit labeling into labeling printer.

2.10 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.
B. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.
C. Factory test UTP cables according to TIA/EIA-568-B.2.
D. Factory test multimode optical fiber cables according to TIA-526-14-A and TIA/EIA-568-B.3.
E. Cable will be considered defective if it does not pass tests and inspections.
F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Install cables in pathways except within consoles, cabinets, desks, and counters. Conceal pathways and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.

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 110-style IDC termination hardware unless otherwise indicated.

4. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and patch panels.

5. 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.

6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.

7. 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.

8. 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.

9. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

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.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. 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:

   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.

6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.3 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."
B. Comply with TIA-569-B, Annex A, "Firestopping."
C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.4 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.5 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

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 backboards. For fire-resistant plywood, do not paint over manufacturer's label.

D. 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. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.

b. Label each unit and field within distribution racks and frames.

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.

E. 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.

3.6 FIELD QUALITY CONTROL

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

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

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

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 6AE, 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. Optical Fiber Cable Tests:

   a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

   b. Link End-to-End Attenuation Tests:

      1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA-526-14-A, Method B, One Reference Jumper.

      2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.

5. 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.

6. Optical Fiber Cable Performance Tests: Perform optical fiber end-to-end link tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.3.

D. 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.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.7 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets. Include training in cabling administration software.

END OF SECTION 27 15 00

SECTION 28 23 00 - INTEGRATED SECURITY MANAGEMENT SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. All CCTV and ISMS equipment is to be purchased off the New York State OGS Data Contract.

B. The Contractor shall provide all equipment, software, programming, hardware, installation, etc. for a fully functioning Integrated Security Management System (ISMS) as shown on the drawings and specified herein.

C. The Contractor shall also be responsible for the following:

1. Coordinate and convene pre-installation verification walk through with Owner to verify work to be delivered by the Contract Documents.

2. Coordinate and convene meetings to educate Owner on programming features of each system at all schools\buildings.

3. Coordination and verification that all peripheral devices provided by the Electrical Contractor are fully compatible with the Integrated Security Management System software and hardware provided.

4. Programming of all ISMS functionality under the supervision of the manufacturer representative and the Owner\owner representative and providing verification that owner requirements have been satisfied.

5. Performance of all items as specified

1.3 CODE REFERENCES AND SYSTEMS CERTIFICATIONS

A. Design and operation of the ISMS shall conform to the following referenced codes, regulations, and standards.

1. National Electric Code, NFPA-70
2. NFPA-730 Guide for Premises Security
3. NFPA-731 Standards for the Installation of Electronic Premises Security Systems
4. UL 294 Access Control Systems
5. UL 1076 Line Supervision
6. FCC Part 15, Part 68 Rules and Regulations
7. Part 15, Radio Frequency Devices
8. National Electrical Manufacturers Association (NEMA)

9. Applicable Federal, State and Local laws and regulations
10. Americans with Disabilities Act (ADA)
11. Where more than one code or regulation is applicable, the more stringent shall apply.
12. Cable installation, identification and termination shall be performed in addition to the applicable codes above

1.4 RELATED SECTIONS

A. Section 27 05 28 – Pathways for Communications Systems
B. Section 27 15 00 – Communications Horizontal Cabling

1.5 DOCUMENTATION

A. Provide a written statement signed by the Owner indicating pre-installation verification of equipment locations was jointly completed by Contractor and Owner.

B. Provide a written statement signed by the Owner indicating pre-programming meeting was completed with attendance by Contractor and Owner.

C. Provide a written statement signed by the Owner indicating Acceptance of final programming of all systems.

D. Submit all final test reports.

E. Complete documentation shall be provided with the system. The documentation shall completely describe all operations, each program, data sets and the hardware and peripherals. All updates, addendum and adjustments to the documentation shall be provided at no additional charge, in the same quantities as originally required.

1. System Administrator Manual - Overview and step by step guide and instructions detailing all System Administrator responsibility and authority.

2. User Manual - Step by step guide and instructions detailing all system user functions and responsibilities.

3. Alarm Monitoring Manual - Step by step guide and instructions detailing all alarm monitoring system user functions and responsibilities.

4. Technical Maintenance Manual - Shall be a comprehensive and detailed document providing all maintenance action, system testing schedules, troubleshooting flowcharts, functional system layout and block diagrams and schematic diagrams of all system wiring.

5. Shop Drawings: Provide complete shop drawings which include the following:

    a. Indicate all system device locations on architectural floor plans. No other system(s) shall be included on these plans.

b. Include full schematic wiring information on these drawings for all devices. Wiring information shall include cable type, conductor routings, quantities, and connection details at device

c. Include a complete ISMS one-line, block diagram.

d. Include a statement of the system sequence of operation.

6. Product Data: Provide complete product data that includes the following:

a. Manufacturer's technical data for all material and equipment at the system and sub system level to be provided as part of the ISMS.
b. Provide complete manufacturer's data for each item listed in PART 2 below.

7. A system description including analysis and calculations used in sizing equipment required by the ISMS. The description shall show how the equipment will operate as a system to meet the performance requirements of the ISMS. The following information shall be supplied as a minimum:

a. Server(s) processor(s), disk space and memory size
b. Description of site equipment and its configuration
c. Network bandwidth, latency and reliability requirements
d. Backup/archive system size and configuration
e. Start up operations
f. System expansion capability and method of implementation
g. System power requirements and UPS sizing
h. Device / component environmental requirements (cooling and or heating parameters)
i. A description of the operating system and application software.

8. Contract Close-Out Submittals: Provide manuals per building including operating instructions, maintenance recommendations and parts list including wiring and connection diagrams modified to reflect as-built conditions.

9. Manuals: Final copies of the manuals shall be delivered after completing the installation test with signed (owner/owner representative) proof of receipt. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of the contractor responsible for the installation and maintenance of the system and the factory representatives for each item of equipment for each system. The manuals shall have a table of contents and labeled sections. The final copies delivered after completion of the installation test shall include all modifications made during installation, checkout, and acceptance testing. The manuals shall consist of the following:

a. Functional Design Manual: The functional design manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included.

b. Hardware Manual: The manual shall describe all equipment furnished including:

1) General description and specifications
2) Installation and check out procedures
3) Equipment layout and electrical schematics to the component level
4) System layout drawings and schematics
5) Alignment and calibration procedures
6) Manufacturers repair parts list indicating sources of supply

c. Software Manual: The software manual shall describe the functions of all software and shall include all other information necessary to enable proper loading, testing, and operation. The manual shall include:

1) Definition of terms and functions
2) System use and application software
3) Initialization, start up, and shut down
4) Reports generation
5) Details on forms customization and field parameters
6) Operators Manual: The operators manual shall fully explain all procedures and instructions for the operation of the system including:
7) Computers and peripherals
8) System start up and shut down procedures
9) Use of system, command, and applications software
10) Recovery and restart procedures
11) Graphic alarm presentation
12) Use of report generator and generation of reports
13) Data entry
14) Operator commands
15) Alarm messages and reprinting formats
16) System permissions functions and requirements

d. Maintenance Manual: The maintenance manual shall include descriptions of maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

10. As-Built Drawings: During system installation, the Contractor shall maintain a separate hard copy set of drawings, elementary diagrams, and wiring diagrams of the ISMS to be used for record drawings. This set shall be accurately kept up to date by the Contractor with all changes and additions to the ISMS. Copies of the final as-built drawings shall be provided to the end user in DXF format.

1.6 WARRANTY

A. ISMS Software and Field Hardware Warranty

1. ISMS Software shall be warranted for a period of one (1) year from the date of installation from the manufacturer to be free of defects and will function in substantial accordance to the published specification.

a. Software shall be ordered for delivered date only after hardware is substantially installed so that software warranty does not expire prior to 1 year Contractor Installation Warranty.

2. ISMS manufactured Field Controller Hardware shall be warranted for a period of two (1) years from the date of installation from the manufacturer, will be free from defects and will function in general accordance with the product specifications.

B. Contractor Installation Warranty

1. Contractor shall warrant all equipment, not covered under Part 1 Section 1.05.A of this specification and associated installation labor for a period of one year from date of beneficial use.

1.7 MAINTENANCE SERVICES

A. General Requirements: The Contractor shall provide all services required and equipment necessary to maintain the entire ISMS in an operational state as specified for a period of one year immediately following the warranty period, and shall provide all necessary material required for performing scheduled service or other unscheduled work.

B. Description of Work: The service and repair of the ISMS including all equipment provided under this specification supplied by the successful contractor. The contractor shall provide the manufacturer's required scheduled and unscheduled maintenance and all other work necessary to keep the ISMS at its maximum performance.

C. Personnel: Service personnel shall be factory certified in the maintenance and repair of the equipment installed under this section of the specification. The owner shall be advised in writing of the name of the designated service representative, and of any change in personnel.

D. Schedule of Work: This work shall be performed during regular working hours, Monday through Friday, excluding federal holidays.

1. Inspections: The Contractor shall perform two minor inspections at 6 month intervals (or more often if required by the manufacturer), and two major inspections offset equally between the minor inspections to effect quarterly inspection of alternating magnitude.

2. Minor Inspections: These inspections shall include:

a. Visual checks and operational tests of all console equipment, peripheral equipment, field hardware, sensors, and electrical and mechanical controls.
b. Mechanical adjustments if required on any mechanical or electromechanical devices

3. Major Inspections: These inspections shall include all work described under paragraph Minor Inspections and the following work:

a. Clean all ISMS equipment, including interior and exterior surfaces.
b. Perform diagnostics on all equipment.

c. Check, walk test, and if required by the manufacturer's maintenance procedures, calibrate each sensor.
d. Run all system software diagnostics and correct all diagnosed problems.

E. Operation: Performance of scheduled adjustments and repair shall verify operation of the ISMS as demonstrated by the applicable tests of the performance verification test.

F. Emergency Service: The owner will initiate service calls when the ISMS is not functioning properly. Qualified personnel shall be available to provide service to the complete ISMS. The owner shall be furnished with a telephone number where the service supervisor can be reached at all times. Service personnel shall be at site within the same business day after receiving a request for service. Service shall be restored within 24 Hrs.

G. Records and Logs: The Contractor shall keep records and logs of each task, and shall organize cumulative records for each component and for the complete system chronologically. A continuous log shall be maintained for all devices. The log shall contain all initial settings. Complete logs shall be kept and shall be available for inspection on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the ISMS.

H. Work Requests: The Contractor shall separately record each service call request on a service request form. The form shall include the model and serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials used, the time and date work started, and the time and date of completion. The Contractor shall deliver a record of the work performed within 5 days after work is accomplished.

I. System Modifications: The Contractor shall make any recommendations for system modification in writing to the Owner. No system modifications shall be made without prior approval of the Owner. Any modifications made to the system shall be incorporated into the operations and maintenance manuals, and other documentation affected.

J. Software: The Contractor shall provide all software updates during the period of the warranty and verify operation in the system. These updates shall be accomplished in a timely manner, fully coordinated with ISMS operators, and shall be incorporated into the operations and maintenance manuals, and software documentation.

1.8 QUALITY ASSURANCE

A. General: Quality control services include inspections, tests, and related actions. Inspection and testing services are required to verify compliance with the requirements specified or indicated.

B. Manufacturer Qualifications

1. Manufacturer of the ISMS shall be an established organization with referenced and documented experience delivering and maintaining Security Management Systems of equal or higher sophistication and complexity as compared to the system detailed in this specification.

2. ISMS Manufacturer shall employ at a minimum the following methods for QA of component and assembly devices:

a. Visual inspection of devices shall be performed to verify assembly according to defined procedures. End of line operational tests shall be performed to ensure product functionality has been correctly configured. A system burn-in period shall be utilized to screen for early life failures of electronic components.

b. Individual functionality and system level regression testing shall be performed to ensure compliance with product specifications. Single and multiple unit system tests shall be performed to mimic end-user installation configurations. Automated hardware and software testing shall be utilized to evaluate system performance under published operational loads and shall be compared to published system capabilities.

PART 2 - PRODUCTS

2.1 SOFTWARE COMPONENTS

A. Equipment to be purchased off the NYS OGS State Contract.

2.2 ISMS HARDWARE – ACCESS CONTROL INTRUSION DETECTION

A. Equipment to be purchased off the NYS OGS State Contract.

2.3 IP DIGITAL VIDEO MANAGEMENT SYSTEM – NETWORK VIDEO RECORDER

A. Equipment to be purchased off the NYS OGS State Contract.

2.4 CCTV CAMERAS

A. Equipment to be purchased off the NYS OGS State Contract.

2.5 MONITORS

A. Equipment to be purchased off the NYS OGS State Contract.

2.6 CCTV EQUIPMENT RACK CABINET ENCLOSURE

A. Equipment to be purchased off the NYS OGS State Contract.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation of the Security Management System shall be performed by the Contractor. However, all installation shall be under the personal supervision of the ISMS Vendor and the owner's representative. The ISMS Vendor shall certify all work is proper and complete. The design, scheduling, coordination, programming, training, and warranty requirements for the project shall be performed by the ISMS Vendor.

B. Comply with manufacturer's instructions and recommendations for installation of products in applications indicated. Anchor products securely in place, accurately located and aligned with other work.

C. Prior to commencing with camera installation, Contractor shall verify the desired view field of each camera. Perform walk through with Owner and review the field of view for each camera. Determine mounting locations of camera(s) to yield view(s)desired by the Owner

D. All wiring and conduit is to be installed in accordance with local and national electrical codes and Division 16 specification.

E. All cable installed in unfinished, exposed areas (i.e. - mechanical spaces, storage rooms, etc.) and where subject to damage (i.e.- crawlspaces, etc.) is to be run in conduit or surface raceway.

F. All conduit sleeves shall be ground smooth to remove all sharp edges and burrs that could potentially damage cabling.

G. All cabling shall be supported and protected at all holes, penetration points, boxes, conduit, etc. with protective grommets or material that will protect the cabling from any abrasive contact with surfaces that might cause damage

H. All Low Voltage (24VAC 12VDC) cabling shall be plenum rated unless ran in conduit for the entire length.

I. In existing construction, install all interior surface mounted devices on surface mounted back boxes supplied by device manufacturer.

J. All cable installed above accessible ceiling areas shall be bundled with nylon tie wraps at 5 foot intervals and hung in saddle rings, supported to structure at 10 foot intervals. All cabling shall be run parallel and perpendicular to building lines in a neat and workmanlike manner.

K. All cable shall be installed at a minimum of three (3) inches from all hot water, steam or condensate piping.

L. Conduit sleeves shall be installed through all concrete or block walls for all cable penetrations. All conduit sleeves shall be properly fireproofed and sealed.

M. At locations with removable mullions provide quick disconnect plugs in order to facilitate the removal of the mullion without cutting the wires to the electric strike.

N. Prior to final acceptance the contractor shall provide accurate documentation, which shall list all equipment installed under this section. The list shall include the following information: equipment description, equipment part number, equipment serial number, manufacturer's warranty period, and location of equipment. Provide owner with all product manuals as supplied by manufacturer. Any information found to be inaccurate during the one year warranty period will require the contractor to physically re-verify all equipment information at no additional cost to the owner. Re-verifications shall be completed within one week after notification of any discrepancy. Submit a copy of all documentation to engineer.

O. Provide complete point to point wiring diagram(s) for all system components.

P. All system components to be fault-tolerant. System shall provide satisfactory operation without damage due to fluctuations of rated voltage per manufacturer(s) specifications, and at plus 3 Hertz variation in line frequency. Protect communication lines against incorrect wiring, static transients and induced magnetic interference. Test all utilized 120V AC circuits for power quality, Use a handheld power quality analyzer or compare voltage readings between two accurate voltmeters measuring the same system voltage: one meter being an "averaging" type of unit (such as an electromechanical movement meter) and the other being a "true-RMS" type of unit (such as a high-quality digital meter). If results indicate variances in power quality to be outside the tolerances of specified low voltage equipment provide static, transient voltage surge suppression circuit protection on 120V circuits.

Q. Provide index on inside cover of each camera power supply indicating connected cameras and loads. Clearly indicate total connected camera load and maximum load capacity of power supply.

R. All cabling entering the CCTV equipment cabinet(s) and console(s) must be installed in conduit or raceway. All cabling within the cabinet will be neatly bundled and secured with tie wraps to the cabinet. The intent is to avoid cable strain on the connectors/terminations. In no instance shall the point of connection serve as the support for a cable bundle.

S. Check all head-end equipment for proper frequency, audio/video carrier levels, and RF level outputs. Adjust all levels per manufacturer's recommendations.

T. All cameras shall be adjusted for focus, back focus, auto iris adjustment, depth (field) of view

U. Do not to attach the camera to any structure that is likely to be grounded.

V. Camera signal wiring shall contain no splices between the camera connection and the connection to the DVR, unless signal attenuation\amplification or equalization is required.

W. Camera Signal\control cabling and camera signal(s) shall be measured\checked for: composite video signal (peak to peak voltage, IRE units, Sync, Luminance, color bursts); pedestal (black level); synchronization pulses. As required, poor video signals shall be corrected with signal attenuation\amplification or equalization amplifiers and or filters. Provide equalization, amplification as required to overcome poor video signals and best picture quality.

X. Cameras shall be properly synchronized\phased to the 60 cycle power line.

Y. The contractor shall utilize Video Volt Meters, Video Timing Meters, Oscilloscopes, hand held meters (Camera Master with a balanced 105 Ohm adapter for UTP Transmission.), etc for measuring and setting levels as required.

Z. Camera output impedance signals shall be measured for 75 Ohm impedance levels. Cameras not meeting this requirement shall not be acceptable.

AA. Control signal, communications, and data transmission line grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.

3.2 CLEAN UP

A. At the completion of the work, all equipment pertinent to this section shall be checked and thoroughly cleaned, and all other areas shall be cleaned around equipment provided under this section. Clean the exposed surfaces of hangers and other exposed metal of grease, plaster, or other foreign materials.

3.3 TESTING

A. Refer to SECTION 26 05 00 – COMMON WORK RESULTS

B. Refer to SECTION 27 15 00 – COMMUNICATION HORIZONTAL CABLING

C. Phased Testing: A phased acceptance test and performance demonstration program shall be developed and documented by the ISMS Vendor. These requirements shall apply to all system components and software, including, but not limited to all system computers, field panels, card reader devices, Photo Imaging system peripherals, CCTV cameras and equipment and interface capability. The ISMS Vendor shall perform the tests and document the results under the supervision and witnessing of the ISMS Systems Engineer and the Owner's Representative. Operational scenarios shall be developed and used by the Contractor to simulate the actual use of the system in the normal environment of the Owner's facility. The ISMS Systems Engineer reserves the right to modify the Contractor's plan or develop new operational test and evaluation procedures to effectively document system operations. Proper operation shall be checked and noted with Owner, Owner representative present with documented sign off. Testing and inspections shall be conducted and submitted per NFPA 731 and as stated below. Remove and replace any malfunctioning equipment and retest as specified herein.

D. Submit all test results in tabular format with reference to or backed up by equipment/riser diagram that accurately represents installed system.

E. Submit written test report from authorized representative of equipment manufacturer stating that system has been tested and is in working order prior to final inspection by Engineer.

F. Engineer and/or Owner's representative reserves right to observe testing.

G. Provide complete panel real-time printout as documentation of device, date and time.

H. Provide inspection complying with requirements of applicable NFPA standards.

I. Intrusion Detection: Provide complete typed list of every initiation, signaling, control, supervisory and auxiliary device with specific information regarding location of device, date tested, manufacturer's model number, serial number of all analog components, status of device and zone or point as related to system. As applicable, identify device by number and by owner's room names/numbers assigned to each device.

J. In addition to NFPA 731 requirements the following shall be checked for proper operation, tested as applicable and all results documented/submitted.

1. ISMS software programming per Para 3.04

2. Credentials\Card Reader for maximum access time shall be 0.75 seconds under all system loads, i.e. regardless of number of cards presented simultaneously.

3. Proper operation of electric door strikes, egress switching (where required), door position monitor switches, lock status sensors, and exit hardware.

4. Proper operation of all Electric Locking Hardware (ELH) including Electric Latch Retraction, (ELR), electro-magnetic locks, and associated static strikes.

5. Proper operation of magnetic door switches, Request to exit sensors (REX), audible notification devices (siren).

6. Proper operation of the intercom system(s) and their door release activation (pushbuttons, software activation, etc.).

7. Proper operation of all interconnections to: Building Fire Alarm Life Safety Systems, LAN, WAN, elevator control systems, PA systems, Telephone Systems, Lighting, HVAC Controls, etc.

8. Proper operation of all CCTV system components, cameras, Server\recording units, monitors, control keyboards/stations etc. Proper operation shall be checked and noted with Owner, Owner representative present and signed off. Equipment including but not limited to the following industry common equipment (equipment not listed and unique to system submitted and implemented shall also be included for testing).

a. Camera enclosure integrity and environmental protection per camera Mfg. requirements

b. Camera Video Signal resolution integrity per camera Mfg. requirements

c. As applicable Camera control functions per camera Mfg. requirements (Pan, Tilt, Zoom, etc.)

d. Camera power circuit voltage requirements per camera Mfg.

e. Camera power supply(s) loads per camera and total per power supply unit

f. Analog Camera output impedance signals shall be tested for 75 Ohm impedance levels.

g. CCTV Monitor Display resolution

h. CCTV Server/recording unit(s) per unit

1) Storage capacity –check after all cameras are connected and programmed per Owner requirements for Min. of one week
2) File retrieval, search parameters
3) Live camera viewing, multiplexed viewing, and recorded file playback

i. All Programming parameters for: Servers\Recording units, Cameras, CCTV system alarm inputs, external device alarm inputs/outputs

j. All Programming parameters for User and Administrator rights

K. All cabling shall be tested by the Contractor to insure continuity, freedom from grounds (except "made" grounds and those required for protection), and insulation resistance, in accordance with "underwriter's requirements and electrical regulations. The Contractor shall furnish and use suitable instruments such as ammeters, voltmeters, etc.

L. In addition to Camera Mfg requirements, Camera video signal cabling and Camera signal(s) shall be tested (Camera Master with a balanced 105 Ohm adapter for UTP Transmission.)for:

1. Composite video signal (peak to peak voltage)
2. IRE units
3. Sync
4. Luminance (white)
5. Color bursts
6. Pedestal (black level)
7. Synchronization pulses (Amplitude)

M. Test all head-end equipment for proper frequency, audio/video carrier levels, and RF level outputs.

N. Perform tests to all systems under direct supervision of manufacturer's representatives or accredited agencies for all specified equipment and services.

3.4 SYSTEM PROGRAMMING

A. The Contractor and the ISMS Vendor are jointly responsible for Initial Programming and report formatting of the ISMS as specified herein and as directed by the owner/owner representative. The owner will convey their programmable operational requirements for all system functions in lay terms, and Initial System programming will be completed to satisfy the owner’s requirements.

B. The Contractor and the ISMS Vendor will be required to meet with the owner’s representatives 3 times to discuss, recommend and document the owner’s needs for programming and sequences of operation.

C. Programming Functions to be provided shall include but not be limited to:

1. Schedules, groups and sequence of operation(s) for:

   a. Access Groups
   b. Access Levels
   c. Actions
   d. Action Groups
   e. Alarm Inputs
   f. Alarm Mask Groups
   g. Alarm Outputs
   h. Areas
   i. Badge Types
   j. Card Formats
   k. Cardholders
   l. Card Readers
   m. Global I/O Function Lists
   n. Global I/O Links
   o. Holidays
   p. Maps
   q. Monitor Zones
   r. Receiver Accounts
   s. System Operators
   t. User Permission Groups
   u. Time Zones
   v. Tour Groups
   w. Badge creation
   x. Visitor management
   y. Intrusion Detection Panels
   z. Digital Video Archive Servers
   aa. Guard Tours
   bb. Central Station Receivers

2. Initial Graphic Map creation with icons and programming setup

3. Set-up and pathing of all alarm notifications

4. Report generation and formats for printing and notifications.

5. Intrusion Detection System: Set-up of all alarm zones; authorization levels, time periods, enunciation and dial-out notification.

6. Door Monitoring Status: Alarm Conditions; Graphic Annunciation

7. CCTV: Camera views; Camera recording (on motion, FPS, Time periods, playback retrieval, integration with card reader/access point activation.)

3.5 TRAINING

A. Provide training to Owner and Owner's designated representatives covering complete operation, programming and maintenance of system.

B. For each school: Training duration shall be for a period of 40 hours, delivered in four hour blocks. Each four hour block of training shall be scheduled at the convenience of the Owner. The full 40 hours of training shall be provided to Owner within 30 days after substantial completion.

C. Training manuals containing information on the complete operation, programming and maintenance of system shall be developed and provided to each person attending the training.

D. Training in creation of personnel objects, card authentication and badge printing until the owner's representatives are fully capable.

E. All training courses shall enable the attendees to be capable of all normal system operations within their respective positions.

F. System Administrators shall receive a course detailing the system functions and operations. Course shall offer configuration training on all aspects of the system including data import-export, reports, cardholder management, system workstations, peripherals and field hardware.

G. Alarm Monitoring Users shall receive a course detailing the operation of all aspects of alarm monitoring functions, reports, error messages, alarm handling, output relay control and general overview of field hardware.

END OF SECTION 28 23 00

SECTION 28 31 11 - DIGITAL, ADDRESSABLE FIRE-ALARM AND VOICE NOTIFICATION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Scope:

1. Mahopac High School

a. Reconnecting of all conventional initiating devices (manual pull stations, heat and smoke detectors) to replacement fire alarm control panel.
b. Addition of visual and voice notification devices.

B. Section Includes:

1. Fire-alarm/voice notification control panel.
2. Notification appliances.

1.3 REFERENCES

A. Comply with New York State Uniform Fire Prevention & Building Code.

B. Comply with U.S. Department of Justice – American Disabilities Act.

C. Acoustical Society of America (ASA)

1. ASA S3.2 Method for Measuring the Intelligibility of Speech Over Communications Systems.

D. National Fire Protection Association Standards:

1. NFPA 70 - National Electrical Code.
2. NFPA 72 - National Fire Alarm Code.
3. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

E. Provide system and components listed by Underwriters Laboratories Inc. (UL) for use in fire protective signaling system under following standards as applicable:

1. UL 864 - UOJZ, APOU Control Units for Fire Protective Signaling Systems.
2. UL 268 - Smoke Detectors for Fire Protective Signaling Systems.
3. UL 268A - Smoke Detectors for Duct Applications.

4. UL 464 - Audible Signaling Appliances.
5. UL 1971 - Visual Signaling Appliances.
6. UL 1481 - Power Supplies for Fire Protective Signaling Systems.

1.4 DEFINITIONS

A. LED: Light-emitting diode.
B. NICET: National Institute for Certification in Engineering Technologies.
C. LOC: Local Operating Console.
D. VNS: Voice Notification System.

1.5 SYSTEM DESCRIPTION

A. Non-coded, UL-certified addressable system, with automatic sensitivity control of certain smoke detectors and multiplexed signal transmission, dedicated to fire-alarm service only. Include in the system wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, control equipment, alarm, and supervisory signal initiating devices, alarm notification appliances, supervising station fire alarm system transmitter, and other accessories and miscellaneous items required for a complete operating system even though each item is not specifically mentioned or described. Provide systems complete and ready for operation.

B. Provide equipment, materials, installation, workmanship, inspection, and testing in strict accordance with the required and advisory provisions of NFPA 70, NFPA 72, except as modified herein. The system layout on the drawings show the intent of coverage and are shown in suggested locations. Submit plan view drawing showing device locations, terminal cabinet locations, junction boxes, other related equipment, conduit routing, wire counts, circuit identification in each conduit, and circuit layouts for all floors. Drawings shall comply with the requirements of NFPA 70. Final quantity, system layout, and coordination are the responsibility of the Contractor.

C. Provide Common Intelligibility Scale (CIS) and sound pressure level calculations with the shop drawing submittal to confirm that intelligibility requirements will be met. CIS calculations shall be done with computer software intended for that purpose.

1.6 SUBMITTALS

A. General Submittal Requirements:

1. Shop Drawings shall be prepared by persons with the following qualifications:

   a. Trained and certified by manufacturer in fire-alarm system design.
   b. NICET-certified fire-alarm technician, Level IV minimum.

B. Product Data: Submit manufacturer′s documentation for all components of proposed fire alarm system required to demonstrate compliance with specified requirements, including (but not limited to) type , size rating, style, catalog number, manufacturer name, photograph, and catalog data sheet for each component.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.

2. Include voltage drop calculations for notification appliance circuits with the system operating on battery power, with battery voltage to the system at 20 volts.

3. Include battery-size calculations.

4. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.

5. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.

6. Include complete one-line riser diagrams showing all equipment locations and sizes, and point-by-point wiring diagram with type and number of all conductors.

7. Submit detailed drawing of FAVN Panel(s) including all module/component locations and panel point-to-point wiring diagrams including all field circuit termination points.

8. Submit floor plan layout of Graphic Display Panel indicating building zones, room numbers, and “You Are Here” location. Orient building floor plan on graphic to the location of person viewing the installed Graphic Display Panel, i.e. the direction the viewer is facing shall be toward the top of the graphic display.

D. Technical Data and Computer Software

1. Technical data and computer software (meaning technical data that relates to computer software) that are specifically identified in this project, and may be defined/required in other specifications, shall be delivered, strictly in accordance with the CONTRACT CLAUSES. Identify data delivered by reference to the particular specification paragraph against which it is furnished. Data to be submitted shall include complete system, equipment, and software descriptions. Descriptions shall show how the equipment will operate as a system to meet the performance requirements of this contract. The data package shall also include the following:

   a. Identification of programmable portions of system equipment and capabilities.
   b. Description of system revision and expansion capabilities and methods of implementation detailing both equipment and software requirements.
   c. Provision of operational software data on all modes of programmable portions of the fire alarm and voice notification system.
   d. Description of fire alarm and voice notification control panel equipment operation.
   e. Description of auxiliary and remote equipment operations.
   f. Library of application software.
   g. Operation and maintenance manuals.

E. Qualification Data:

1. Supervisor

   a. NICET Fire Alarm Technicians to perform the installation of the system. A NICET Level 4 Fire Alarm Technician shall supervise the installation of the fire alarm system/voice notification system. The Fire Alarm technicians supervising the installation of equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

2. Technician

   a. NICET Level III Fire Alarm Technicians with a minimum of four years of experience utilized to install and terminate fire alarm/voice notification devices, cabinets and panels. The Fire Alarm technicians installing the equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

3. Installer

   a. Fire Alarm installer with a minimum of two years of experience utilized to assist in the installation of fire alarm/voice notification devices, cabinets and panels. An electrician shall be allowed to install wire, cable, conduit and backboxes for the fire alarm system/voice notification system. The Fire Alarm installer shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

4. Test Personnel

   a. Fire Alarm Technicians with a minimum of eight years of experience (NICET Level IV) utilized to test and certify the installation of the fire alarm/voice notification devices, cabinets and panels. The Fire Alarm technicians testing the equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

5. Manufacturer's Representative

   a. The fire alarm and voice notification equipment manufacturer's representative shall be present for the connection of wiring to the control panel. The Manufacturer's Representative shall be an employee of the manufacturer with necessary technical training (NICET Level IV] on the system being installed.

6. Manufacturer

   a. Components shall be of current design and shall be in regular and recurrent production at the time of installation. Provide design, materials, and devices for a protected premises fire alarm system, complete, conforming to NFPA 72, except as otherwise or additionally specified herein.

F. Regulatory Requirements

1. Requirements for Fire Protection Service

a. Equipment and material shall have been tested by UL and listed in UL Fire Prot Dir or approved by FM and listed in FM APP GUIDE. Where the terms "listed" or "approved" appear in this specification, they shall mean listed in UL Fire Prot Dir or FM APP GUIDE. The omission of these terms under the description of any item of equipment described shall not be construed as waiving this requirement. All listings or approval by testing laboratories shall be from an existing ANSI or UL published standard.

2. Fire Alarm/Voice Notification System

a. Furnish equipment that is compatible and is UL listed, FM approved, or listed by a nationally recognized testing laboratory for the intended use. All listings by testing laboratories shall be from an existing ANSI or UL published standard. Submit a unique identifier for each device, including the control panel and initiating and indicating devices, with an indication of test results, and signature of the factory-trained technician of the control panel manufacturer and equipment installer. With reports on preliminary tests, include printer information. Include the NFPA 72 Record of Completion and NFPA 72 Inspection and Testing Form, with the appropriate test reports.

3. Fire alarm Testing Services or Laboratories

a. Construct fire alarm and fire detection equipment in accordance with UL Fire Protection Dir, UL Electrical Construction, or FM APP GUIDE.

4. Contractor performing fire alarm system work shall be a licensed fire alarm contractor. Contractor shall provide Fire Alarm Installation Certification with fire alarm system submittal.

G. Field quality-control reports.

H. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.

3. Record copy of site-specific software.

4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:

   a. Frequency of testing of installed components.
   b. Frequency of inspection of installed components.
   c. Requirements and recommendations related to results of maintenance.
   d. Manufacturer's user training manuals.

5. Manufacturer's required maintenance related to system warranty requirements.

6. Abbreviated operating instructions for mounting at fire-alarm control panel.

7. Copy of NFPA 25.

1.7 QUALITY ASSURANCE

A. Source Limitations for Fire-Alarm/Voice Notification System and Components: Obtain fire-alarm/Voice Notification system from single source from single manufacturer.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
C. NFPA Certification: Obtain certification according to NFPA 72 by a Nationally Recognized Testing Laboratory (NRTL).

1.8 PROJECT CONDITIONS

A. 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. Coordinate and comply with the requirements of the local Fire Marshall, or Authority Having Jurisdiction, concerning the fire alarm system shutdown plans, procedures, and fire watch plans that will be implemented for system interruptions during construction. All existing fire alarm devices shall remain active until new cabling and devices are installed. Temporary interruptions are allowed while work is being done on the system. Work shall be coordinated so that system is fully functional at the end of the workday. If system is not fully functional at end of workday, Contractor shall provide personnel for fire watch as required by local Fire Marshall and shall be responsible for all associated costs.

   2. Notify Construction Manager and Owner no fewer than two days in advance of proposed interruption of fire-alarm service.

   3. Do not proceed with interruption of fire-alarm service without Construction Manager and Owner’s written permission.

1.9 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. Coordinate and comply with the requirements of the local Fire Marshall, or Authority Having Jurisdiction, concerning the fire alarm system shutdown plans, procedures, and fire watch plans that will be implemented for system interruptions during construction.

B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.10 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning with Substantial Completion, provide software support for two years.

C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.11 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. Strobe Units: Quantity equal to 5 percent of amount installed, but no fewer than 2 units.
2. Keys and Tools: One extra set for access to locked and tamper proofed components.
3. Audible and Visual Notification Appliances: Quantity equal to 5 percent of amount installed, but no fewer than 2 units.
4. Fuses: Five of each type installed in the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. The existing manufacturer for the fire alarm system is Notifier and Edwards at the Mahopac High School.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices systems:

1. Manual stations.
2. Heat detectors.
3. Smoke detectors.
4. Duct smoke detectors.
5. Verified automatic alarm operation of smoke detectors
6. Automatic sprinkler system water flow.
7. Fire-extinguishing system operation.
8. Fire standpipe system.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm/voice notification appliances.
2. Identify alarm at fire-alarm control panel and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Release fire and smoke doors held open by magnetic door holders.
5. Shut down heating, ventilating, and air-conditioning equipment.
6. Close smoke dampers in air ducts of designated air-conditioning duct systems.
7. Recall elevators to primary or alternate recall floors.
8. Activate emergency shutoffs for gas and fuel supplies.
9. Record events in the system memory.

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.

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 primary power at fire-alarm/voice notification control panel.
4. Ground or a single break in fire-alarm control panel internal circuits.
5. Abnormal ac voltage at fire-alarm control panel.
6. Break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at fire-alarm/voice notification control panel or annunciator.

E. System Trouble and Supervisory Signal Actions: Annunciate at fire-alarm/voice notification control panel and remote annunciators.

2.3 FIRE-ALARM/VOICE NOTIFICATION CONTROL PANEL

A. General Requirements for modified Fire-Alarm/Voice Notification Control Panel:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.

    a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), 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.

2. Addressable interface devices that communicate device identity and status.

    a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control panel.
    b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.

3. Addressable interface devices for operation of mechanical equipment.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control panel 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, 3 line(s) of 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

C. Circuits:

1. Signal Line Circuits and Notification Appliance Circuits: NFPA 72-2010, Class B.

2. Install no more than 100 addressable devices on each signal line circuit.

3. Connect Notification Appliance Circuits so that signaling circuit or power supply output does not exceed 70 percent of rated capacity. Provide circuits with appropriately sized cable, sized per 100 percent of power supply output, in accordance with manufacturer's requirements.

4. Wire and control the Notification Appliance Circuits such that the audible alarm indicating devices can be turned off while the visual alarm notifications remain operational.

D. Amplifiers, Preamplifiers, Tone Generators

1. Any amplifiers, preamplifiers, tone generators, digitalized voice generators, and other hardware necessary for a complete, operational, textual audible circuit conforming to NFPA 72 shall be housed in a remote FVCP, terminal cabinet, or in the FVCP. Submit data to indicate that the amplifiers have sufficient capacity to simultaneously drive all notification speakers at the maximum rating plus 50 percent spare capacity. Annotate data for each circuit on the drawings.

2. Operation - The system shall automatically operate and control all building speakers except those installed in the stairs and within elevator cabs. The speakers in the stairs and elevator cabs shall operate only when the microphone is used to deliver live messages.

3. Construction - Amplifiers shall utilize computer grade solid state components and shall be provided with output protection devices sufficient to protect the amplifier against any transient up to 10 times the highest rated voltage in the system.

4. Inputs - Equip each system with separate inputs for the tone generator, digitalized voice driver and panel mounted microphone and public address paging function. Microphone inputs shall be of the low impedance, balanced line type. Both microphone and tone generator input shall be operational on any amplifier.

5. Tone Generator - The tone generator shall be of the modular, plug-in type with securely attached labels to identify the component as a tone generator and to identify the specific tone it produces. The tone generator shall produce a code 3 temporal tone and shall be constantly repeated until interrupted by either the digitalized voice message, the microphone input, or the alarm silence mode as specified. The tone generator shall be single channel with an automatic backup generator per channel such that failure of the primary tone generator causes the backup generator to automatically take over the functions of the failed unit and also causes transfer of the common trouble relay.

6. Protection Circuits - Each amplifier shall be constantly supervised for any condition that could render the amplifier inoperable at its maximum output. Failure of any component shall cause automatic transfer to a designated backup amplifier, illumination of a visual "amplifier trouble" indicator on the control panel, appropriate logging of the condition on the system printer, and other actions for trouble conditions as specified.

E. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control panel.
2. Activate an NRTL-listed and -approved "alarm-verification" sequence at fire-alarm control panel and detector.
3. Record events by the system log.
4. Sound general alarm if the alarm is verified.
5. Cancel fire-alarm control panel indication and system reset if the alarm is not verified.

F. Notification Appliance System:

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.

3. The Audible Notification System shall comply with the requirements of NFPA 72 for Emergency Voice/Alarm Communications System requirements except as specified herein.

4. The system shall be a one-way multi-channel voice notification system incorporating user selectability of a minimum eight distinct sounds for tone signaling, and the incorporation of a voice module for delivery of prerecorded messages. Audible appliances shall produce a temporal code

5. 3 tone for three cycles followed by a voice message that is repeated until the control panel is reset or silenced. Automatic messages shall be broadcast through speakers throughout the building/facility but not in stairs or elevator cabs. A live voice message shall override the automatic audible output through use of a microphone input at the control panel or the LOC.

6. When using the microphone, live messages shall be broadcast throughout a selected floor or floors or all call. The system shall be capable of operating all speakers at the same time. The microprocessor shall actively interrogate circuitry, field wiring, and digital coding necessary for the immediate and accurate rebroadcasting of the stored voice data into the appropriate amplifier input. Loss of operating power, supervisory power, or any other malfunction that could render the digitalized voice module inoperative shall automatically cause the code 3 temporal tone to take over all functions assigned to the failed unit in the event an alarm is activated.

7. The Voice Notification functions shall override the manual or automatic fire alarm notification or Public Address (PA) functions. Other fire alarm functions including transmission of a signal(s) to the fire department shall remain operational. The system shall have the capability of utilizing LOC with redundant controls of the notification system control panel. Notification Appliance Circuits (NAC) shall be provided for the activation of strobe appliances. The activation of the NAC Circuits shall follow the operation of the speaker NAC circuits. Audio output shall be selectable for line level. Amplifier outputs shall be not greater than 100 watts RMS output. The strobe NAC Circuits shall provide at least 2 amps of 24 VDC power to operate strobes and have the ability to synchronize all strobes. A hand held microphone shall be provided and, upon activation, shall take priority over any tone signal, recorded message or PA microphone operation in progress, while maintaining the strobe NAC Circuits activation.

G. Outputs and Operational Modules

1. All outputs and operational modules shall be fully supervised with on-board diagnostics and trouble reporting circuits. Provide form "C" contacts for system alarm and trouble conditions. Provide circuits for operation of auxiliary appliance during trouble conditions. During a Voice Notification event the panel shall not generate nor cause any trouble alarms to be generated with the Fire Alarm system.

H. Voice Notification: Voice Notification functions shall take precedence over all other function performed by the Audible Notification System. Messages shall utilize a male voice and shall be similar to the following:

1. 1000 Hz tones (as required in 18.4.2.1 of NFPA 72)

2. "May I have your attention please. May I have your attention please. A fire emergency has been reported in the building. Please leave the building by the nearest exit or exit stairway. Do not use the elevators." (Provide a 2 second pause.) "May I have your attention please, (repeat the message)."

3. The LOC shall incorporate a Push-To-Talk (PTT) microphone, redundant controls and system status indicators of/for the system. The unit shall incorporate microphone override of any tone generation or prerecorded messages. The unit shall be fully supervised from the control panel. The housing shall contain a latch (not lock).

4. Auxiliary Input Module shall be designed to be an outboard expansion module to either expand the number of optional LOC's, or allow a telephone interface.

5. LOC shall incorporate a Push-To-Talk (PTT) microphone, and controls to allow Public Address paging in the facility. The Public Address paging function shall not override any alarm or notification functions and shall be disabled by such signals. The microphone shall be desktop style. All wiring to the LOC shall be supervised. Systems that require field modification or are not supervised for multiple LOC's shall not be approved.

6. When an installation has more than one LOC, the LOC's shall be programmed to allow only one LOC to be available for page or messaging at a time. Once one LOC becomes active, all other LOC's will have an indication that the system is busy (Amber Busy Light) and cannot be used at that time. This is to avoid two messages being given at the same time. Also, it must be possible to override or lockout the LOC's from the Master Command Panel (in accordance with NFPA 72.)

I. Elevator Recall:

1. Smoke detectors at the following locations shall initiate automatic elevator recall. Alarm-initiating devices, except those listed, shall not start elevator recall.

    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 lobby detectors located on the designated recall floors shall be programmed to move the cars to the alternate recall floor.

3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.

    a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

J. Door Controls: Door hold-open devices at doors in smoke barrier walls shall be connected to fire-alarm system to disconnect power to closures upon any alarm.

K. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory.

L. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station via a Digital Alarm Communicating Transmitter (DACT).

M. 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 shall be powered by 24-V dc source.

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

N. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed, valve-regulated, recombinant lead acid.

O. 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.

P. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control panel and shall be able to identify the detector's location within the system and its sensitivity setting.

2. An operator at fire-alarm control panel, 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.

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. Addressable Interface Device Fan Shutdown Relay: Rated to interrupt fan motor-control circuit.

2.4 ADDRESSABLE INTERFACE DEVICES

A. Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.

B. Microelectronic relay module: Relay shall have form C dry contacts. NRTL listed for use in providing a system address for providing a signal to:

1. Air handling units to initiate fan shutdown.

2.5 NOTIFICATION APPLIANCES

A. Fire Alarm/Voice Notification Speakers

1. Audible appliances shall conform to the applicable requirements of UL 464. Appliances shall be connected into notification appliance circuits. Surface mounted audible appliances shall be factory painted red. Speakers shall conform to the applicable requirements of UL 1480. Speakers shall have six different sound output levels and operate with audio line input levels of 70.7 VRMs and 25 VRMs, by means of selectable tap settings. Tap settings shall include taps of 1/8, 1/4, 1/2, 1, and 2 watt. Speakers shall incorporate a high efficiency speaker for maximum output at minimum power across a frequency range of 150 Hz to 10,000 Hz, and shall have a sealed back construction. Sleeping room speakers must produce a 520 Hz signal temporal three (T3) signal in accordance with NFPA 72. Speakers shall be capable of installation on standard 100 mm square electrical boxes. Where speakers and strobes are provided in the same location, they may be combined into a single wall mounted unit. All inputs shall be polarized for compatibility with standard reverse polarity supervision of circuit wiring via the FAVN panel.

a. Provide speaker mounting plates constructed of cold rolled steel having a minimum thickness of 1.519 mm (16 gauge) or molded high impact plastic and equipped with mounting holes and other openings as needed for a complete installation. Fabrication marks and holes shall be ground and finished to provide a smooth and neat appearance for each plate. Each plate shall be primed and painted.

b. Speakers shall utilize screw terminals for termination of all field wiring.

B. Visual Notification Appliances

1. Visual notification appliances shall conform to the applicable requirements of UL 1971 and conform to the Architectural Barriers Act (ABA). The lens of the fire alarm strobe, voice notification strobe, or both (if in the same appliance) shall be located such that the entire lens is located not less than 2032 mm and not more than 2438 mm above the finished floor. The manufacturer shall have the color lens tested to the full UL 1971 polar plotting criteria, voltage drop, and temperature rise as stated in 1971. Fire Alarm Notification Appliances shall have clear high intensity optic lens, xenon flash tubes, and be marked "Fire" in red letters. Voice Notification appliances, Fire Alarm/Voice Notification Appliances shall have clear high intensity optic lens, xenon flash tubes, and output white light and be marked "FIRE" in red letters. Fire Alarm and Voice Notification strobes may be combined into a single device with single strobe. The light pattern shall be disbursed so that it is visible above and below the strobe and from a 90 degree angle on both sides of the strobe. Strobe flash rate shall be 1 flash per second and a minimum of 15 candela, (actual output after derating for tinted lens) based on the UL 1971 test. Strobe shall be surface mounted to existing walls and semi-flush mounted to new walls. Where more than one appliance is located in the same room or corridor or field of view, provide synchronized operation. Devices shall use screw terminals for all field wiring.

2.6 SMOKE DETECTOR REMOTE STATUS AND ALARM INDICATORS

A. Remote power/alarm indicator and key switch. Contains green and red LED power/alarm indicators and keyed test/reset switch mounted on a stainless steel plate.

2.7 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 manufacturer of device.
2. Finish: Paint of color to match the protected device.
3. Locations where require for additional equipment: Gymnasiums and Adaptive Play Rooms.

2.8 ADDITIONAL FIRE ALARM DEVICES

A. Additional fire alarm devices not indicated on drawings, the devices below can be added at any time during construction up to and including project final inspections, base bid price to include device, wiring and programming.

1. Include in bid price material and labor to install (4) new fire alarm speaker/strobe lights in existing spaces and wire said speaker/strobe lights, assuming wiring lengths of 50’ from speaker/strobe to nearest Notification Appliance Circuit. Wiring is to be on a per device basis.

2.9 FIRE ALARM WIRE AND CABLE

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. Comtran Corporation.
2. Draka Cableteq USA.
3. Genesis Cable Products; Honeywell International, Inc.
4. Rockbestos-Suprenant Cable Corp.
5. West Penn Wire; a brand of Belden Inc.

B. General Wire and Cable Requirements: Install Type FPLP plenum rated fire alarm cable for all initiating circuit wiring and notification circuit wiring, sized in accordance with manufacturer's recommendations. NRTL listed and labeled as complying with NFPA 70, Article 760.

C. Signaling Line Circuits: Twisted, shielded pair, or twisted, unshielded pair, not less than No. 16 AWG. Refer to fire alarm system manufacturer for recommended sizes and shielding requirements.

D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.

1. Low-Voltage Circuits: No. 16 AWG, minimum.
2. Line-Voltage Circuits: No. 12 AWG, minimum.

PART 3 - EXECUTION

3.1 VERIFICATION OF EXISTING CONDITIONS (BY INSTALLER)

A. Verification of Existing Conditions (by Installer): Examine conditions under which fire alarm system is to be installed in coordination with Installer of materials and components specified in this Section and notify affected Contractors and Architect in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

1. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to Architect written confirmation from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.

3.2 PROTECTION

A. Protection: Provide dust covers on all existing detectors in renovation areas during construction.

3.3 EQUIPMENT INSTALLATION

A. Install fire alarm system in accordance with applicable provisions of NEC, NFPA-70, Article 760 - Fire Protective Signaling Systems.

1. Contractor performing fire alarm system work shall be a licensed fire alarm contractor. Contractor shall provide Fire Alarm Installation Certification with fire alarm system submittal.

2. Since existing fire alarm system is being replaced, Contractor performing fire alarm system work shall comply with the requirements of the local Fire Marshall concerning the fire alarm system shutdown plans, procedures, and fire watch plans that will be implemented for system interruptions during construction. All existing fire alarm devices shall remain active until new cabling and devices are installed. Temporary interruptions are allowed while work is being done on the system. Work shall be coordinated so that system is fully functional at the end of the workday. If system is not fully functional at end of workday, Contractor shall provide personnel for fire watch as required by local Fire Marshall and shall be responsible for all associated costs.

3. Provide all labor, materials, equipment and services to perform all operations required for complete installation of fire alarm system and related construction as shown on Drawings and specified in this Section.

4. Completely check, program and adjust all new and existing equipment on each system.

5. Label each addressable device with label indicating device's unique address. Label shall comply with Specification Section 26 05 53 Identification for Electrical Systems. Labels shall be installed so that they are visible without removing device from mounting base.

B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections by testing 100% of system and submitting complete test reports.

1. Connect new equipment to replacement control panel in existing part of the building.

2. Connect new FAVN to existing monitoring equipment at the supervising station.

3. Expand, modify, and supplement existing equipment as necessary to extend existing functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

C. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.

D. In areas where detection and notification devices may be subject to physical damage, devices shall have protective wire guards as manufactured by Safety Technology International (www.sti-usa.com). All guards shall be listed for the fire alarm system devices and appliances protected.

E. In new construction, install all devices flush or semi-flush mounted, unless otherwise authorized by Owner.

F. In existing construction, install all interior surface mounted devices on surface mounted back boxes supplied by device manufacturer.

G. In locations where new device is replacing existing, contractor shall coordinate removal/replacement to allow re-use of existing backbox/conduits if possible.

H. In locations where building construction prohibits flush-mounted installations, provide surface raceway. At such locations obtain written authorization from Owner's representative or Architect prior to providing surface raceway device.

I. Demolition of existing system:

1. Disconnect and remove existing fire alarm system as indicated on floor plans. Existing wiring may be reused if fire alarm system manufacturer confirms same in writing.
2. Repair all damaged surfaces upon removal of existing devices and raceway. Repair, patch and paint existing construction to match existing finishes.

J. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.

K. Remote Status and Alarm Indicators: Install near each duct detector, smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

L. Wire the Notification Appliance Circuits such that the audible alarm indicating devices can be turned off while the visual alarm notifications remain operational.

M. Locate audible/visible signaling devices in strict accordance with requirements of Americans with Disabilities Act (ADA).

N. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install speakers on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

O. Visible Alarm-Indicating Devices: Install adjacent to each alarm speaker and place strobe light lens 80 inches minimum and 96 inches maximum above floor level. In locations where ceiling height is less than 90 inches AFF, place strobe light lens 6 inches below ceiling.

P. Where combination audible/visible units used, place strobe light lens 80 inches minimum and 96 inches maximum above floor level. In locations where ceiling height is less than 90 inches AFF, place strobe light lens 6 inches below ceiling.

Q. Device Location-Indicating Lights: Locate in public space near the device they monitor.

R. Fire-Alarm/Voice Notification Control Panel: Surface mounted, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

3.4 WIRING

A. Install Type FPLP plenum rated fire alarm cable for all initiating circuit wiring and notification circuit wiring, sized in accordance with manufacturer's recommendations.

B. Signaling Line Circuits: Power-limited fire alarm cables shall not be installed in the same cable or raceway as signaling line circuits.

C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

E. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

F. Install all plenum cable above corridor ceilings bundled and tie-wrapped at 5 foot intervals and hung in saddle rings or J-hooks, supported to structure at 5 foot intervals.

G. Cable shall not be considered properly supported by lying over top of conduits, piping, or building supports or bracing. Approved saddle rings or J-hooks must be used.

H. For wall mounted devices in existing construction where wiring cannot be concealed, all wiring shall be installed in surface metallic raceway from device location to accessible ceiling space. Paint raceway to match existing surface in occupied spaces.

I. Install all wiring in approved surface metallic raceway or EMT conduit in the following locations:

1. Unfinished areas (EMT conduit).
2. Exposed areas (Surface metallic raceway).
3. Where subject to damage.
4. Coordinate paragraph below with Drawings. Wind speed is usually a requirement of the applicable building code.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Install framed instructions in a location visible from fire-alarm control panel.

3.6 GROUNDING

A. Ground fire-alarm control panel and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control panel.

3.7 ADJUSTING / CLEANING

A. Completely clean all smoke detectors, as instructed by authorized factory representative, when system is substantially complete and when authorized by Owner.

3.8 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by Owners Representative and authorities having jurisdiction.

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

C. 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 NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.

    b. Comply with "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. Perform 100 percent inspection and testing of all system devices.

    a. Provide complete panel real-time printout as documentation of device, date and time. Any acceptance test not accompanied by real-time printout requires retesting of entire system by Contractor, including both alarm activation tests and tests of supervisory circuit at each device.

    b. Provide inspection complying with requirements of applicable NFPA standards.

    c. Provide to Owner and Fire Sub Code Official complete typed list of every initiation, signaling, control, supervisory and auxiliary device with specific information regarding system address of device, location of device, date tested, manufacturer's model number, and serial number of all analog components, status of device and zone or point as related to system. Obtain from Owner, the Owner’s room names/numbers that are to be assigned to each device.

3. Provide complete set of battery test results for panels including:

    a. Charger output voltage under normal conditions.

b. Charger output current under normal conditions.
c. Open battery voltage.
d. Supply voltage and current under primary power failure.
e. Supply voltage and current under primary power failure and system alarm that has activated all of panel's audible, visual and control circuits.
f. Calculations using battery test data obtained to determine minimum battery capacity of 24 hours under normal conditions and 5-minute alarm condition.
g. Take voltage readings at end of line of each alarm signal circuit to insure minimum operational levels.
h. If voltage drop exceeds the minimum rating of the last device in the circuit, while under full circuit load, rewire circuits with appropriately heavier gage wire as required to comply with specified requirements.

4. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.

5. Test visible appliances for the public operating mode according to manufacturer's written instructions.

6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

D. Intelligibility Tests

1. Intelligibility testing of the System shall be accomplished in accordance with NFPA 72 for Voice Evacuation Systems, IEC 60268-16, and ASA S3.2. Following are the specific requirements for intelligibility tests:

   a. Intelligibility Requirements: Verify intelligibility by measurement after installation.

2. Ensure that a CIS value greater than the required minimum value is provided in each area where building occupants typically could be found. The minimum required value for CIS is .7

3. The contractor must submit a waiver letter for areas of the building they believe will not meet the minimum CIS value at the beginning of the shop drawing phase. Areas of the building provided with hard wall and ceiling surfaces (such as metal or concrete) that are found to cause excessive sound reflections may be permitted to have a CIS score less than the minimum required value if approved by the Architect, and if it can be determined that building occupants in these areas can determine that a voice signal is being broadcast and they can walk no more than 30 feet m to find a location with at least the minimum required CIS value within the same area.

4. Areas of the building where occupants are not expected to be normally present are permitted to have a CIS score less than the minimum required value if personnel can determine that a voice signal is being broadcast and they must walk no more than 50 feet to a location with at least the minimum required CIS value within the same area.

5. Take measurements near the head level applicable for most personnel in the space under normal conditions (e.g., standing, sitting, as appropriate).

6. The distance the occupant must walk to the location meeting the minimum required CIS value shall be measured on the floor or other walking surface as follows:

    a. Along the centerline of the natural path of travel, starting from any point subject to occupancy with less than the minimum required CIS value.
    b. Curving around any corners or obstructions, with a 12 inch clearance there from.
    c. Terminating directly below the location where the minimum required CIS value has been obtained.

7. Use commercially available test instrumentation to measure intelligibility as specified by ISO 7240-19 and ISO 7240-16 as applicable. Use the mean value of at least three readings to compute the intelligibility score at each test location.

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.

H. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.9 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.10 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.

3.11 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system. Training shall consist of a total of 8 hours delivered in 2 hour blocks.

B. Provide copy of sign-in sheet of District staff receiving training in O&M Manuals.

END OF SECTION 28 31 11

SECTION 31 10 00 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General 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. Temporary erosion and sedimentation-control measures.
8. Disposal of waste material.

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 (insitu): 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 in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

D. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated on Drawings.

E. 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, GENERAL

A. General: Submit all informational submittals required by this Section concurrently.

1.6 INFORMATIONAL 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 video.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

1.7 CLOSEOUT SUBMITTALS

A. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.8 PROJECT CONDITIONS

A. Verification of Conditions: Examine conditions under which site clearing is to be accomplished and notify Architect in writing of any conditions detrimental to proper and timely accomplishment. Do not proceed with site clearing until unsatisfactory conditions have been corrected.

B. 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.

C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

D. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures 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.

H. 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 Section 31 20 00 "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. Flag each tree trunk at 54 inches above the ground.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

D. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

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. Refer to Section 31 25 00, “Erosion and Sedimentation Controls”.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree or plant 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 Section 31 25 00 "Erosion and Sedimentation Controls."

B. Should any trees or shrubs be damaged which are to be saved, arrange to have such damage treated by a licensed arborist or tree surgeon.

C. Protect tree and shrub root systems from smothering. Do not store construction materials, debris, or excavated material within plant protection zone. Do not permit vehicular traffic or parking within plant protection zone. Restrict foot traffic to prevent excessive compaction of soil over tree, shrub and turf root systems.

D. Trees or shrubs which die because of the Contractor's failure to conform to the Drawings and specifications shall be evaluated by a qualified organization selected by the Owner's Representative. The removal and replacement of the tree, and the evaluation expenses shall be paid for by the Contractor. Contractor shall be required to replace the damaged tree with plant material of comparable size and quality (i.e. damaged 12" caliper Red Maple shall be replaced by three 4" cal. or four 3" cal. Red Maples). Substitutions for variety shall be approved by the Architect.

3.4 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed.

1. Owner will arrange to shut off indicated utilities when requested by Contractor.

B. Locate, identify, and disconnect utilities indicated to be abandoned in place.

C. 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 ten working days in advance of proposed utility interruptions.

D. 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 minimum depth of 18 inches 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, and compact each layer in accordance with Section 31 20 00 "Earth Moving".

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil in a manner to prevent intermingling with underlying subsoil or other waste materials.

C. Do not remove surplus topsoil from site.

D. Refer to Section 32 92 00 "Turfs and Grasses" for topsoil screening requirements.Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

F. 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.
2. Do not stockpile topsoil within protection zones.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction including foundations, slabs, paving, curbs, gutters, retaining walls, aggregate base and other improvements.

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. Leave cut edge neat and square where existing material is cut to adjoin new work.

2. Remove asphalt concrete paving material to full depth and remove from site. Do not use asphalt materials for on-site fill.

3. Gravel and stone fill under removed sidewalks may be reused if suitable for the particular new use and if approved by the Architect.

4. Break up and completely remove miscellaneous concrete, such as small foundations. Remove concrete, retaining walls or foundations below grade to a minimum depth of 2'.

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 31 10 00

SECTION 31 20 00 - EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Preparing subgrades for walks, pavements, and natural turf and grasses
2. Structural Fill: For backfill under structures, pavements, concrete pads, synthetic turf paving section (under carpet and subbase), etc.
3. Granular Fill: Subbase for interior concrete slabs-on-grade, asphalt paving, concrete paving, etc.
4. Subsurface drainage fill for foundation drains, underdrains, etc.
5. Excavating and backfilling for buildings and structures.
6. Excavating and backfilling trenches for utilities and pits for buried utility structures.

B. Related Requirements:

1. Section 03 30 00 - Cast-in-Place Concrete
2. Section 31 10 00 - Site Clearing
3. Section 32 18 13 - Synthetic Grass System
4. Section 32 92 00 - Turf and Grasses
5. Section 33 41 00 – Storm Utility Drainage Piping

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. Subbase: Granular aggregate layer supporting the slab-on-grade and pavement that also minimizes upward capillary flow of pore water.

G. 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 Geotechnical Engineer.

2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.

3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Geotechnical Engineer or Architect. Unauthorized excavation, as well as remedial work directed by Geotechnical Engineer or Architect shall be without additional compensation.

H. Fill: Soil materials used to raise existing grades.

I. Hazardous Soil Materials: Soils that are contaminated with petroleum product and/or hazardous chemicals, waste or industrial waste.

J. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation or for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

1. Rock Excavation: Track-mounted excavator rated at not less than 222-hp flywheel power with weight of 70,000 lbs or greater and a 30-in wide short-tip radius rock bucket. (Ratings are based on Caterpillar's "Model No. 330B”.)

K. 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.

L. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below aggregate base, structural fill, drainage fill, or topsoil materials.

M. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

N. Non-Granular Fill: Soil fill material used to raise existing grades in areas that do not require granular or structural fill.

O. Well-Graded: Soils containing a good range of all representative particle sizes between the largest and the smallest. All sizes must be represented, and no one size should be either overabundant or missing.

P. Poorly-Graded: Soils which either contain a narrow range of particle sizes or have some intermediate sizes lacking.

1.4 SUBMITTALS

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

B. Action Submittals:

1. Product Data: For each type of the following manufactured products required:

   a. Geotextiles.
   b. Warning tapes.

2. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:

   a. Classification according to ASTM D 2487.
   b. Laboratory compaction curve according to ASTM D 1557.
   c. Submitted material testing and analysis shall demonstrate that no unsuitable soil groups are present.
   d. Submitted material testing and analysis shall demonstrate that no absorbent clays are present.

3. Delegated-Design Submittal:

   a. For excavations greater than or equal to 20 feet in depth require engineered systems design per OSHA requirements, signed and sealed by a professional engineer, and submitted for review.

   b. Plan for protection of persons passing excavations including diagram or description of means and methods to protect all people from project hazards through the duration of the project shall be submitted for review.

4. Samples for Verification: For the following products, in sizes or quantities indicated below:

   a. Fill: One-half gallon by volume of material in sturdy container of each type of fill, naming source for each material.
   b. Geotextile: 12 by 12 inches.
   c. Warning Tape: 12 inches long; of each color.

5. Verification of Conditions: Written confirmation from installer that installation of Earthwork Materials installed in accordance with specifications.

C. Informational Submittals:

1. Qualification Data: For qualified testing agency.

2. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, which might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Qualified Installers as defined below:

1. Earthwork Contractor Experience Requirements: Provide a list of at least four Earthwork projects of comparable size, scope, and quality completed successfully by the proposed Sub Contractor within the past two years that includes the date completed, project Owner's name and current contact information, including telephone numbers and e-mail addresses.

B. Civil/Structural Preconstruction Conference: Attend Civil/Structural Preconstruction Conference.

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: If work includes improvements on adjoining property, written authorization for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Architect.

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 and permanent erosion- and sedimentation-control measures, specified in Division 31 Section "Erosion and Sedimentation Control" are in place.

E. Do not commence earth moving operations until plant-protection measures specified in Division 31 Sections "Erosion and Sedimentation Control" and "Site Clearing" are in place.

F. The following practices are prohibited within tree- or plant-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.
8. Directing vehicle or equipment exhaust towards protection zones.
9. Heat sources, flames, ignition sources, and smoking within or near protection zones.

G. Existing Hazardous Materials:

1. If during the performance of the work suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. If present, hazardous materials will be removed by Owner under a separate contract.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Soil Materials:

1. General: Provide imported soil materials when sufficient satisfactory soil materials are not available from onsite excavations.
2. Topsoil: Refer to Turf and Grasses Specification, Division 32.

B. Hazardous Materials:

1. Provide fill materials that are not contaminated with petroleum product, hazardous waste or industrial waste.
2. Contamination above federal, state or local requirements is not acceptable. Materials with a visible sheen or petroleum odor shall be rejected.

C. Unsuitable Soils: (Includes excavated native and imported non-granular, granular and structural fill materials)

1. Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.

   a. Soils Materials shall not contain any absorbent aluminum phyllosilicates, including but not limited to: bentonite (sodium, calcium, or potassium), tonstein, montmorillonite, kaolinite. or other absorbent clays.

2. Unsuitable soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

3. Submitted material testing and analysis shall demonstrate that material classification meets ASTM-D2487 USC system criteria and that no unsuitable soil groups, or absorbent clays are present.

D. Non-Granular Fill: Material is to comply with NYSDOT requirements for Select Borrow and Select Fill with modifications shown below. This material is not allowed in areas where granular soils are required, including within the building footprint, below pavement areas or below a synthetic turf athletic field.

1. On-Site Non-Granular Fill

   a. Submittal must be provided demonstrating that on-site soil material meets the criteria outlined in this Section for use as fill material.

b. Obtain approval of Architect before proceeding with use of on-site material.

c. Material is to have no particles greater than 3" in maximum dimension, no more than 70% by weight passing the #40 sieve and no more than 20% passing the #200 sieve.

d. Testing submitted is to demonstrate that proper compaction can be achieved as required in Part 3, Execution.

2. Imported Non-Granular Fill

a. Where quantity of approved non-granular fill materials required exceeds that available from on-site stock-piles, provide suitable material from off-site sources.

b. Obtain approval of Architect before proceeding with use of imported fill material.

c. Material is to have no particles greater than 3" in maximum dimension, no more than 70% passing by weight the #40 sieve and no more than 15% passing the #200 sieve.

d. Testing submitted is to demonstrate that proper compaction can be achieved as required in Part 3, Execution.

E. Structural Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand.

1. Type 1 Fill (NYSDOT ITEM No. 304.11 Granular Fill) gradation requirements:

Sieve Designation	**Percent by Weight Passing Square Mesh Sieves**
3 inch	100
2 inch	90 to 100
1/4-inch	30 to 65
#40	5 to 40
#200	0 to 10

F. Granular Fill: Import all granular fill types from off-site sources. Granular fill consists of stone, sand, and gravel, or blends of these materials, free of slag, complying with New York State Department of Transportation (NYSDOT) Standard Specification, Section 304, as modified below:

1. Type 2 Fill (NYSDOT ITEM No. 304.12 – Product to be crushed / blasted ledge rock stone or crushed / blasted limestone *(Processed, naturally occurring bank run gravel material <u>not</u> allowed*) Gradation Requirements.

Sieve Designation	**Percent by Weight Passing Square Mesh Sieves**
2 inch	100
1/4-inch	25 to 60
#40	5 to 40
#200	0 to 10

G. Crushed Stone: Crushed stone to complying with New York State Department of Transportation (NYSDOT) Standard Specifications, Section 703-0201 which is product of mechanical crushing. Where indicated, provide the following fill materials, consisting of clean, free of slag, durable, sharp-angled fragments of rock of uniform quality. The crushed stone used as coarse aggregate for all items shall be obtained from sources conforming to the requirements of the NYSDOT as to sampling, testing methods, Quarry Reports and any other required procedures and complying with following requirements:

1. NYSDOT No. 1 Crushed Stone Gradation Requirements (NYSDOT 703-4 # 1 Stone):

Sieve Designation	**Percent by Weight Passing Square Mesh Sieves**
1 inch	100
1/2-inch	90 to 100
1/4-inch	0 to 15
#200	0 to 1

2. NYSDOT No. 2 Crushed Stone Gradation Requirements (NYSDOT 703-4 #2 Stone):

Sieve Designation	**Percent by Weight Passing Square Mesh Sieves**
1-1/2 inch	100
1 inch	90 to 100
1/2-inch	0 to 15
#200	0 to 1

H. Drainage Fill: Mixture of 50 percent NYSDOT No. 1 crushed stone and 50 percent NYSDOT No. 2 crushed stone, complying with New York State Department of Transportation Standard Specifications, Section 703-02.

Sieve Designation	**Percent by Weight Passing Square Mesh Sieves**
1-1/2 inch	100
1 inch	95 to 100
1/2-inch	25 to 60
# 4	0 to 10
# 8	0 to 5

I. Sand for general use and/or utility bedding: ASTM C 33; fine aggregate.

J. Sand for storm water quality sand filter: Clean (washed) AASHTO M-6/ASTM C-33 medium aggregate coarse concrete sand, with effective particle size (D10) between 0.3mm and 0.5mm, a uniformity coefficient (Uc) of < 4, and < 4% fines passing the 100 sieve.

2.2 GEOTEXTILES

A. Separation/Filter Fabric - Nonwoven needle-punched polypropylene geotextile filter/separation fabric complying with the following:

Fabric Property	Value	Test Method
Grab Tensile Strength	120 lb	ASTM D 4632
Grab Tensile Elongation	50 percent	ASTM D 4632
Trapezoid Tear Strength	50 lbs	ASTM D 4533
CBR Puncture Strength	310 lbs min	ASTM D 6241
Apparent Opening Size	No. 70 sieve max	ASTM D 4751
Permittivity	1.7 sec^{-1}	ASTM D 4491
Flow Rate	135 gal min/ft^2	ASTM D 4491
UV Stability	70% after 500 hours	ASTM D 4355

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. TenCate Mirafi - 140N
    b. Amoco - 4547
    c. Geotex – 451

B. Soil Stabilization Fabric: Heavy duty, commercially manufactured woven polypropylene geotextile meeting the following properties:

Fabric Property	Test Method	Unit	Typical Value
Grab Tensile Strength	ASTM D 4632	lbs	200
Grab Tensile Elongation	ASTM D 4632	%	15
Trapezoidal Tear Strength	ASTM D 4533	lbs	75 min.
CBR Puncture Strength	ASTM D 6241	lbs	700
UV Resistant after 500 hours	ASTM D 4355	% Strength	70
Apparent Opening Size	ASTM D 4751	US Sieve	40
Permittivity	ASTM D 4491	sec^{-1}	0.05
Water Flow Rate	ASTM D 4491	gal/min/ft^2	4.0

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. TenCate Mirafi - 500X
    b. US Fabrics, Inc. - US 200
    c. Carthage Mills – FX-55
    d. Propex – 200 ST

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which earthwork is to be accomplished in coordination with Installer of materials and components specified in this Section and notify affected Prime Contractors and Architect in writing of any conditions detrimental to proper and timely accomplishment. Do not proceed with earthwork until unsatisfactory conditions have been corrected in manner acceptable to Installer.

1. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to Architect written confirmation from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.

3.2 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.

1. Contractor is entirely responsible for strength and adequacy of bracing and shoring, and for safety and support of construction from damage or injury caused by lack of adequate protection or by movement or settlement.

2. Contractors are advised that they are required to comply with Occupational Safety and Health Administration's (OSHA) standards pertaining to excavation.

3. All excavations must be barricaded at all times using either traffic or A-Frame type barricades. Gaps between barricades may be up to 6-inches wide and must be blocked with caution tape.

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.

3.3 UNDERGROUND UTILITY SURVEY

A. An underground utility survey must be conducted prior to the start of any excavation. Call 811

3.4 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.

3.5 EXPLOSIVES

A. Explosives: Do not use explosives.

3.6 SITE CLEARING

A. Refer to Division 31 Section "Site Clearing".

3.7 EXCAVATION, GENERAL

A. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Geotechnical Engineer. Changes in the Contract Time may be authorized for rock excavation.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.

    a. Intermittent drilling; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

2. Rock excavation includes removal and disposal of rock (refer to Definitions section: "Rock" paragraph above). Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:

    a. 24 inches outside of concrete forms other than at footings.
    b. 12 inches outside of concrete forms at footings.
    c. 6 inches 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 beneath bottom of concrete slabs-on-grade.
    f. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

3.8 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

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. Protect trees and other plants in accordance with requirements in Division 1 Section "Temporary Facilities and Controls" and Division 31 Section "Erosion and Sedimentation Control".

3.9 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.10 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 higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: 12 inches each side of pipe or conduit.

C. Trench Bottoms: Excavate trenches 6 inches (150 mm) deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe. Remove projecting stones and sharp objects along trench subgrade.

D. 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 in accordance with standard nursery practice and Division 31 Section “Erosion and Sedimentation Control”.

3.11 SUBGRADE INSPECTION

A. Notify Architect when excavations have reached required subgrade.
B. If Geotechnical Engineer determines that unsuitable soil is present, continue excavation and replace with compacted backfill or fill material as directed.

3.12 PROOF-ROLLING

A. Proof-roll subgrade below building slabs, concrete pads and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing 15 tons 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 and repeating proof-rolling in direction perpendicular to first direction with a minimum of six overlapping passes. Limit vehicle speed to 3 mph.

2. Excavate soft spots, unsuitable soils, and areas of excessive pumping or rutting, as identified by Geotechnical Engineer and as directed by Owner, and replace with compacted backfill or fill as directed. Notify Architect in writing of any required remediation.

3. Foundations: Proof-roll prior to excavation for foundations but after top soil is stripped.

B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities without additional compensation.

3.13 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. CLSM (flowable fill), per this specification section, may be used when approved by Architect.

1. Fill unauthorized excavations under other construction, pipe, or conduit in accordance with this Section unless otherwise directed by Geotechnical Engineer.

3.14 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.

3.15 SOIL STABILIZATION FABRIC

A. Install soil stabilization fabric: After subgrade has been compacted and proof-rolled, install soil stabilization fabric as specified by the manufacturer, including the following:

1. Lay fabric in the direction of traffic.
2. Overlap fabric side to side and end to end a minimum of two feet.
3. Insure that fabric lies flat during fill placement.

3.16 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.

3.17 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 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. Trenches under Roadways: Provide 4-inch- thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Division 03 Section "Cast-in-Place Concrete"

E. Backfill voids with satisfactory soil while removing shoring and bracing.

F. Place and compact initial backfill of subbase material or satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches 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.

G. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches over the pipe or conduit. Coordinate backfilling with utilities testing.

H. Place and compact final backfill of satisfactory soil to final subgrade elevation.

I. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.

J. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.18 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. Refer to Part 2 for material requirements and specific conditions for the use of each type of soil material. All fill materials to be approved by Architect per requirements noted in Part 2.

   1. Under grass and planted areas:

      a. Use satisfactory non-granular fill material.

2. Under walks, pavements and exterior slabs:

   a. Use Structural Fill below subbase layer and Type 2 granular fill for subbase layer.

3. Under steps and ramps

   a. Use structural fill below subbase layer and Type 2 granular fill for subbase layer.

4. Under building slabs:

   a. Use structural fill below subbase layer. For subbase, use No. 2 Crushed Stone. See Drawings for depth.

5. Under synthetic turf fields:

   a. Use Structural Fill or Granular Fill below subbase.
   b. For subbase requirements, refer to Synthetic Turf Fields Section.

6. Under footings and foundations:

   a. Use structural fill.

7. Under catch basins, manholes, vaults or other underground structures.

   a. Use structural fill or as noted on drawings.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.19 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 density.

3.20 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Maximum layer depth before compaction:

1. Under Pavement: Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

2. Place backfill and fill soil materials in layers not more than 12 inches in loose depth for material compacted by heavy compaction equipment, and not more than 8 inches 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 weight density according to ASTM D 1557:

1. Under structures, building slabs, steps, synthetic turf and pavements**:**

a. Scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.

2. Under walkways:

a. Scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 95 percent.

3. Under natural turf or unpaved areas:

a. Compact each layer of subgrade backfill or fill soil material at 85 percent. Compact all layers beneath the upper 2'-0" to at least 95 percent.

4. Utility trenches:

a. Compact each layer of initial and final backfill soil material at 85 percent.

5. Landscape Planting Areas:

a. Compact each layer of subgrade backfill or fill soil material at 75 percent.

6. Under catch basins, manholes, vaults or other underground structures.

a. Scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.

3.21 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.

2. Walks: Plus or minus 1 inch.
3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge and within +0” / -1” tolerance of bottom of slab.

3.22 SUBSURFACE DRAINAGE

A. Drainage Tubing / Subdrainage Pipe: Specified in Division 33 Section "Storm Utility Drainage Piping”.

B. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench as shown in Drawings.

1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698.

C. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.

1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698 with a minimum of two passes of a plate-type vibratory compactor.

3.23 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place granular fill base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place granular fill base course under pavements and walks as follows:

1. Place base course material over subgrade under hot-mix asphalt pavement.

a. If separation geotextile is shown in the details, install on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.

2. Shape base course to required crown elevations and cross-slope grades.

3. Place base course 6 inches or less in compacted thickness in a single layer.

4. Place base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.

5. Compact 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 1557.

3.24 SUBBASE FOR CONCRETE SLABS-ON-GRADE

A. Place subbase on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact subbase under cast-in-place concrete slabs-on-grade as follows:

1. Place subbase 8 inches or less in compacted thickness in a single layer.
2. Place subbase that exceeds 8 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 8 inches thick or less than 3 inches thick.
3. Compact each layer of subbase to required cross sections and thicknesses to not less than 95 percent of maximum dry density according to ASTM D 4254.

3.25 INSTALLATION OF SURFACE STONE MATERIAL

A. Place surface stone material (stone dust, cover stone, etc.) on subgrades free of mud, frost, snow, or ice.

B. Compact so that surface stone layer is consolidated. During installation avoid bringing subgrade material to the surface. If subgrade material becomes intermixed with surface stone, remove contaminated surface stone material and reinstall new surface stone.

3.26 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections unless otherwise noted.

B. 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.

C. Inspections and tests:

1. Geotechnical observations: Proof rolling procedures, site preparation, unsuitable soils removal, excavations, footing bearing, and fill placement.

2. Field Density Testing:

a. 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 Geotechnical Engineer.

b. 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) Fill under Footings: In each compacted fill layer, 1 compaction test for every 30 linear feet of wall may be taken. 1 compaction test may be made under each individual footing.

2) Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 50 feet or less of wall length, but no fewer than two tests.

3) Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2,000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.

4) Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.

c. 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. Laboratory testing for on-site fills:

a. ASTM D 1557 Modified Proctor compaction curve including sieve analysis.

3.27 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 Geotechnical Engineer or 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.

3.28 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 31 20 00

GEOTECHNICAL BORING MAPS AND LOGS

Appendix to Project Manual Section 31 20 00, EARTH MOVING

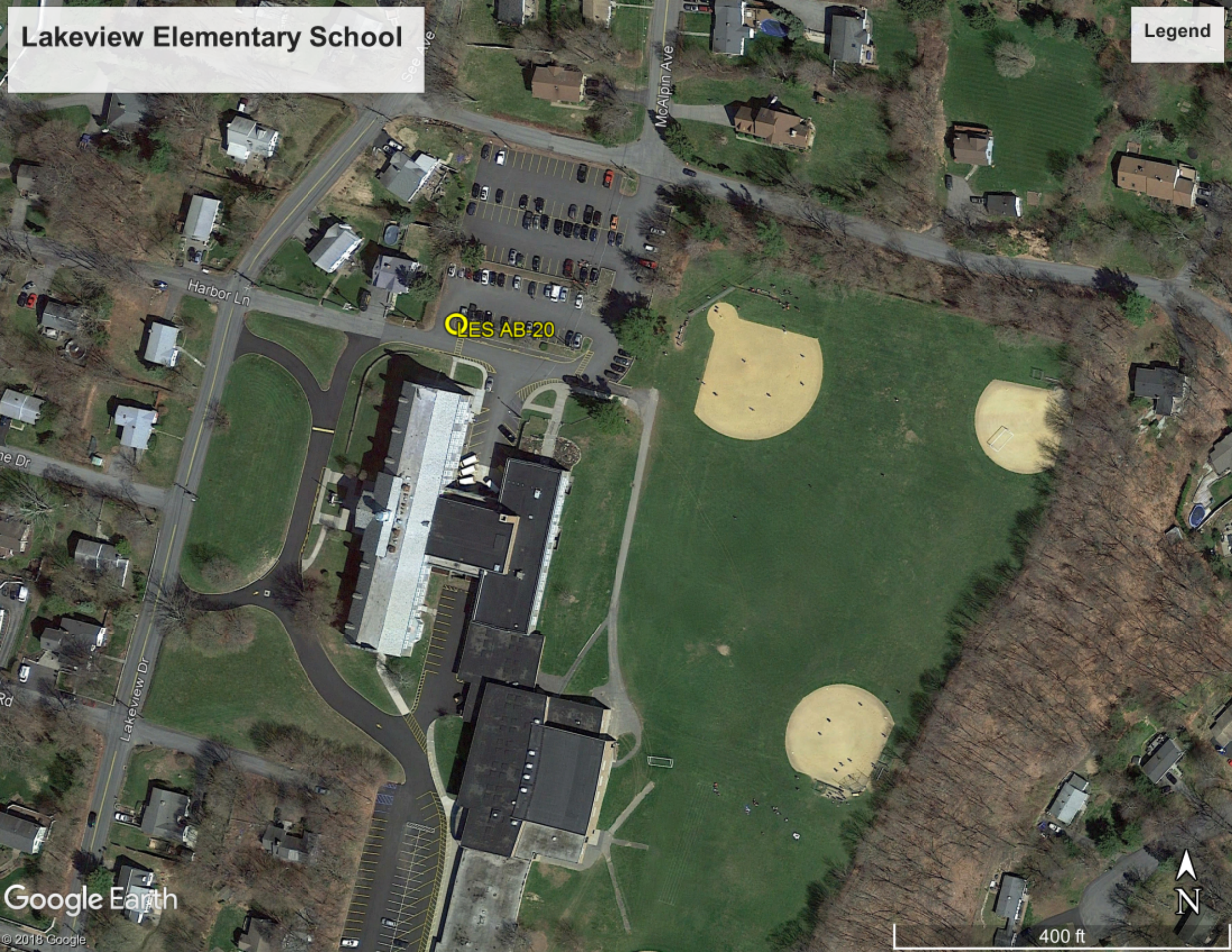
Boring Map and Log Source:
Geotechnical Engineering Study
Appendix A - Subsurface
Exploration Plan
Mahopac Central School District
Hamlet of Mahopac
Putnam County, New York
September 26, 2019

APPENDIX A

Subsurface Exploration Plan

Fulmar Road Elementary School

Lakeview Elementary School




Mahopac Middle and High Schools
Legend
MMS I-1
MMS I-2
MMS B10-1
MMS PB-2
MMS PB-1
MMS I-3
MMS PB-3
MMS B10-2
MMS PB-6
MMS PB-4
MMS PB-7
MMS PB-8
MMS AB20
MMS PB-9
Tribbe Hill
MMS B10-3
MMS I-4
MMS PB-10
MHS TS-2
MHS I-3
MHS AB-2
MHS TS-1
MHS I-1
MHS B-1
MHS TS-3
MMS I-5
MMS PB-11
MHS I-2
MHS AB-4
MHS B-2
MHS I-4
MHS TS-4
MMS PB-12
MHS AB20-2
MHS AB-3
MMS I-6
MHS I-6
MHS PB-1
MHS I-5
MHS AB-1
MHS PB-2
MHS PB-4
Google Earth
© 2018 Google
N
600 ft

APPENDIX B

Test Boring Logs

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Latham, NY 12110
Telephone: (518) 786-7400
Fax: (518) 786-7299

BORING NUMBER FES AB2-1

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 9/19/19 **COMPLETED** 9/19/19
GROUND ELEVATION _____ **HOLE SIZE** 3.75 inches
DRILLING CONTRACTOR Aztech Environmental
GROUND WATER LEVELS:
DRILLING METHOD Flush-Joint Casing 3.75"
AT TIME OF DRILLING ---
LOGGED BY J. Scheetz **CHECKED BY** A. Diop
AT END OF DRILLING --- Not Encountered
NOTES Geoprobe 7822DT, Auto hammer
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		2" TOPSOIL										
		(SM) SILTY SAND: Brown, dry, medium dense, fine to medium SAND, Some Clayey Silt, trace fine gravel	SS 1	71	3-7-10-12 (17)							
		-Grades dense from 2.0', rock fragment in shoes of SS-2	SS 2	63	7-8-25-33 (33)							
5		-Grades medium dense from 4.0', rock fragment in shoe of SS-3	SS 3	63	15-10-8-14 (18)							
		-Grades very dense, fine to coarse SAND, no silt from 6.0'	SS 4	58	22-30-23-10 (53)							
		-Rock fragment in shoe of SS-5	SS 5	58	35-30-26-40 (56)							
10		-Grades occasional shale fragments from 10.0'	SS 6	4	28-28-20-18 (48)							
15		-Grades fine to medium SAND, Some Clayey Silt, little fine fravel, frequent shale fragments from 15.0'	SS 7	100	34-30-38-42 (68)							
		-Becomes damp @16.5'										
		-Casing refusal @17.0'	SS 8	0	50/4"							
		Borehole backfilled with soil cuttings and sand at completion of drilling.										
		Bottom of borehole at 17.3 feet.										

C.T. Male Associates
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BORING NUMBER FES AB2-2(A)

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 7/26/19 **COMPLETED** 7/26/19
GROUND ELEVATION _____ **HOLE SIZE** 3.75 inches
DRILLING CONTRACTOR Aztech Environmental
GROUND WATER LEVELS:
DRILLING METHOD Flush-Joint Casing 3.75"
AT TIME OF DRILLING ---
LOGGED BY J. Scheetz **CHECKED BY** A. Diop
AT END OF DRILLING --- Not Encountered
NOTES Geoprobe 3200, Auto hammer
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		3" TOPSOIL										
		FILL: Brown, damp, medium dense, fine SAND and SILT, little fine gravel	SS 1	79	2-5-6-6 (11)							
		-Grades fine to coarse SAND, little fine gravel, trace silt from 2.0'	SS 2	17	7-5-8-20 (13)							
5		-Grades little silt from 4.0'	SS 3	46	17-7-3-5 (10)							

Tooling broke, hole abandoned
Borehole backfilled with soil cuttings and sand at completion of drilling.

Bottom of borehole at 6.0 feet.

C.T. Male Associates
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BORING NUMBER FES AB2-2(B)

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 9/19/19 **COMPLETED** 9/19/19
GROUND ELEVATION _____ **HOLE SIZE** 3.75 inches
DRILLING CONTRACTOR Aztech Environmental
GROUND WATER LEVELS:
DRILLING METHOD Flush-Joint Casing 3.75"
AT TIME OF DRILLING ---
LOGGED BY J. Scheetz **CHECKED BY** A. Diop
AT END OF DRILLING --- Not Encountered
NOTES Geoprobe 7822DT, Auto hammer
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		4" TOPSOIL										
		FILL: Brown, dry, medium dense, fine to medium SAND, Some Clayey Silt, little fine gravel, little debris (concrete)	SS 1	75	2-6-7-5 (13)							
		-Grades loose from 2.0', rock fragment in shoe of SS-2	SS 2	42	3-2-7-22 (9)							
		-Becomes damp at 3.5'										
5		Casing refusal at 4.0', offset 1 foot and continued drilling -Becomes Some Debris (wood) from 4.0-5.5'	SS 3	71	2-3-2-2 (5)							
		-Becomes moist at 5.5'										
		-Cobble fragments in shoe of SS-4	SS 4	38	4-4-5-9 (9)							
			SS 5	67	2-2-7-9 (9)							
10		(SM) SILTY SAND: Brown, dry, medium dense, fine to medium SAND, little silt	SS 6	83	10-10-11-18 (21)							
15		-Grades fine to coarse SAND, trace fine gravel from 15.0'	SS 7	71	10-7-8-10 (15)							
		-Becomes wet at 16.5'										
			SS 8	0	50/2"							
		Borehole backfilled with soil cuttings and sand at completion of drilling. Bottom of borehole at 17.6 feet.										

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BORING NUMBER LES AB-20

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 9/19/19 **COMPLETED** 9/19/19
GROUND ELEVATION _____ **HOLE SIZE** 3.75 inches
DRILLING CONTRACTOR Aztech Environmental
GROUND WATER LEVELS:
DRILLING METHOD Flush-Joint Casing 3.75"
AT TIME OF DRILLING ---
LOGGED BY J. Scheetz **CHECKED BY** A. Diop
AT END OF DRILLING --- Not Encountered
NOTES Geoprobe 7822DT, Auto hammer
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		6" Topsoil										
		(SM) SILTY SAND: Brown, dry, medium dense, SILT, Some fine to medium Sand, trace fine gravel	SS 1	58	2-8-8-8 (16)							
		-Rock fragments in shoe of SS-2	SS 2	71	8-10-10-9 (20)							
5		-Grades fine to medium SAND, Some Silt, no gravel from 4.0'	SS 3	75	5-7-8-8 (15)							
		-Grades SILT, Some fine Sand from 6.0'	SS 4	58	3-6-5-4 (11)							
		-Grades damp, fine to coarse SAND, Some Silt from 8.0'	SS 5	100	5-5-7-12 (12)							
10												

Bottom of borehole at 10.0 feet.

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BORING NUMBER MHS AB20-2

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 7/26/19 **COMPLETED** 7/26/19
GROUND ELEVATION _____ **HOLE SIZE** 3.75 inches
DRILLING CONTRACTOR Aztech Environmental
GROUND WATER LEVELS:
DRILLING METHOD Flush-Joint Casing 3.75"
AT TIME OF DRILLING ---
LOGGED BY J. Scheetz **CHECKED BY** A. Diop
AT END OF DRILLING --- Not Encountered
NOTES Geoprobe 3200, Auto hammer
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		7" TOPSOIL										
		(SP) SAND: Brown, dry, medium dense, fine to medium SAND, trace fine gravel, trace silt	SS 1	75	3-5-5-5 (10)							
			SS 2	33	14-13-11-3 (24)							
5		-Grades loose from 4.0'	SS 3	92	4-3-2-2 (5)							
		-Becomes damp from 5.5'										
		ORGANIC CLAYEY SILT: Black, moist, medium stiff, Organic Clayey SILT	SS 4	75	5-2-2-3 (4)							
		-Grades some fine sand from 7.5'	SS 5	42	NR-NR-NR-NR (NR)							
10		(SP) SAND: Wet, gray, medium dense, fine to coarse SAND, trace fine gravel, trace silt	SS 6	33	3-5-7-12 (12)							
15		-Grades some fine gravel, little silt from 15.0'	SS 7	33	5-12-14-12 (26)							
			SS 8	75	11-10-14-13 (24)							

Borehole backfilled with soil cuttings and sand at completion of drilling.

Bottom of borehole at 19.0 feet.

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BORING NUMBER MHS AB-1

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 7/25/19 **COMPLETED** 7/25/19
GROUND ELEVATION _____ **HOLE SIZE** 3.75 inches
DRILLING CONTRACTOR Aztech Environmental
GROUND WATER LEVELS:
DRILLING METHOD Flush-Joint Casing 3.75"
AT TIME OF DRILLING ---
LOGGED BY J. Scheetz **CHECKED BY** A. Diop
AT END OF DRILLING --- Not Encountered
NOTES Geoprobe 3200, Auto hammer
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		6" TOPSOIL										
		(SM) SILTY SAND: Brown, dry, medium dense, fine to coarse SAND and SILT, trace fine gravel	SS 1	83	5-16-14-11 (30)							
			SS 2	54	9-11-11-10 (22)							
5		-Grades damp, loose from 4.0'	SS 3	17	4-3-2-1 (5)			11				44
		-Grades medium dense from 6.0'	SS 4	75	2-2-10-11 (12)							
10			SS 5	96	13-11-12-13 (23)			12				48
			SS 6	92	7-16-11-16 (27)							
15		-Grades dense from 15.0'	SS 7	63	20-13-29-33 (42)			9				39
		-Grades medium dense from 18.0'	SS 8	71	12-12-11-14 (23)							
20												

Borehole backfilled with soil cuttings and sand at completion of drilling.

Bottom of borehole at 20.0 feet.

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BORING NUMBER MHS AB-2

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 7/26/19 **COMPLETED** 7/26/19
GROUND ELEVATION _____ **HOLE SIZE** 3.75 inches
DRILLING CONTRACTOR Aztech Environmental
GROUND WATER LEVELS:
DRILLING METHOD Flush-Joint Casing 3.75"
AT TIME OF DRILLING ---
LOGGED BY J. Scheetz **CHECKED BY** A. Diop
AT END OF DRILLING --- Not Encountered
NOTES Geoprobe 3200, Auto hammer
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		4" TOPSOIL										
		(SM) SILTY SAND: Brown, dry, medium dense, fine to medium SAND, Some Silt, trace fine gravel	SS 1	67	2-5-6-5 (11)							
		-Rock fragment in shoe of SS-2	SS 2	71	5-6-14-9 (20)							
5		-Grades dense, little fine gravel from 4.0'	SS 3	92	7-15-17-19 (32)			13				27
			SS 4	88	19-27-21-22 (48)							
		-Grades damp from 8.0'	SS 5	88	19-21-20-17 (41)							29
10		-Grades medium dense from 10.0'	SS 6	83	15-14-10-9 (24)			8				
		-Becomes moist at 11.5'										
15		-Grades very dense form 15.0'	SS 7	83	18-41-49-45 (90)							
			SS 8	63	42-45-31-28 (76)							
20		Borehole backfilled with soil cuttings and sand at completion of drilling.										

Bottom of borehole at 20.0 feet.

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BORING NUMBER MHS AB-3

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 7/26/19 **COMPLETED** 7/26/19
GROUND ELEVATION _____ **HOLE SIZE** 3.75 inches
DRILLING CONTRACTOR Aztech Environmental
GROUND WATER LEVELS:
DRILLING METHOD Flush-Joint Casing 3.75"
AT TIME OF DRILLING ---
LOGGED BY J. Scheetz **CHECKED BY** A. Diop
AT END OF DRILLING --- Not Encountered
NOTES Geoprobe 3200, Auto hammer
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		3" TOPSOIL										
		(SM) SILTY SAND: Brown, damp, medium dense, fine to coarse SAND, Some Silt, little fine gravel	SS 1	88	5-10-10-12 (20)							
			SS 2	79	9-10-13-30 (23)							
5			SS 3	54	17-10-7-5 (17)			8				36
		-Grades very loose from 6.0'	SS 4	8	WOH-WOH-WOH-WOH (0)							
		-Grades medium dense, trace fine gravel from 8.0'	SS 5	92	4-4-6-14 (10)			13				27
10			SS 6	92	12-9-9-8 (18)							
15			SS 7	92	12-14-13-16 (27)							
20		-Broken rock fragment in shoe of SS-8 (likely cobble)	SS 8	100	25-50/3"							

Borehole backfilled with soil cuttings and sand at completion of drilling.

Bottom of borehole at 20.8 feet

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BORING NUMBER MHS AB-4

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 7/26/19 **COMPLETED** 7/26/19
GROUND ELEVATION _____ **HOLE SIZE** 3.75 inches
DRILLING CONTRACTOR Aztech Environmental
GROUND WATER LEVELS:
DRILLING METHOD Flush-Joint Casing 3.75"
AT TIME OF DRILLING ---
LOGGED BY J. Scheetz **CHECKED BY** A. Diop
AT END OF DRILLING --- Not Encountered
NOTES Geoprobe 3200, Auto hammer
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		6" TOPSOIL										
		(SM) SILTY SAND: Brown, damp, medium dense, fine to coarse SAND and SILT, trace fine gravel	SS 1	83	5-7-9-6 (16)							
			SS 2	8	6-6-7-5 (13)							
5		-Grades dense from 4.0'	SS 3	54	28-23-12-8 (35)							
		-Grades little fine to coarse gravel from 6.0'	SS 4	58	9-16-21-20 (36)							
			SS 5	92	14-22-16-14 (38)							
10		-Grades medium dense from 10.0'	SS 6	79	10-12-12-9 (24)			10				36
15												
		-Grades trace fine gravel from 17.0'	SS 7	75	10-14-16-12 (30)							
20			SS 8	71	11-10-13-14 (23)			11				40

Borehole backfilled with soil cuttings and sand at completion of drilling.

Bottom of borehole at 20.0 feet.

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Fax: (518) 786-7299

BORING NUMBER MHS B-1

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 7/25/19 **COMPLETED** 7/25/19
GROUND ELEVATION _____ **HOLE SIZE** 3.75 inches
DRILLING CONTRACTOR Aztech Environmental
GROUND WATER LEVELS:
DRILLING METHOD Flush-Joint Casing 3.75"
AT TIME OF DRILLING ---
LOGGED BY J. Scheetz **CHECKED BY** A. Diop
AT END OF DRILLING --- Not Encountered
NOTES Geoprobe 3200, Auto hammer
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		5" TOPSOIL										
		(SM) SILTY SAND: Brown, damp, medium dense, fine to coarse SAND, Some Silt, little fine gravel	SS 1	79	3-5-6-7 (11)							
			SS 2	67	8-6-5-5 (11)							
5			SS 3	42	9-12-9-8 (21)			8				31
		-Grades dense, fine to medium SAND, no gravel from 6.0'	SS 4	96	19-18-20-42 (38)							
10		-Grades very dense, SILT and fine to medium SAND, trace fine gravel from 8.0'	SS 5	79	46-48-48-36 (96)			9				50

Borehole backfilled with soil cuttings and sand at completion of drilling.

Bottom of borehole at 10.0 feet.

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BORING NUMBER MHS B-2

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 7/25/19 **COMPLETED** 7/25/19
GROUND ELEVATION _____ **HOLE SIZE** 3.75 inches
DRILLING CONTRACTOR Aztech Environmental
GROUND WATER LEVELS:
DRILLING METHOD Flush-Joint Casing 3.75"
AT TIME OF DRILLING ---
LOGGED BY J. Scheetz **CHECKED BY** A. Diop
AT END OF DRILLING --- Not Encountered
NOTES Geoprobe 3200, Auto hammer
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		6" TOPSOIL										
		(SM) SILTY SAND: Brown, damp, medium dense, fine to coarse SAND and SILT, little fine gravel	SS 1	83	2-4-6-8 (10)							
			SS 2	71	7-10-11-7 (21)			11				47
5			SS 3	75	7-6-6-9 (12)							
		-Grades trace fine gravel from 6.0'	SS 4	42	5-7-8-14 (15)			12				46
		-Grades very dense from 8.0'	SS 5	96	21-34-17-19 (51)							
10												

Borehole backfilled with soil cuttings and sand at completion of drilling.

Bottom of borehole at 10.0 feet.

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BORING NUMBER MHS PB-1

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 7/25/19 **COMPLETED** 7/25/19
GROUND ELEVATION _____ **HOLE SIZE** 3.75 inches
DRILLING CONTRACTOR Aztech Environmental
GROUND WATER LEVELS:
DRILLING METHOD Open Hole
AT TIME OF DRILLING ---
LOGGED BY J. Scheetz **CHECKED BY** A. Diop
AT END OF DRILLING --- Not Encountered
NOTES Geoprobe 3200, Auto hammer
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		5" ASPHALT										
		(SM) SILTY SAND: Light brown, dry, medium dense, fine to medium SAND, little silt	SS 1	63	25-8-5-8 (13)							
		-Grades dense from 2.0'	SS 2	79	15-21-16-20 (37)							

Borehole backfilled with soil cuttings and sand at completion of drilling, topped with cold patch.
Bottom of borehole at 4.0 feet.

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BORING NUMBER MHS PB-2

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 7/25/19 **COMPLETED** 7/25/19
GROUND ELEVATION _____ **HOLE SIZE** 3.75 inches
DRILLING CONTRACTOR Aztech Environmental
GROUND WATER LEVELS:
DRILLING METHOD Open Hole
AT TIME OF DRILLING ---
LOGGED BY J. Scheetz **CHECKED BY** A. Diop
AT END OF DRILLING --- Not Encountered
NOTES Geoprobe 3200, Auto hammer
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		6" ASPHALT										
		(SP) SAND: Light brown, dry, medium dense, fine to medium SAND, trace fine gravel, trace silt	SS 1	58	29-9-4-4 (13)							
		-Grades loose from 2.0'	SS 2	67	3-3-5-5 (8)							

Borehole backfilled with soil cuttings and sand at completion of drilling, topped with cold patch.
Bottom of borehole at 4.0 feet.

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BORING NUMBER MHS PB-3

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 7/25/19 **COMPLETED** 7/25/19
GROUND ELEVATION _____ **HOLE SIZE** 3.75 inches
DRILLING CONTRACTOR Aztech Environmental
GROUND WATER LEVELS:
DRILLING METHOD Open Hole
AT TIME OF DRILLING ---
LOGGED BY J. Scheetz **CHECKED BY** A. Diop
AT END OF DRILLING --- Not Encountered
NOTES Geoprobe 3200, Auto hammer
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		8" ASPHALT										
		(SP) SAND: Light brown, dry, dense, fine to coarse SAND, little fine gravel, trace silt	SS 1	75	42-24-12-10 (36)							
		-Grades medium dense from 2.0'	SS 2	0	11-9-2-5 (16)							

Borehole backfilled with soil cuttings and sand at completion of drilling, topped with cold patch.
Bottom of borehole at 4.0 feet.

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BORING NUMBER MHS PB-4

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 7/25/19 **COMPLETED** 7/25/19
GROUND ELEVATION _____ **HOLE SIZE** 3.75 inches
DRILLING CONTRACTOR Aztech Environmental
GROUND WATER LEVELS:
DRILLING METHOD Open Hole
AT TIME OF DRILLING ---
LOGGED BY J. Scheetz **CHECKED BY** A. Diop
AT END OF DRILLING --- Not Encountered
NOTES Geoprobe 3200, Auto hammer
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		4" ASPHALT										
		(SP) SAND: Light brown, dry, medium dense, fine to medium SAND, little fine gravel, trace silt	SS 1	67	19-8-7-10 (15)							
		-Grades dense from 2.0'	SS 2	25	12-14-19-21 (33)							

Borehole backfilled with soil cuttings and sand at completion of drilling, topped with blacktop.
Bottom of borehole at 4.0 feet.

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BORING NUMBER MMS AB20

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 7/25/19 **COMPLETED** 7/25/19
GROUND ELEVATION _____ **HOLE SIZE** 3.75 inches
DRILLING CONTRACTOR Aztech Environmental
GROUND WATER LEVELS:
DRILLING METHOD Flush-Joint Casing 3.75"
AT TIME OF DRILLING ---
LOGGED BY J. Scheetz **CHECKED BY** A. Diop
AT END OF DRILLING 18.40 ft Casing: 18.0'; Stablization Time: 5 min
NOTES Geoprobe 3200, Auto hammer
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		8" TOPSOIL										
		(ML) SANDY SILT: Dark brown, damp, very loose, SILT and fine to medium SAND, trace fine gravel	SS 1	88	3-2-1-1 (3)							
		-Grades loose from 2.0'	SS 2	33	4-2-4-3 (6)							
5		ORGANIC SILTY SAND: Brown, moist, loose, Organic fine to medium SAND, Some Silt, Some fine Gravel (frequent wood debris) -Grades medium dense from 4.0'	SS 3	38	7-10-10-18 (20)			25				23
		(SP) SAND: Brown, wet, dense, fine to coarse SAND, Some Silt, trace fine gravel	SS 4	50	15-22-15-13 (37)							
		-Grades medium dense from 8.0'	SS 5	63	11-10-13-14 (23)							
10		-Grades dense from 10.0'	SS 6	33	8-18-18-19 (36)			14				23
15		-Grades Some fine Gravel from 15.0'	SS 7	91	33-50/5"							
		▼	SS 8	71	35-26-21-44 (47)			9				25
20												

Borehole backfilled with soil cuttings and sand at completion of drilling.

Bottom of borehole at 20.0 feet.

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BORING NUMBER MMS B10-1

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 7/25/19 **COMPLETED** 7/25/19
GROUND ELEVATION _____ **HOLE SIZE** 3.75 inches
DRILLING CONTRACTOR Aztech Environmental
GROUND WATER LEVELS:
DRILLING METHOD Flush-Joint Casing 3.75"
AT TIME OF DRILLING ---
LOGGED BY J. Scheetz **CHECKED BY** A. Diop
AT END OF DRILLING --- Not Encountered
NOTES Geoprobe 3200, Auto hammer
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		3" TOPSOIL										
		(SM) SILTY SAND: Light brown, damp, loose, fine to medium SAND, Some Silt, little fine gravel	SS 1	67	2-3-2-6 (5)							
		-Grades dense, fine to coarse SAND, little silt from 2.0'	SS 2	75	13-18-15-13 (33)							
5		-Grades medium dense, trace fine gravel from 4.0'	SS 3	67	12-13-12-10 (25)			7				26
		-Becomes damp at 6.5'	SS 4	58	8-7-7-5 (14)							
10			SS 5	75	12-19-17-17 (36)							

Borehole backfilled with soil cuttings and sand at completion of drilling.

Bottom of borehole at 10.0 feet.

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BORING NUMBER MMS B10-2

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 7/25/19 **COMPLETED** 7/25/19
GROUND ELEVATION _____ **HOLE SIZE** 3.75 inches
DRILLING CONTRACTOR Aztech Environmental
GROUND WATER LEVELS:
DRILLING METHOD Flush-Joint Casing 3.75"
AT TIME OF DRILLING ---
LOGGED BY J. Scheetz **CHECKED BY** A. Diop
AT END OF DRILLING 7.50 ft Casing: 8.0; Stablization Time: 15 mins
NOTES Geoprobe 3200, Auto hammer
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		(SM) SILTY SAND: Gray, damp, medium dense, fine to medium SAND, little silt	SS 1	25	9-7-12-8 (19)							
		-Grades Some Clayey Silt, little fine gravel from 2.0'	SS 2	63	4-5-7-10 (12)							
5		-Grades moist, dense, some fine gravel from 4.0'	SS 3	71	17-17-14-12 (31)							
		-Grades wet, medium dense from 6.0'	SS 4	63	10-10-11-6 (21)							
		-Grades dense, fine to medium SAND and Clayey SILT, trace fine gravel from 8.0'	SS 5	42	22-21-16-16 (37)			15				45
10												

Borehole backfilled with soil cuttings and sand at completion of drilling, topped with cold patch.

Bottom of borehole at 10.0 feet.

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BORING NUMBER MMS B10-3

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 7/25/19 **COMPLETED** 7/25/19
GROUND ELEVATION _____ **HOLE SIZE** 3.75 inches
DRILLING CONTRACTOR Aztech Environmental
GROUND WATER LEVELS:
DRILLING METHOD Flush-Joint Casing 3.75"
AT TIME OF DRILLING ---
LOGGED BY J. Scheetz **CHECKED BY** A. Diop
AT END OF DRILLING --- Not Encountered
NOTES Geoprobe 3200, Auto hammer
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		5" TOPSOIL										
		(SM) SILTY SAND: Brown, damp, medium dense, SILT and fine to medium SAND, trace fine gravel	SS 1	83	2-6-9-13 (15)							
		-Grades loose from 2.0'	SS 2	50	5-6-3-7 (9)			13				50
5		-Grades little silt, little fine gravel from 4.0'	SS 3	25	3-4-3-5 (7)							
		-Grades medium dense, Some Silt, little fine gravel from 6.0'	SS 4	42	4-6-12-16 (18)			10				36
10		-Becomes moist at 9.0'	SS 5	79	21-22-17-17 (39)							

Borehole backfilled with soil cuttings and sand at completion of drilling.

Bottom of borehole at 10.0 feet.

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BORING NUMBER MMS PB-1

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 7/20/19 **COMPLETED** 7/20/19
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR C.T. Male Associates
GROUND WATER LEVELS:
DRILLING METHOD Open Hole
AT TIME OF DRILLING ---
LOGGED BY R. Smaka **CHECKED BY** A. Diop
AT END OF DRILLING --- Not Encountered
NOTES Portable coring equipment
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		2.5" ASPHALT										
		(SW) GRAVELLY SAND: Brown, dry, fine to coarse SAND and fine to coarse GRAVEL	GB 1									
		-Hand tool refusal at 1.25'										
		Borehole backfilled with soil cuttings and sand at completion of drilling, topped with cold patch.										
		Bottom of borehole at 1.3 feet.										

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BORING NUMBER MMS PB-2

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 7/20/19 **COMPLETED** 7/20/19
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR C.T. Male Associates
GROUND WATER LEVELS:
DRILLING METHOD Open Hole
AT TIME OF DRILLING ---
LOGGED BY R. Smaka **CHECKED BY** A. Diop
AT END OF DRILLING --- Not Encountered
NOTES Portable coring equipment
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		3.5" ASPHALT										
		(SW) GRAVELLY SAND: Brown, dry, fine to coarse SAND and fine to coarse GRAVEL	GB 1									
		(SM) SILTY SAND: Brown, dry, fine to coarse SAND, little silt										
		-Hand tool refusal at 1.83'										
		Borehole backfilled with soil cuttings and sand at completion of drilling, topped with cold patch.										
		Bottom of borehole at 1.8 feet.										

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BORING NUMBER MMS PB-3

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 7/20/19 **COMPLETED** 7/20/19
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR C.T. Male Associates
GROUND WATER LEVELS:
DRILLING METHOD Open Hole
AT TIME OF DRILLING ---
LOGGED BY R. Smaka **CHECKED BY** A. Diop
AT END OF DRILLING --- Not Encountered
NOTES Portable coring equipment
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		2.5" ASPHALT										
		(SW) GRAVELLY SAND: Brown, dry, fine to coarse SAND and fine to coarse GRAVEL	GB 1									
		-Hand tool refusal at 1.33'										
		Borehole backfilled with soil cuttings and sand at completion of drilling, topped with cold patch.										
		Bottom of borehole at 1.3 feet.										

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BORING NUMBER MMS PB-4

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 7/20/19 **COMPLETED** 7/20/19
GROUND ELEVATION _____ **HOLE SIZE** 4 inches
DRILLING CONTRACTOR C.T. Male Associates
GROUND WATER LEVELS:
DRILLING METHOD Open Hole
AT TIME OF DRILLING ---
LOGGED BY R. Smaka **CHECKED BY** A. Diop
AT END OF DRILLING --- Not Encountered
NOTES Portable coring equipment
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		3.5" ASPHALT										
		(SW) GRAVELLY SAND: Brown, dry, fine to coarse SAND, little fine gravel	GB 1									
		-Hand tool refusal at 1.67'										
		Borehole backfilled with soil cuttings and sand at completion of drilling, topped with cold patch.										
		Bottom of borehole at 1.7 feet.										

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BORING NUMBER MMS PB-5

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 7/25/19 **COMPLETED** 7/25/19
GROUND ELEVATION _____ **HOLE SIZE** 3.75 inches
DRILLING CONTRACTOR Aztech Environmental
GROUND WATER LEVELS:
DRILLING METHOD Open Hole
AT TIME OF DRILLING ---
LOGGED BY J. Scheetz **CHECKED BY** A. Diop
AT END OF DRILLING --- Not Encountered
NOTES Geoprobe 3200, Auto hammer
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		4" ASPHALT										
		(SM) SILTY SAND: Brown, damp, medium dense, fine to medium SAND, Some Silt, little fine gravel	SS 1	58	21-10-8-9 (18)							
		-Organic material in shoe of SS-2	SS 2	63	9-7-5-2 (12)							

Borehole backfilled with soil cuttings and sand at completion of drilling, topped with cold patch.
Bottom of borehole at 4.0 feet.

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BORING NUMBER MMS PB-6

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 7/25/19 **COMPLETED** 7/25/19
GROUND ELEVATION _____ **HOLE SIZE** 3.75 inches
DRILLING CONTRACTOR Aztech Environmental
GROUND WATER LEVELS:
DRILLING METHOD Open Hole
AT TIME OF DRILLING ---
LOGGED BY J. Scheetz **CHECKED BY** A. Diop
AT END OF DRILLING --- Not Encountered
NOTES Geoprobe 3200, Auto hammer
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		5" ASPHALT										
		(SM) SILTY SAND: Dark brown, dry, medium dense, fine to medium SAND, Some Silt, little fine to coarse gravel	SS 1	71	22-12-4-4 (16)							
		-Grades fine to coarse SAND, Some fine Gravel from 3.0'	SS 2	67	6-11-9-8 (20)							

Borehole backfilled with soil cuttings and sand at completion of drilling, topped with cold patch.

Bottom of borehole at 4.0 feet.

C.T. Male Associates
50 Century Hill Drive
Latham, NY 12110
Telephone: (518) 786-7400
Fax: (518) 786-7299

BORING NUMBER MMS PB-7

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 7/25/19 **COMPLETED** 7/25/19
GROUND ELEVATION _____ **HOLE SIZE** 3.75 inches
DRILLING CONTRACTOR Aztech Environmental
GROUND WATER LEVELS:
DRILLING METHOD Open Hole
AT TIME OF DRILLING ---
LOGGED BY J. Scheetz **CHECKED BY** A. Diop
AT END OF DRILLING --- Not Encountered
NOTES Geoprobe 3200, Auto hammer
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		4" ASPHALT (SM) SILTY SAND: Brown, damp, medium dense, fine to coarse SAND, Some Silt, Some fine Gravel	SS 1	63	24-7-5-4 (12)							
		-Grades dense from 2.0'	SS 2	100	26-21-13-15 (34)							

Borehole backfilled with soil cuttings and sand at completion of drilling, topped with cold patch.
Bottom of borehole at 4.0 feet.

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BORING NUMBER MMS PB-8

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 7/25/19 **COMPLETED** 7/25/19
GROUND ELEVATION _____ **HOLE SIZE** 3.75 inches
DRILLING CONTRACTOR Aztech Environmental
GROUND WATER LEVELS:
DRILLING METHOD Open Hole
AT TIME OF DRILLING ---
LOGGED BY J. Scheetz **CHECKED BY** A. Diop
AT END OF DRILLING --- Not Measured
NOTES Geoprobe 3200, Auto hammer
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		3.5" ASPHALT										
		(SM) SILTY SAND: Dark brown, damp, medium dense, fine to medium SAND, Some Silt, little fine gravel	SS 1	63	22-10-10-10 (20)							
		-Grades fine to coarse SAND, little silt from 3.5'	SS 2	71	7-5-5-10 (10)							

Borehole backfilled with soil cuttings and sand at completion of drilling, topped with cold patch.

Bottom of borehole at 4.0 feet.

C.T. Male Associates
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BORING NUMBER MMS PB-9

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 7/25/19 **COMPLETED** 7/25/19
GROUND ELEVATION _____ **HOLE SIZE** 3.75 inches
DRILLING CONTRACTOR Aztech Environmental
GROUND WATER LEVELS:
DRILLING METHOD Open Hole
AT TIME OF DRILLING ---
LOGGED BY J. Scheetz **CHECKED BY** A. Diop
AT END OF DRILLING --- Not Encountered
NOTES Geoprobe 3200, Auto hammer
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		2.5" ASPHALT										
		(SW) GRAVELLY SAND: Brown, dry, very dense, fine to coarse SAND and fine GRAVEL, trace silt -Possibly pushed cobble from 0.5' to 4.0'	SS 1	46	28-67-28-13 (95)							
		-Grades medium dense from 2.0'	SS 2	8	9-10-12-14 (22)							

Borehole backfilled with soil cuttings and sand at completion of drilling, topped with cold patch.
Bottom of borehole at 4.0 feet.

C.T. Male Associates
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BORING NUMBER MMS PB-10

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 7/25/19 **COMPLETED** 7/25/19
GROUND ELEVATION _____ **HOLE SIZE** 3.75 inches
DRILLING CONTRACTOR Aztech Environmental
GROUND WATER LEVELS:
DRILLING METHOD Open Hole
AT TIME OF DRILLING ---
LOGGED BY J. Scheetz **CHECKED BY** A. Diop
AT END OF DRILLING --- Not Measured
NOTES Geoprobe 3200, Auto hammer
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		6" ASPHALT										
		(SP) Brown, dry, fine to coarse SAND, little silt, little fine gravel	SS 1	79	35-16-10-6 (26)							
		-Grades loose from 2.0'	SS 2	46	4-2-3-3 (5)							

Borehole backfilled with soil cuttings and sand at completion of drilling, topped with cold patch.
Bottom of borehole at 4.0 feet.

C.T. Male Associates
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BORING NUMBER MMS PB-11

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 7/25/19 **COMPLETED** 7/25/19
GROUND ELEVATION _____ **HOLE SIZE** 3.75 inches
DRILLING CONTRACTOR Aztech Environmental
GROUND WATER LEVELS:
DRILLING METHOD Open Hole
AT TIME OF DRILLING ---
LOGGED BY J. Scheetz **CHECKED BY** A. Diop
AT END OF DRILLING --- Not Encountered
NOTES Geoprobe 3200, Auto hammer
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		9" ASPHALT										
		(SP) SAND: Light brown, dry, dense, fine SAND, little fine gravel	SS 1	83	38-30-14-12 (44)							
		-Grades medium dense, fine to medium SAND, Some fine Gravel from 2.0'	SS 2	71	8-7-5-5 (12)							

Borehole backfilled with soil cuttings and sand at completion of drilling, topped with cold patch.
Bottom of borehole at 4.0 feet.

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BORING NUMBER MMS PB-12

CLIENT TetraTech
PROJECT NAME Mahopac Schools
PROJECT NUMBER 19.9414
PROJECT LOCATION Mahopac, NY
DATE STARTED 7/25/19 **COMPLETED** 7/25/19
GROUND ELEVATION _____ **HOLE SIZE** 3.75 inches
DRILLING CONTRACTOR Aztech Environmental
GROUND WATER LEVELS:
DRILLING METHOD Open Hole
AT TIME OF DRILLING ---
LOGGED BY J. Scheetz **CHECKED BY** A. Diop
AT END OF DRILLING --- Not Encountered
NOTES Geoprobe 3200, Auto hammer
AFTER DRILLING ---

DEPTH / ELEV. (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		7" ASPHALT										
		(SP) SAND: Light brown, dry, dense, fine to medium SAND, trace silt, trace fine gravel	SS 1	75	38-21-15-18 (36)							
		-Grades medium dense, fine to coarse SAND from 2.0'	SS 2	83	13-9-9-7 (18)							

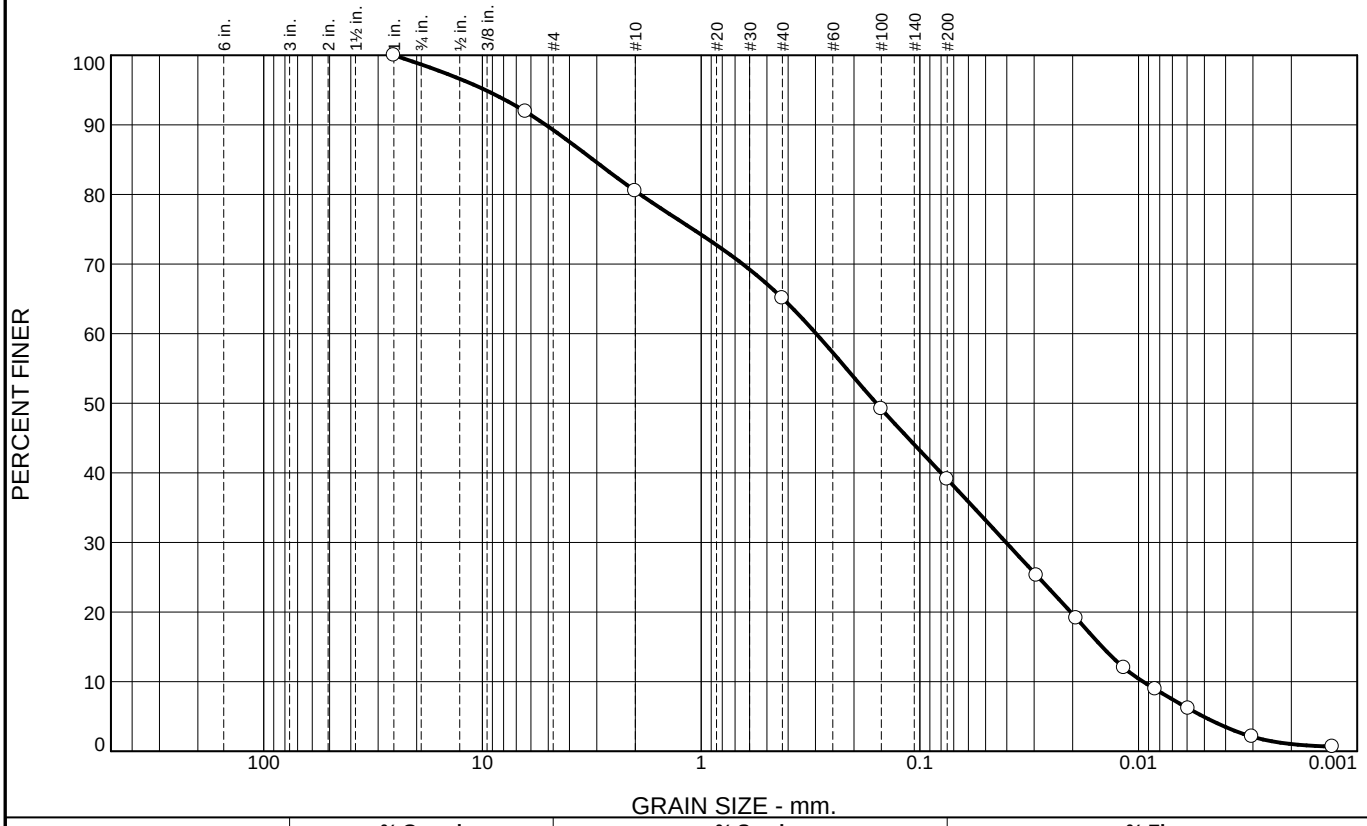
Borehole backfilled with soil cuttings and sand at completion of drilling, topped with cold patch.

Bottom of borehole at 4.0 feet.

APPENDIX C

Geotechnical Laboratory Test Results

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	1.3	9.4	8.8	15.4	26.0	34.2	4.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1	100.0		
.25	91.9		
#10	80.5		
#40	65.1		
#100	49.2		
#200	39.1		
0.0292 mm.	25.3		
0.0193 mm.	19.1		
0.0116 mm.	12.0		
0.0084 mm.	8.9		
0.0059 mm.	6.2		
0.0030 mm.	2.1		
0.0013 mm.	0.7		

* (no specification provided)

Soil Description

Topsoil

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 5.1319 D_{85}= 3.1189 D_{60}= 0.2979
D_{50}= 0.1580 D_{30}= 0.0403 D_{15}= 0.0146
D_{10}= 0.0095 C_u= 31.27 C_c= 0.57

Classification

USCS= AASHTO=

Remarks

pH: 6.6

Organic Content: 5.7 %

Location: TS-1
Sample Number: 19-264

Date: 8/2/19

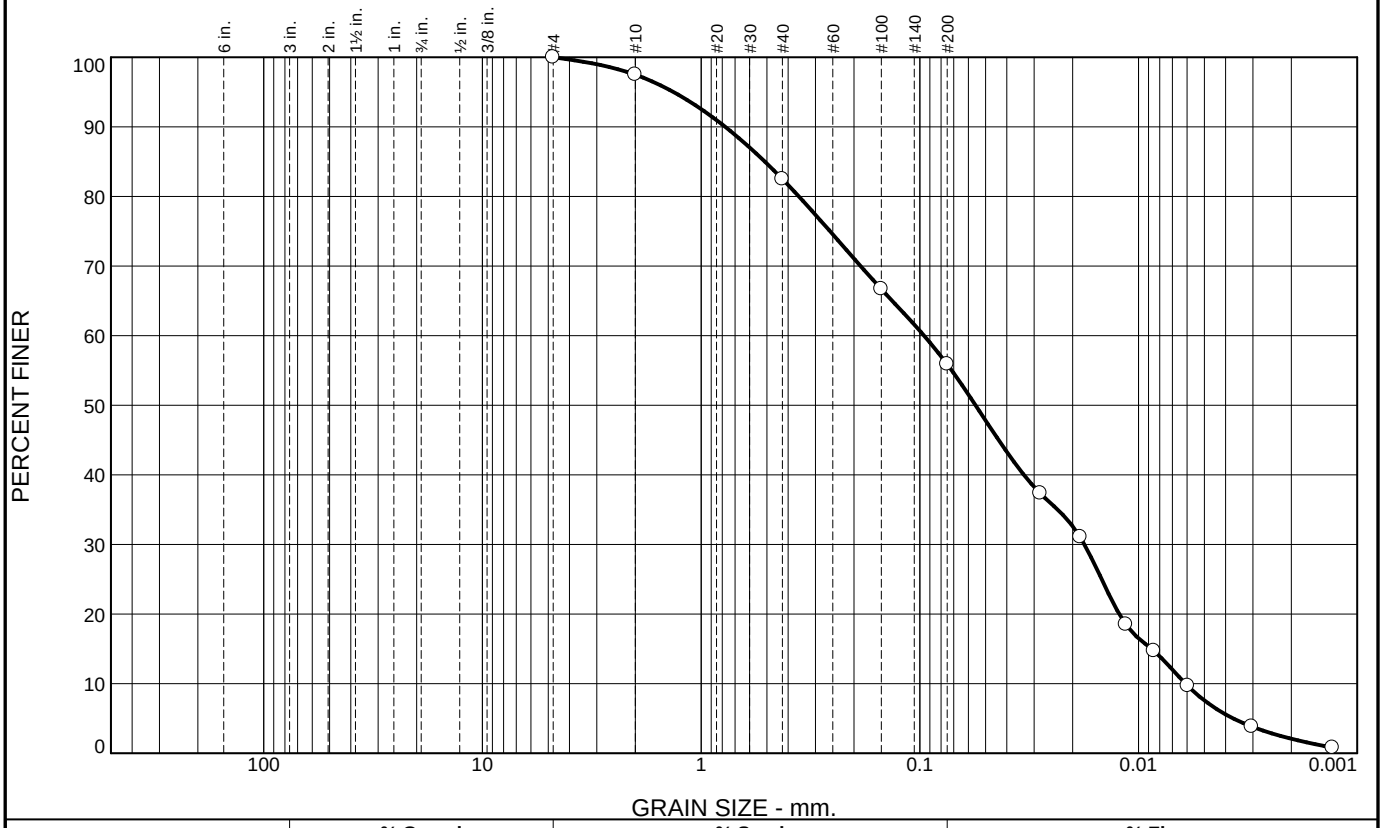
QCQA Laboratories, Inc.

Schuylerville, NY

Client: CT Male Associates
Project: Mahopac School District

Project No: ST19-079 **Figure** 19-264

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	2.5	15.0	26.6	48.3	7.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	97.5		
#40	82.5		
#100	66.7		
#200	55.9		
0.0281 mm.	37.4		
0.0185 mm.	31.1		
0.0114 mm.	18.5		
0.0085 mm.	14.7		
0.0060 mm.	9.7		
0.0030 mm.	3.9		
0.0013 mm.	0.8		

* (no specification provided)

Soil Description

Topsoil

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.7761 D_{85}= 0.5110 D_{60}= 0.0956
D_{50}= 0.0556 D_{30}= 0.0177 D_{15}= 0.0087
D_{10}= 0.0061 C_u= 15.71 C_c= 0.54

Classification

USCS= AASHTO=

Remarks

pH: 6.5

Organic Content: 6.9 %

Location: TS-2
Sample Number: 19-265

Date: 8/2/19

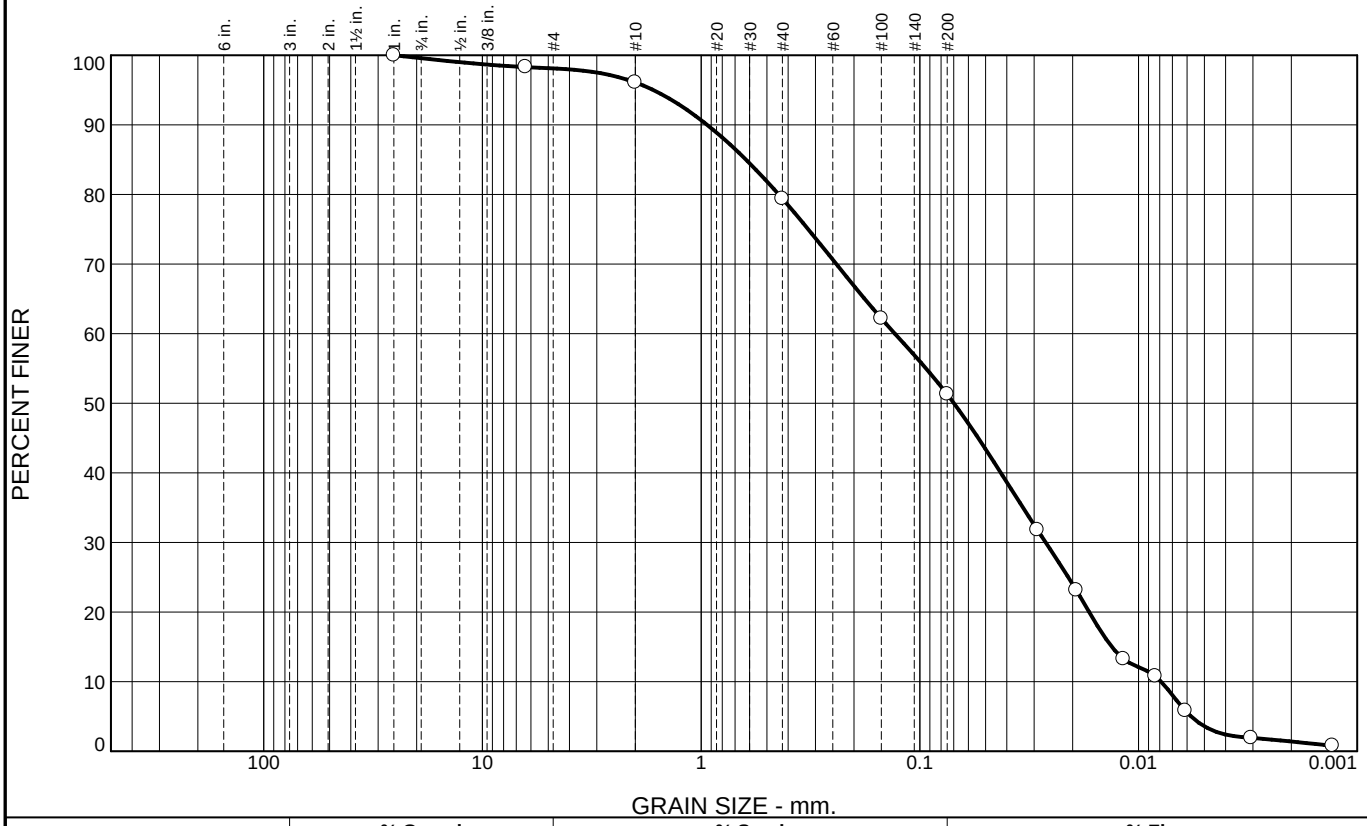
QCQA Laboratories, Inc.

Schuylerville, NY

Client: CT Male Associates
Project: Mahopac School District

Project No: ST19-079 **Figure** 19-265

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.4	1.5	2.0	16.7	28.1	47.7	3.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1	100.0		
.25	98.3		
#10	96.1		
#40	79.4		
#100	62.2		
#200	51.3		
0.0290 mm.	31.8		
0.0193 mm.	23.2		
0.0117 mm.	13.3		
0.0084 mm.	10.8		
0.0061 mm.	5.8		
0.0031 mm.	1.9		
0.0013 mm.	0.8		

* (no specification provided)

Soil Description

Topsoil

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.9383 D_{85}= 0.6236 D_{60}= 0.1300
D_{50}= 0.0698 D_{30}= 0.0266 D_{15}= 0.0132
D_{10}= 0.0079 C_u= 16.50 C_c= 0.69

Classification

USCS= AASHTO=

Remarks

pH: 6.6

Organic Content: 7.7 %

Location: TS-3
Sample Number: 19-266

Date: 8/2/19

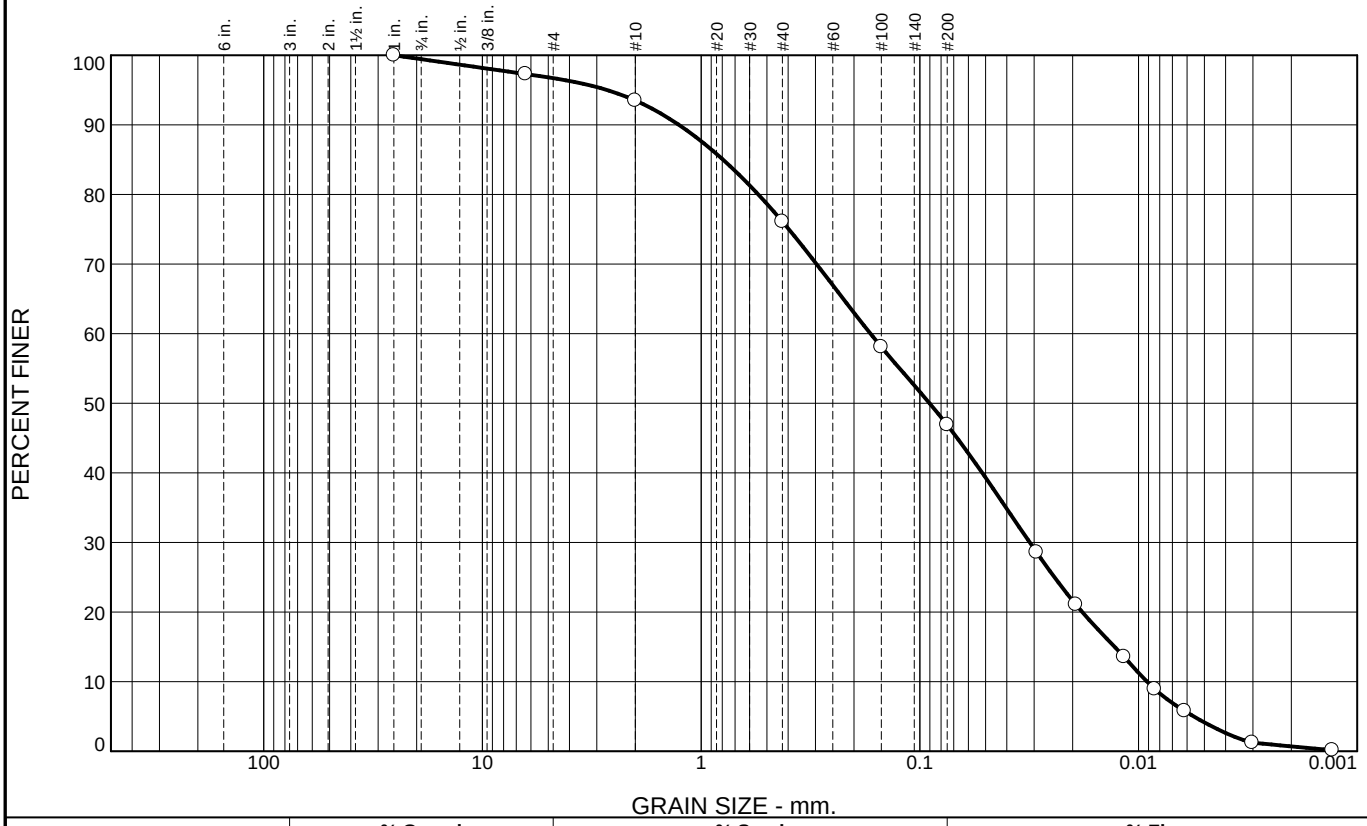
QCQA Laboratories, Inc.

Schuylerville, NY

Client: CT Male Associates
Project: Mahopac School District

Project No: ST19-079 **Figure** 19-266

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.6	2.7	3.2	17.4	29.2	42.7	4.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1	100.0		
.25	97.3		
#10	93.5		
#40	76.1		
#100	58.1		
#200	46.9		
0.0292 mm.	28.6		
0.0193 mm.	21.1		
0.0116 mm.	13.6		
0.0084 mm.	8.9		
0.0062 mm.	5.8		
0.0030 mm.	1.2		
0.0013 mm.	0.2		

* (no specification provided)

Soil Description

Topsoil

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 1.2641 D_{85}= 0.7941 D_{60}= 0.1680
D_{50}= 0.0902 D_{30}= 0.0314 D_{15}= 0.0129
D_{10}= 0.0091 C_u= 18.38 C_c= 0.64

Classification

USCS= AASHTO=

Remarks

pH: 6.7

Organic Content: 6.7 %

Location: TS-4
Sample Number: 19-267

Date: 8/2/19

QCQA Laboratories, Inc.

Schuylerville, NY

Client: CT Male Associates
Project: Mahopac School District

Project No: ST19-079 **Figure** 19-267

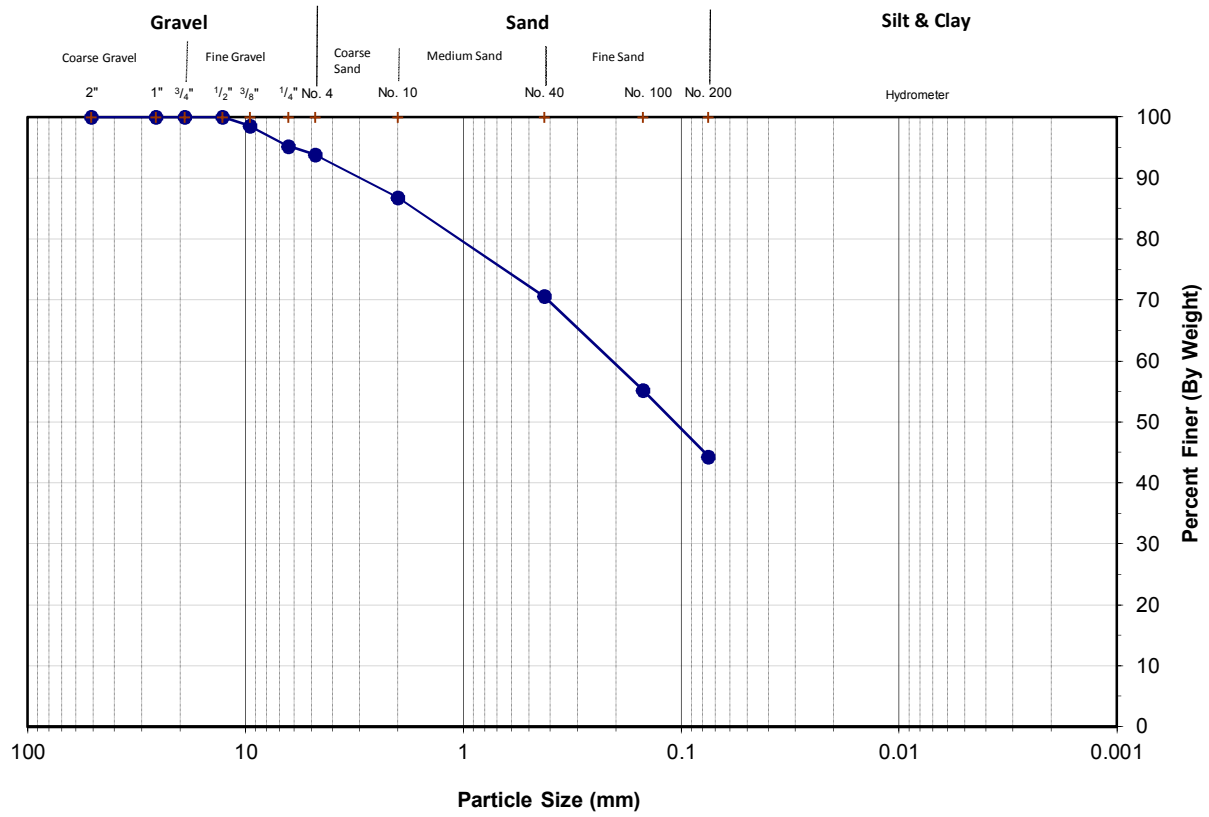
C.T. Male Associates

Sieve Analysis
Geotechnical Engineering Laboratory

Project: *Mahopac Schools*

Location: *Mahopac, NY*
Client: *TetraTech*

Sample ID: MHS AB-1 4'-6'
Date Tested: **7/31/2019**
Lab No:
CTM Project No: **19.9414**
Visual Description : Sand



Sieve	% Passing	Composition						
3 in.	100.00%	Gravel		Sand			Fines	
3/4 in.	100.00%	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
No. 4	93.80%	0.00%	6.20%	7.00%	16.20%	26.30%	44.30%	
No. 10	86.80%							
No. 40	70.60%							
No. 200	44.30%							

Sample Index Properties

D_{10} (mm)	-
D_{30} (mm)	-
D_{60} (mm)	0.21

Coefficient of Uniformity, C_u	-
Coefficient of Curvature, C_c	-
Liquid Limit, LL	-
Plastic Limit, PL	-
Plasticity Index, PI	-
Moisture Content (%)	11.1

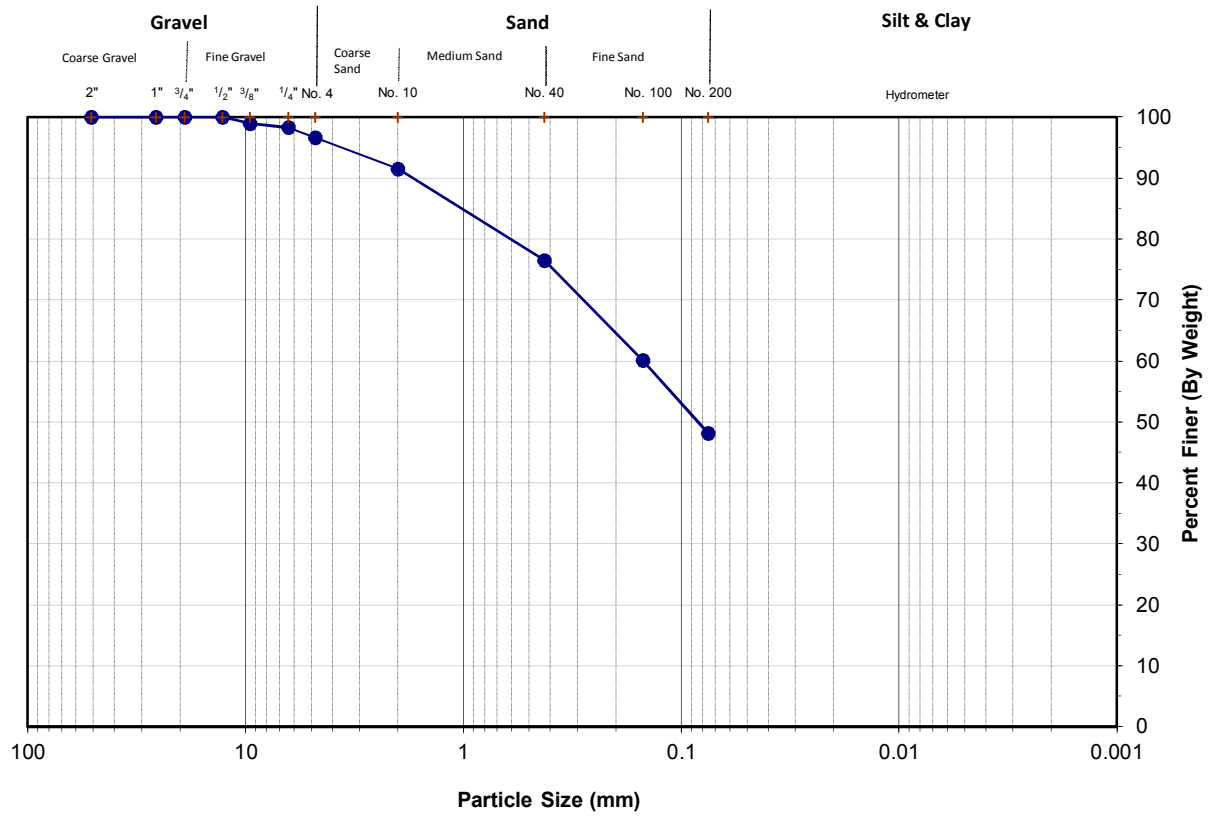
C.T. Male Associates

Sieve Analysis
Geotechnical Engineering Laboratory

Project: *Mahopac Schools*

Location: *Mahopac, NY*
Client: *TetraTech*

Sample ID: MHS AB-1 8'-10'
Date Tested: **7/31/2019**
Lab No:
CTM Project No: **19.9414**
Visual Description : Sand



Sieve	% Passing	Composition						
3 in.	100.00%	Gravel		Sand			Fines	
3/4 in.	100.00%	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
No. 4	96.60%	0.00%	3.40%	5.10%	15.00%	28.40%	48.10%	
No. 10	91.50%							
No. 40	76.50%							
No. 200	48.10%							

Sample Index Properties

D_{10} (mm)	-
D_{30} (mm)	-
D_{60} (mm)	0.16

Coefficient of Uniformity, C_u	-
Coefficient of Curvature, C_c	-
Liquid Limit, LL	-
Plastic Limit, PL	-
Plasticity Index, PI	-
Moisture Content (%)	11.7

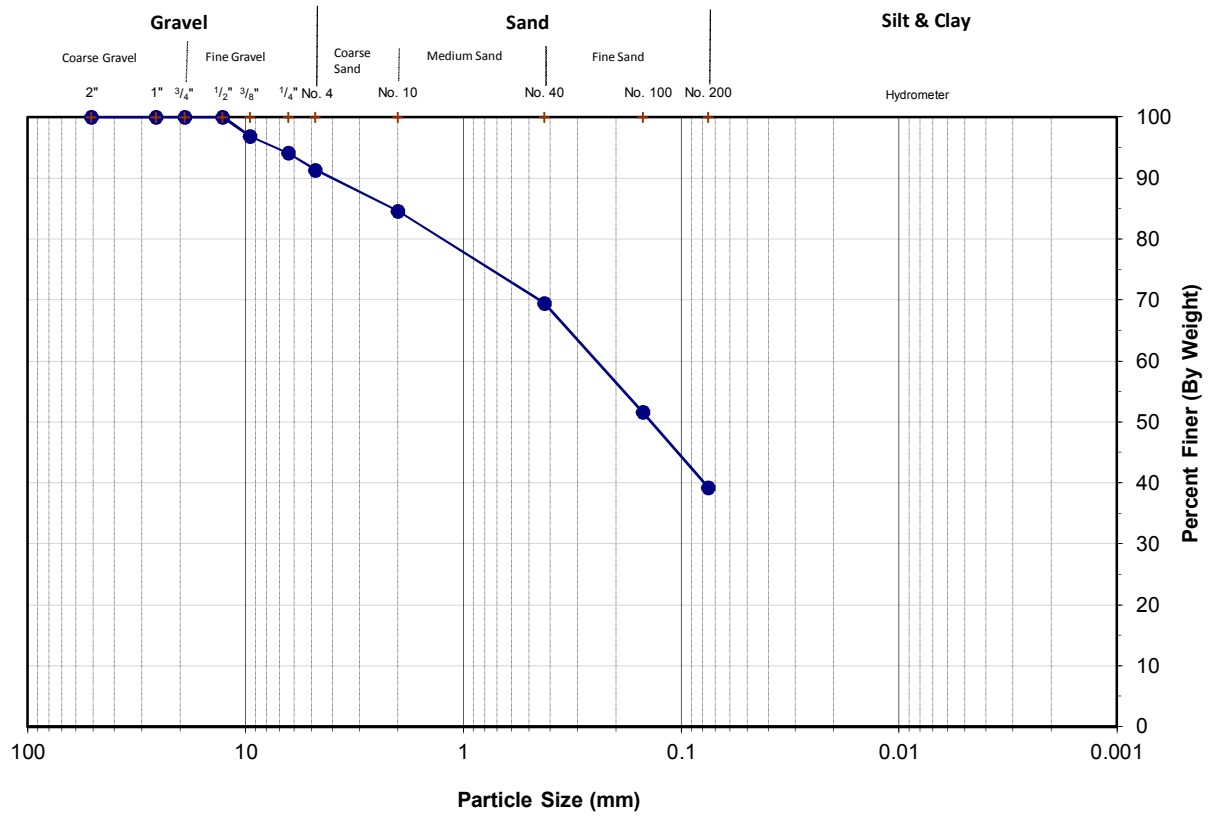
C.T. Male Associates

Sieve Analysis
Geotechnical Engineering Laboratory

Project: *Mahopac Schools*

Location: *Mahopac, NY*
Client: *TetraTech*

Sample ID: MHS AB-1 15'-17'
Date Tested: **8/2/2019**
Lab No:
CTM Project No: **19.9414**
Visual Description : Sand



Sieve	% Passing	Composition						
3 in.	100.00%	Gravel		Sand			Fines	
3/4 in.	100.00%	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
No. 4	91.30%	0.00%	8.70%	6.70%	15.10%	30.30%	39.20%	
No. 10	84.60%							
No. 40	69.50%							
No. 200	39.20%							

Sample Index Properties

D_{10} (mm)	-
D_{30} (mm)	-
D_{60} (mm)	0.25

Coefficient of Uniformity, C_u	-
Coefficient of Curvature, C_c	-
Liquid Limit, LL	-
Plastic Limit, PL	-
Plasticity Index, PI	-
Moisture Content (%)	8.9

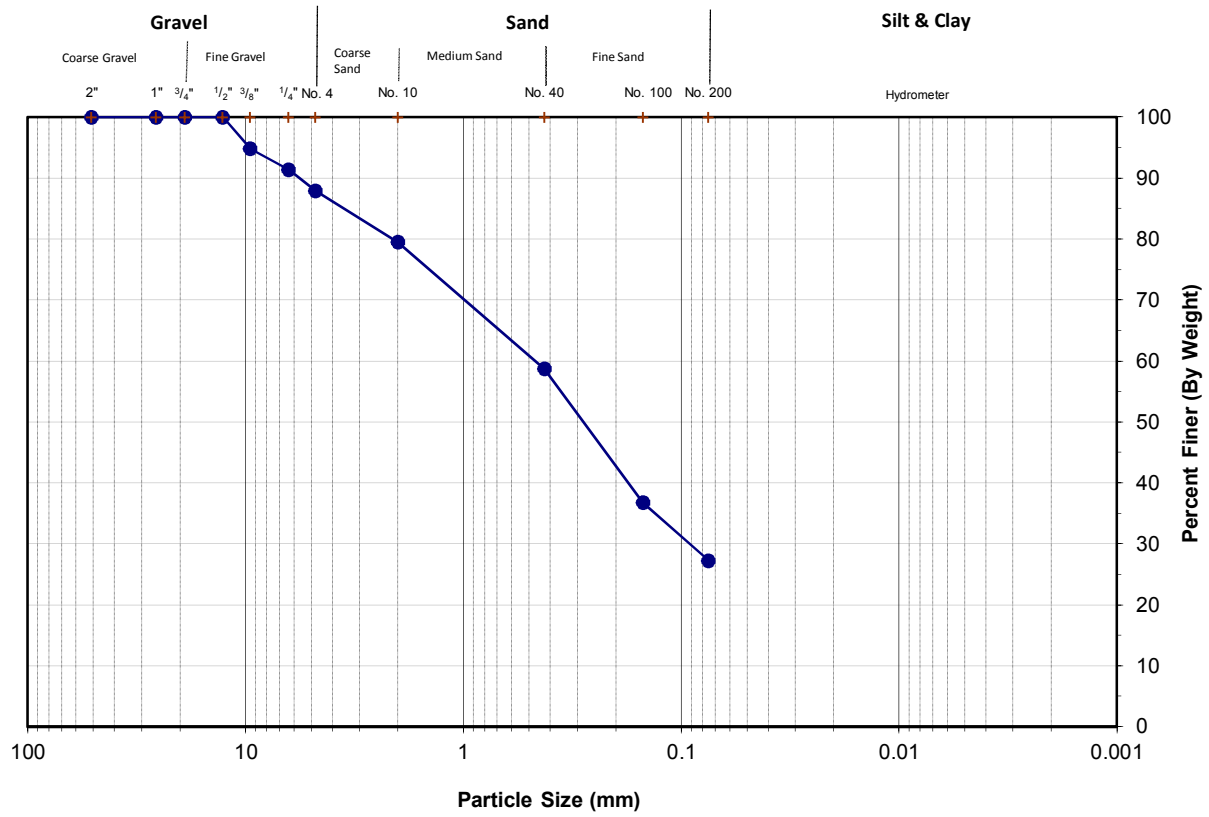
C.T. Male Associates

Sieve Analysis
Geotechnical Engineering Laboratory

Project: *Mahopac Schools*

Location: *Mahopac, NY*
Client: *TetraTech*

Sample ID: MHS AB-2 4'-6'
Date Tested: **8/2/2019**
Lab No:
CTM Project No: **19.9414**
Visual Description : Sand



Sieve	% Passing	Composition						
3 in.	100.00%	Gravel		Sand			Fines	
3/4 in.	100.00%	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
No. 4	87.90%	0.00%	12.10%	8.40%	20.80%	31.40%	27.30%	
No. 10	79.50%							
No. 40	58.70%							
No. 200	27.30%							

Sample Index Properties

D_{10} (mm)	-
D_{30} (mm)	0.092
D_{60} (mm)	0.48

Coefficient of Uniformity, C_u	-
Coefficient of Curvature, C_c	-
Liquid Limit, LL	-
Plastic Limit, PL	-
Plasticity Index, PI	-
Moisture Content (%)	13.2

Test Boring No. :
Sample ID:
Lab ID No. :

Sieve No.	Diameter (mm)	% Passing	Fraction Passing
2"	50.8	100.0	1
1"	25.7	100.0	1
3/4"	19.0	100.0	1
1/2"	12.7	97.3	0.973
3/8"	9.51	95.8	0.958
1/4"	6.35	89.5	0.895
No. 4	4.76	87.9	0.879
No. 10	2.00	79.8	0.798
No. 40	0.425	60.0	0.6
No. 100	0.15	40.6	0.406
No. 200	0.075	29.4	0.294

Hidden Series

Sieve No.	Diameter (mm)	% Passing
2"	50.8	100.0
1"	25.7	100.0
3/4"	19.0	100.0
1/2"	12.7	100.0
3/8"	9.51	100.0
1/4"	6.35	100.0
No. 4	4.76	100.0
No. 10	2.00	100.0
No. 40	0.425	100.0
No. 100	0.15	100.0
No. 200	0.075	100.0

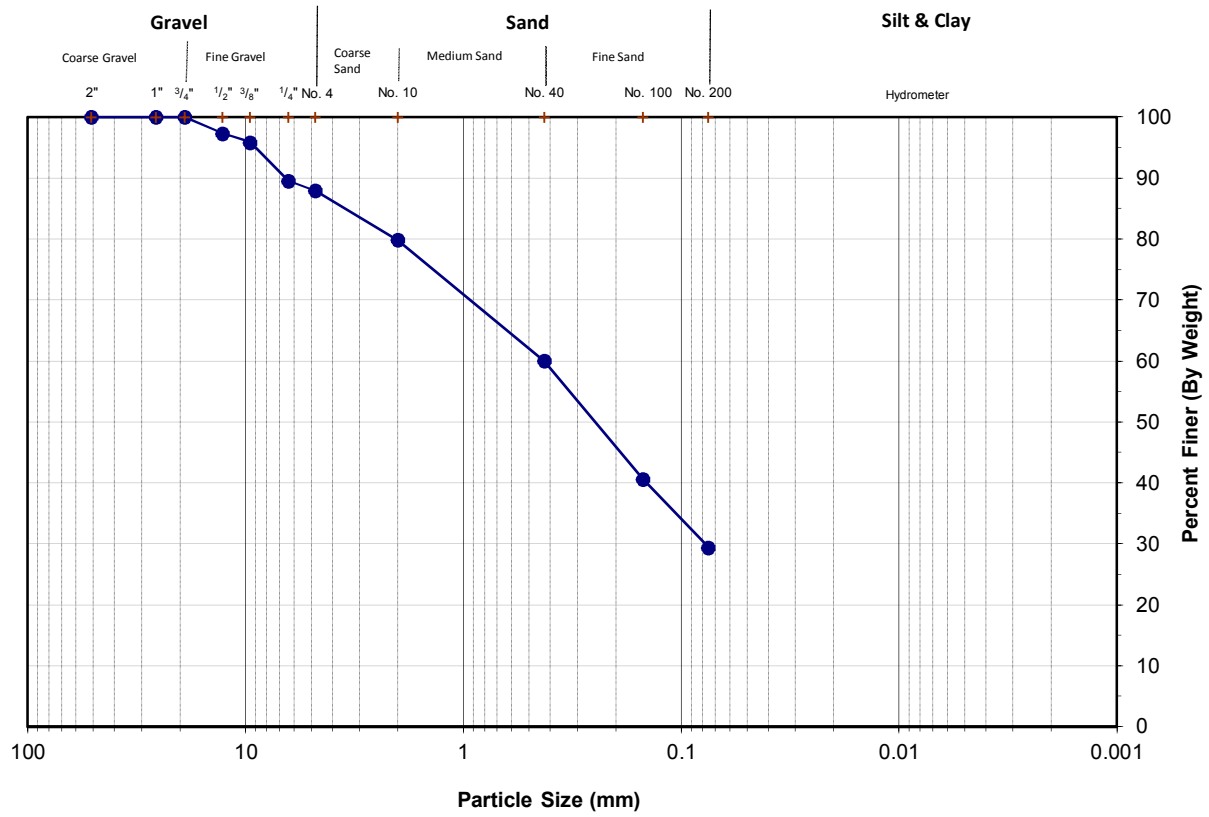
C.T. Male Associates

Sieve Analysis
Geotechnical Engineering Laboratory

Project: *Mahopac Schools*

Location: *Mahopac, NY*
Client: *TetraTech*

Sample ID: MHS AB-2 10'-12'
Date Tested: **8/2/2019**
Lab No:
CTM Project No: **19.9414**
Visual Description : Sand



Sieve	% Passing	Composition						
3 in.	100.00%	Gravel		Sand			Fines	
3/4 in.	100.00%	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
No. 4	87.90%	0.00%	12.10%	8.10%	19.80%	30.60%	29.40%	
No. 10	79.80%							
No. 40	60.00%							
No. 200	29.40%							

Sample Index Properties

D_{10} (mm)	-
D_{30} (mm)	0.075
D_{60} (mm)	0.43

Coefficient of Uniformity, C_u	-
Coefficient of Curvature, C_c	-
Liquid Limit, LL	-
Plastic Limit, PL	-
Plasticity Index, PI	-
Moisture Content (%)	7.9

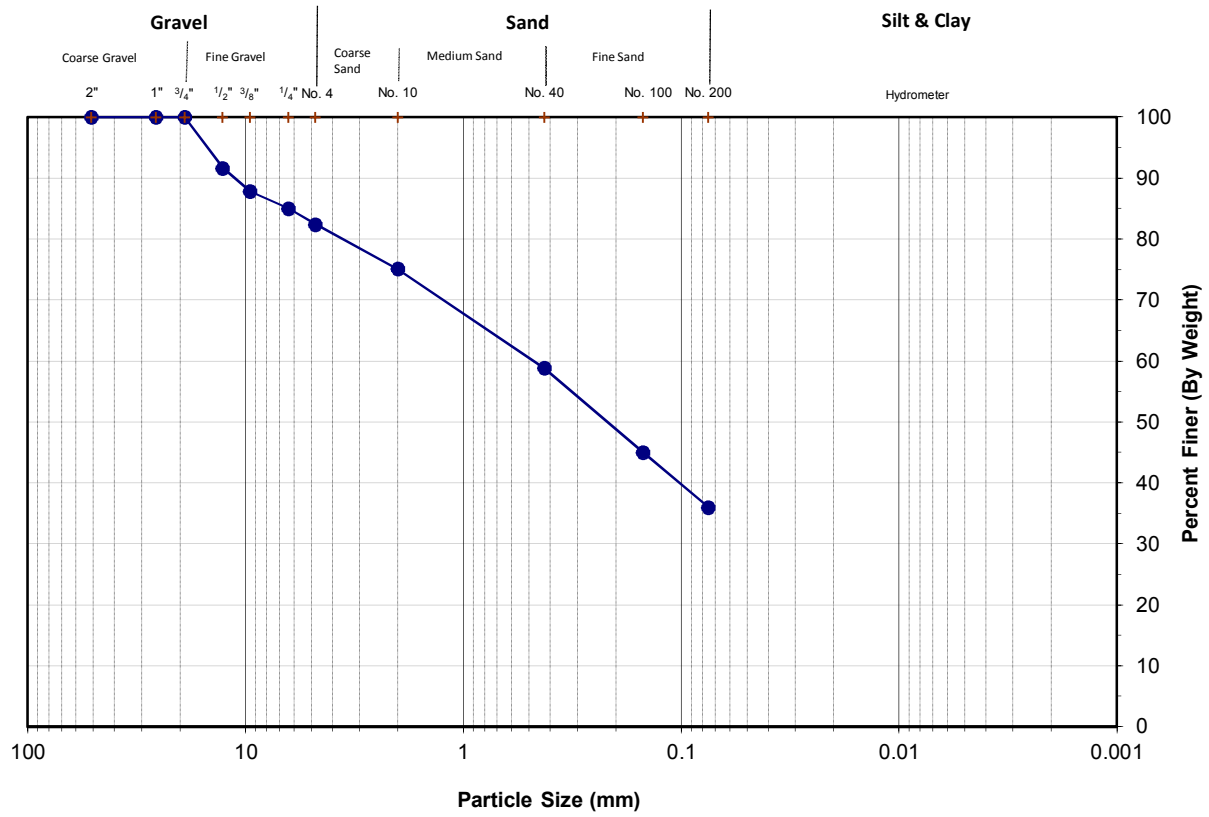
C.T. Male Associates

Sieve Analysis
Geotechnical Engineering Laboratory

Project: *Mahopac Schools*

Location: *Mahopac, NY*
Client: *TetraTech*

Sample ID: MHS AB-3 4'-6'
Date Tested: **8/2/2019**
Lab No:
CTM Project No: **19.9414**
Visual Description : Sand, Some Silt



Sieve	% Passing	Composition						
3 in.	100.00%	Gravel		Sand			Fines	
3/4 in.	100.00%	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
No. 4	82.40%	0.00%	17.60%	7.30%	16.30%	22.80%	36.00%	
No. 10	75.10%							
No. 40	58.80%							
No. 200	36.00%							

Sample Index Properties

D_{10} (mm)	-
D_{30} (mm)	-
D_{60} (mm)	0.48

Coefficient of Uniformity, C_u	-
Coefficient of Curvature, C_c	-
Liquid Limit, LL	-
Plastic Limit, PL	-
Plasticity Index, PI	-
Moisture Content (%)	8.4

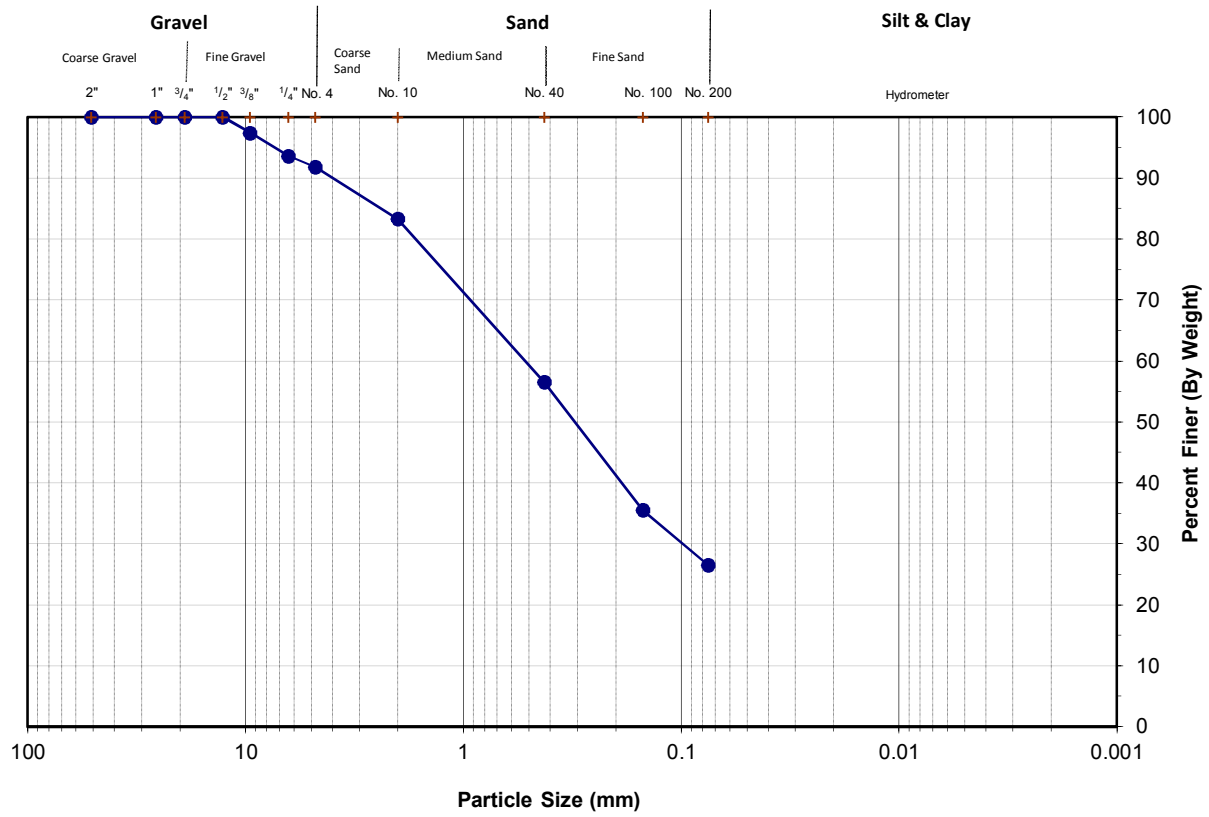
C.T. Male Associates

Sieve Analysis
Geotechnical Engineering Laboratory

Project: *Mahopac Schools*

Location: *Mahopac, NY*
Client: *TetraTech*

Sample ID: MHS AB-3 8'-10'
Date Tested: **8/2/2019**
Lab No:
CTM Project No: **19.9414**
Visual Description : Sand



Sieve	% Passing	Composition						
3 in.	100.00%	Gravel		Sand			Fines	
3/4 in.	100.00%	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
No. 4	91.80%	0.00%	8.20%	8.50%	26.80%	30.00%	26.50%	
No. 10	83.30%							
No. 40	56.50%							
No. 200	26.50%							

Sample Index Properties

D_{10} (mm)	-
D_{30} (mm)	0.099
D_{60} (mm)	0.51

Coefficient of Uniformity, C_u	-
Coefficient of Curvature, C_c	-
Liquid Limit, LL	-
Plastic Limit, PL	-
Plasticity Index, PI	-
Moisture Content (%)	12.9

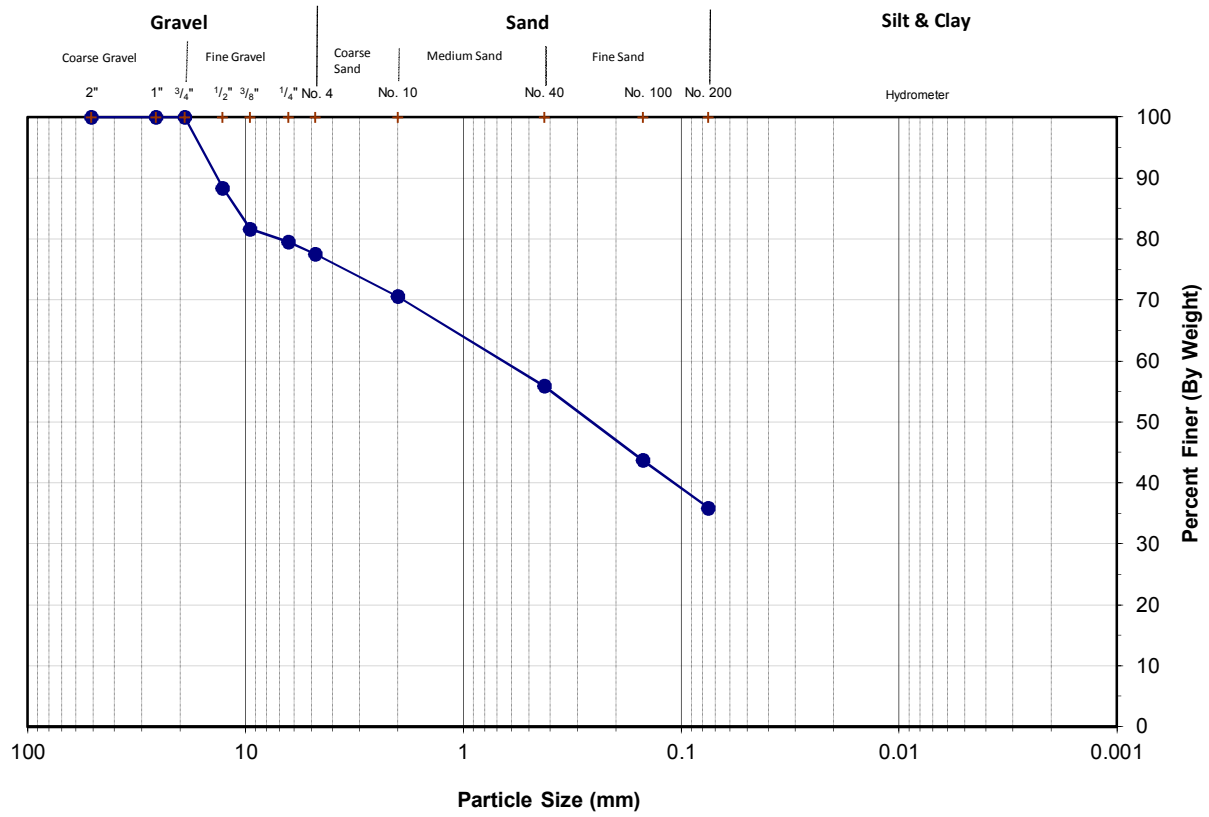
C.T. Male Associates

Sieve Analysis
Geotechnical Engineering Laboratory

Project: *Mahopac Schools*

Location: *Mahopac, NY*
Client: *TetraTech*

Sample ID: MHS AB-4 10'-12'
Date Tested: **8/2/2019**
Lab No:
CTM Project No: **19.9414**
Visual Description :



Sieve	% Passing	Composition						
3 in.	100.00%	Gravel		Sand			Fines	
3/4 in.	100.00%	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
No. 4	77.50%	0.00%	22.50%	6.90%	14.70%	20.00%	35.90%	
No. 10	70.60%							
No. 40	55.90%							
No. 200	35.90%							

Sample Index Properties

D_{10} (mm)	-
D_{30} (mm)	-
D_{60} (mm)	0.65

Coefficient of Uniformity, C_u	-
Coefficient of Curvature, C_c	-
Liquid Limit, LL	-
Plastic Limit, PL	-
Plasticity Index, PI	-
Moisture Content (%)	10.3

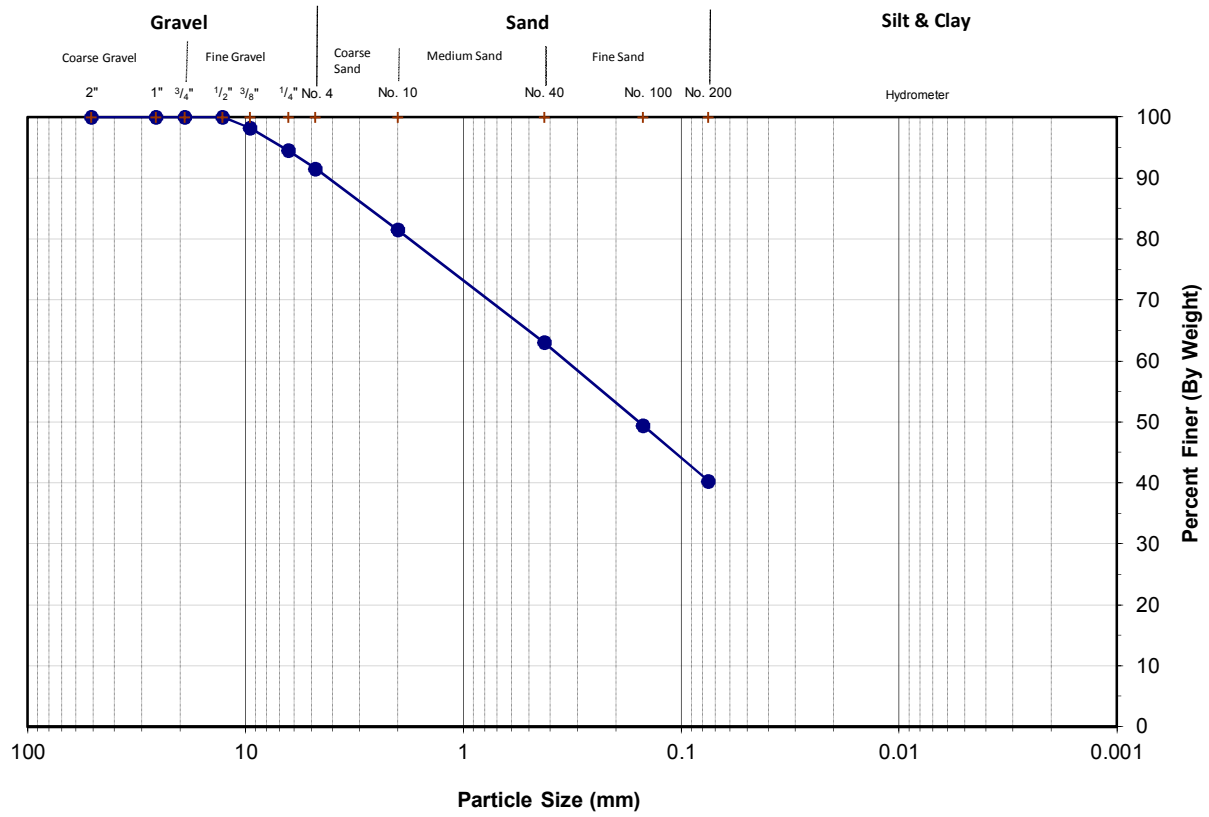
C.T. Male Associates

Sieve Analysis
Geotechnical Engineering Laboratory

Project: *Mahopac Schools*

Location: *Mahopac, NY*
Client: *TetraTech*

Sample ID: MHS AB-4 17'-19'
Date Tested: **8/2/2019**
Lab No:
CTM Project No: **19.9414**
Visual Description :



Sieve	% Passing	Composition						
3 in.	100.00%	Gravel		Sand			Fines	
3/4 in.	100.00%	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
No. 4	91.50%	0.00%	8.50%	10.00%	18.50%	22.70%	40.30%	
No. 10	81.50%							
No. 40	63.00%							
No. 200	40.30%							

Sample Index Properties

D_{10} (mm)	-
D_{30} (mm)	-
D_{60} (mm)	0.34

Coefficient of Uniformity, C_u	-
Coefficient of Curvature, C_c	-
Liquid Limit, LL	-
Plastic Limit, PL	-
Plasticity Index, PI	-
Moisture Content (%)	10.9

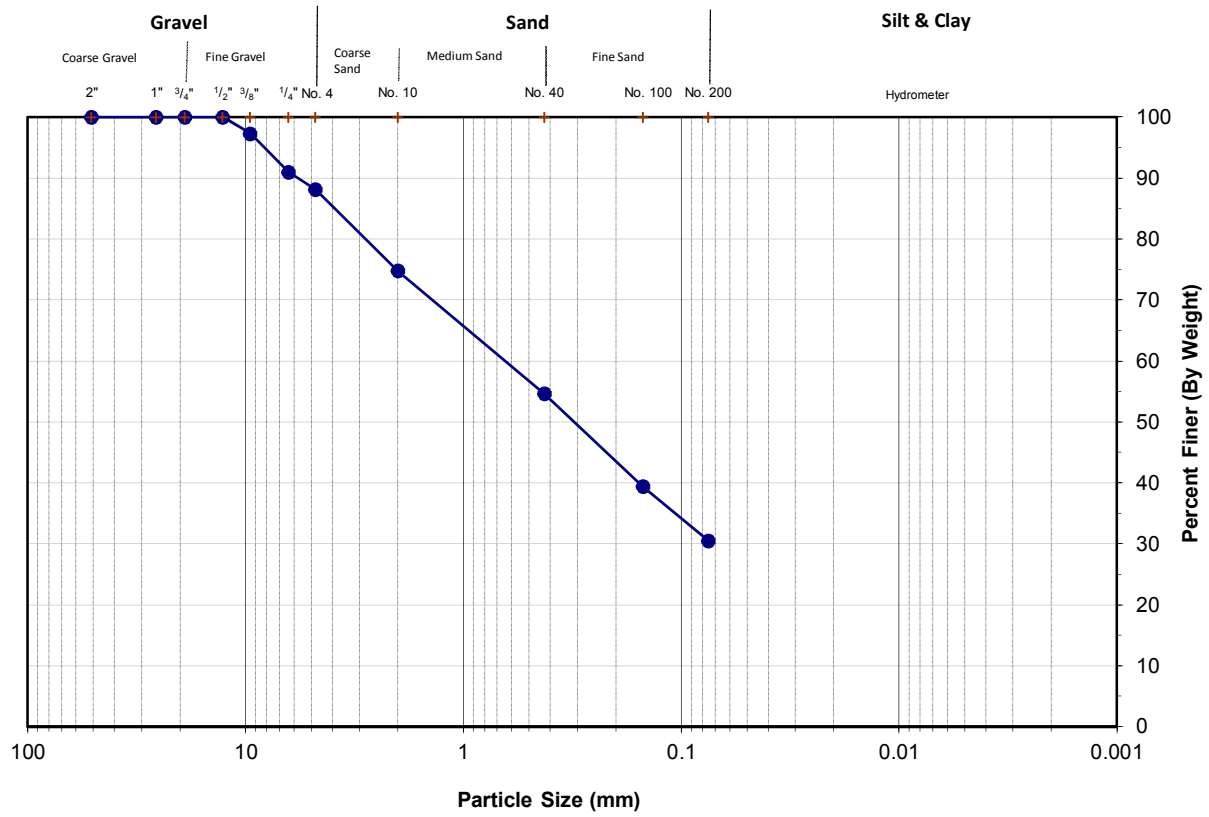
C.T. Male Associates

Sieve Analysis
Geotechnical Engineering Laboratory

Project: *Mahopac Schools*

Location: *Mahopac, NY*
Client: *TetraTech*

Sample ID: MHS B-1 4'-6'
Date Tested: **8/2/2019**
Lab No:
CTM Project No: **19.9414**
Visual Description : Sand



Sieve	% Passing	Composition						
3 in.	100.00%	Gravel		Sand			Fines	
3/4 in.	100.00%	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
No. 4	88.10%	0.00%	11.90%	13.30%	20.20%	24.10%	30.50%	
No. 10	74.80%							
No. 40	54.60%							
No. 200	30.50%							

Sample Index Properties

D_{10} (mm)	-
D_{30} (mm)	-
D_{60} (mm)	0.65

Coefficient of Uniformity, C_u	-
Coefficient of Curvature, C_c	-
Liquid Limit, LL	-
Plastic Limit, PL	-
Plasticity Index, PI	-
Moisture Content (%)	7.9

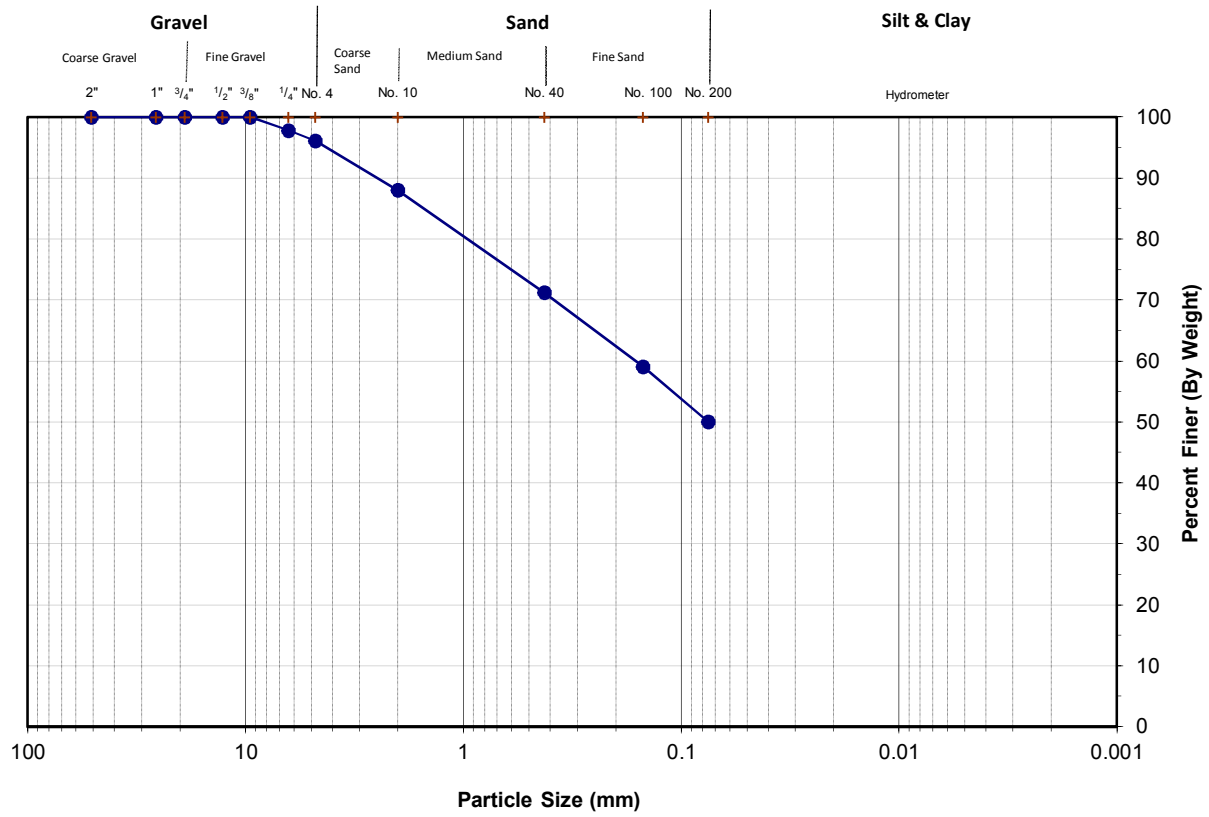
C.T. Male Associates

Sieve Analysis
Geotechnical Engineering Laboratory

Project: *Mahopac Schools*

Location: *Mahopac, NY*
Client: *TetraTech*

Sample ID: MHS B-1 8'-10'
Date Tested: **8/2/2019**
Lab No:
CTM Project No: **19.9414**
Visual Description : Sand



Sieve	% Passing	Composition						
3 in.	100.00%	Gravel		Sand			Fines	
3/4 in.	100.00%	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
No. 4	96.10%	0.00%	3.90%	8.10%	16.80%	21.20%	50.00%	
No. 10	88.00%							
No. 40	71.20%							
No. 200	50.00%							

Sample Index Properties

D_{10} (mm)	-
D_{30} (mm)	-
D_{60} (mm)	0.16

Coefficient of Uniformity, C_u	-
Coefficient of Curvature, C_c	-
Liquid Limit, LL	-
Plastic Limit, PL	-
Plasticity Index, PI	-
Moisture Content (%)	9.1

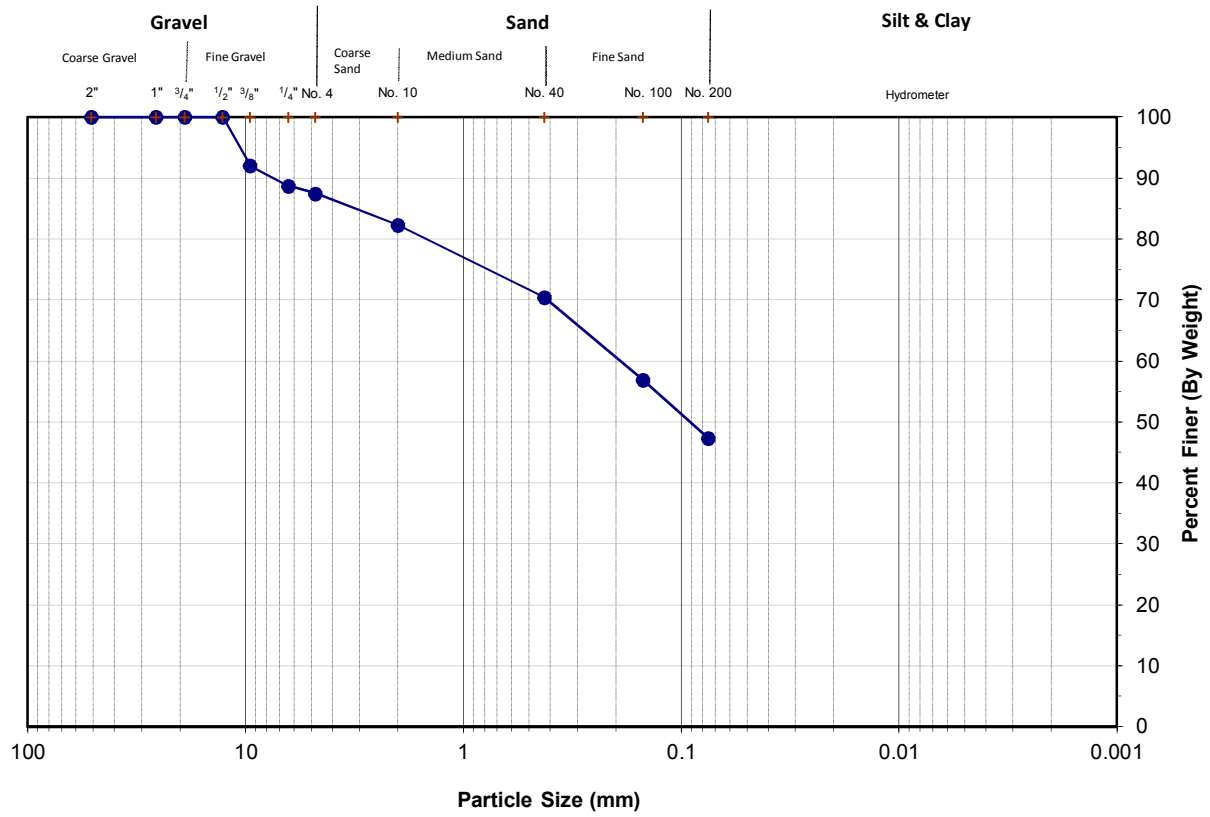
C.T. Male Associates

Sieve Analysis
Geotechnical Engineering Laboratory

Project: *Mahopac Schools*

Location: *Mahopac, NY*
Client: *TetraTech*

Sample ID: MHS B-2 2'-4'
Date Tested: **8/2/2019**
Lab No:
CTM Project No: **19.9414**
Visual Description : Sand, Some Gravel



Sieve	% Passing	Composition						
3 in.	100.00%	Gravel		Sand			Fines	
3/4 in.	100.00%	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
No. 4	87.40%	0.00%	12.60%	5.10%	11.90%	23.10%	47.30%	
No. 10	82.30%							
No. 40	70.40%							
No. 200	47.30%							

Sample Index Properties

D_{10} (mm)	-
D_{30} (mm)	-
D_{60} (mm)	0.19

Coefficient of Uniformity, C_u	-
Coefficient of Curvature, C_c	-
Liquid Limit, LL	-
Plastic Limit, PL	-
Plasticity Index, PI	-
Moisture Content (%)	10.5

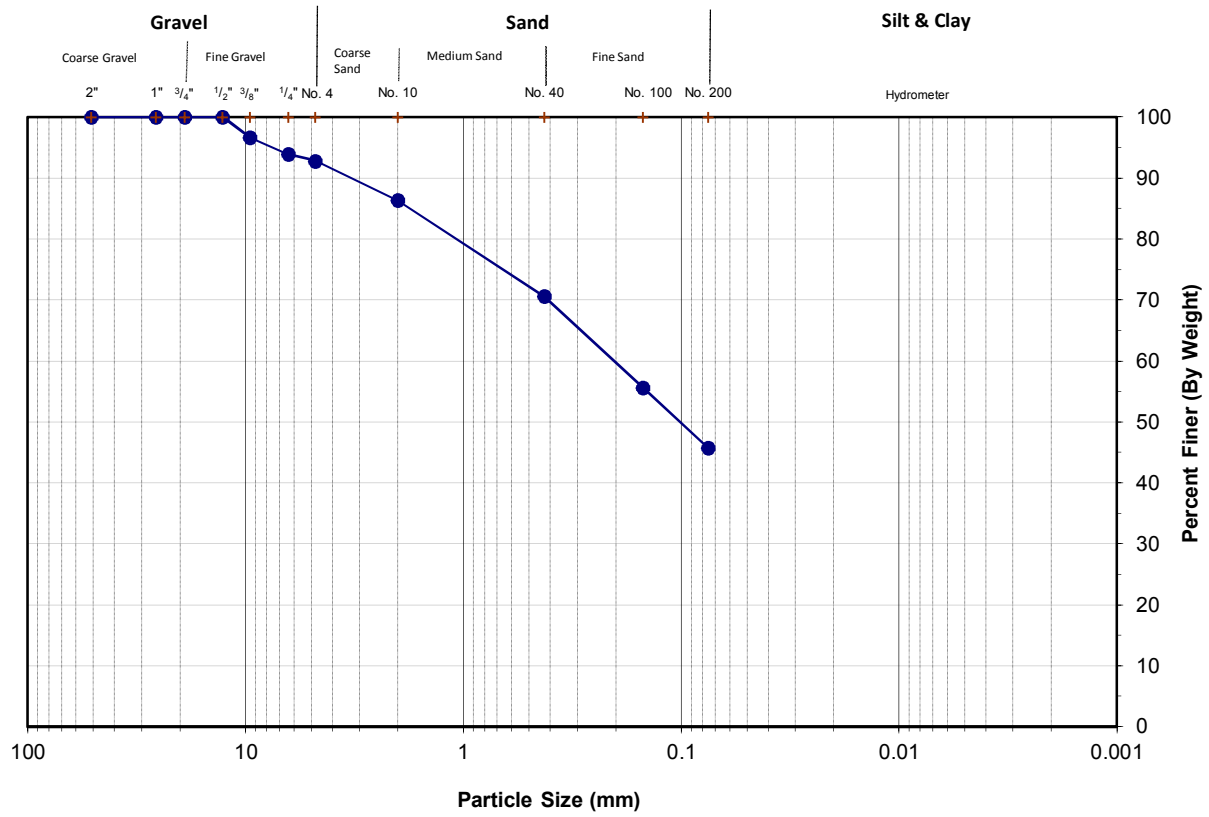
C.T. Male Associates

Sieve Analysis
Geotechnical Engineering Laboratory

Project: *Mahopac Schools*

Location: *Mahopac, NY*
Client: *TetraTech*

Sample ID: MHS B-2 6'-8'
Date Tested: **8/2/2019**
Lab No:
CTM Project No: **19.9414**
Visual Description : Sand, Some Silt



Sieve	% Passing	Composition						
3 in.	100.00%	Gravel		Sand			Fines	
3/4 in.	100.00%	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
No. 4	92.80%	0.00%	7.20%	6.50%	15.70%	24.90%	45.70%	
No. 10	86.30%							
No. 40	70.60%							
No. 200	45.70%							

Sample Index Properties

D_{10} (mm)	-
D_{30} (mm)	-
D_{60} (mm)	0.2

Coefficient of Uniformity, C_u	-
Coefficient of Curvature, C_c	-
Liquid Limit, LL	-
Plastic Limit, PL	-
Plasticity Index, PI	-
Moisture Content (%)	11.9

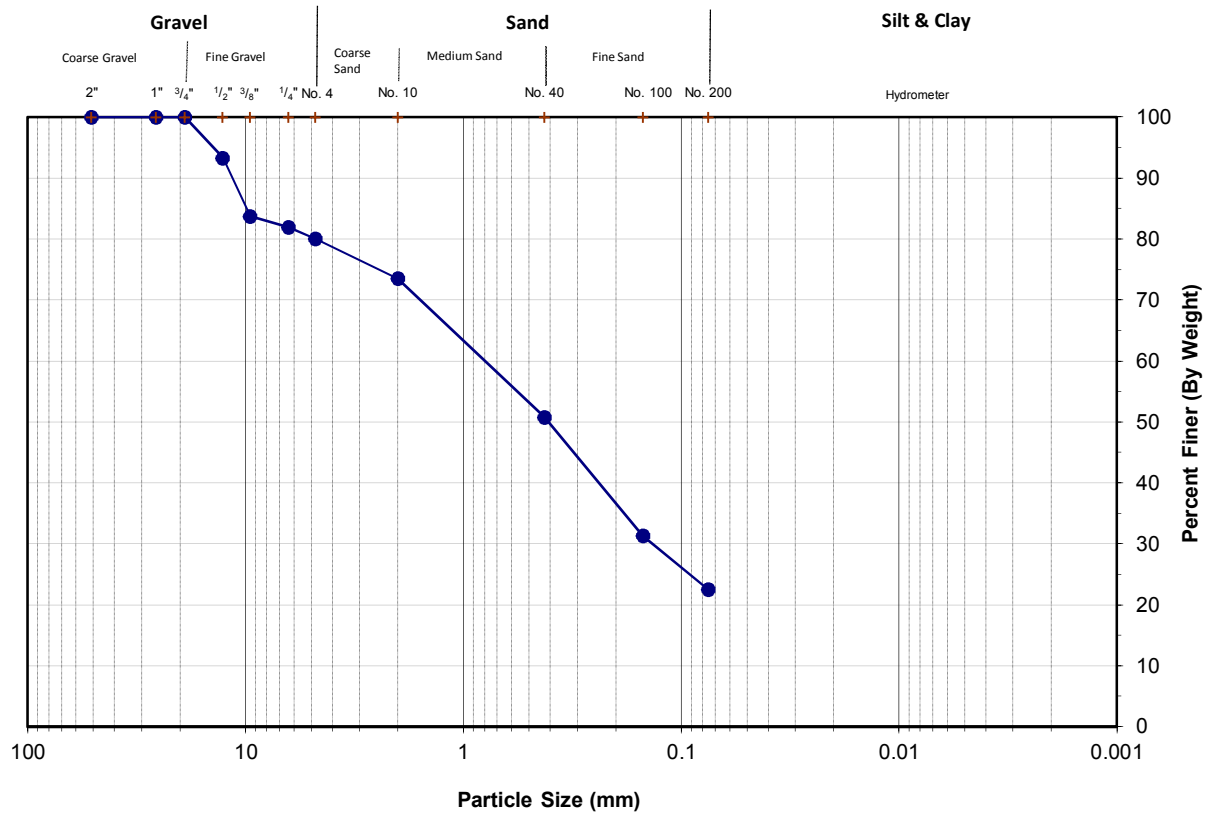
C.T. Male Associates

Sieve Analysis
Geotechnical Engineering Laboratory

Project: *Mahopac Schools*

Location: *Mahopac, NY*
Client: *TetraTech*

Sample ID: MMS AB-20 4'-6'
Date Tested: **7/31/2019**
Lab No:
CTM Project No: **19.9414**
Visual Description : Silt and Sand



Sieve	% Passing	Composition						
3 in.	100.00%	Gravel		Sand			Fines	
3/4 in.	100.00%	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
No. 4	80.00%	0.00%	20.00%	6.50%	22.70%	28.30%	22.50%	
No. 10	73.50%							
No. 40	50.80%							
No. 200	22.50%							

Sample Index Properties

D_{10} (mm)	-
D_{30} (mm)	0.14
D_{60} (mm)	0.8

Coefficient of Uniformity, C_u	-
Coefficient of Curvature, C_c	-
Liquid Limit, LL	-
Plastic Limit, PL	-
Plasticity Index, PI	-
Moisture Content (%)	24.8

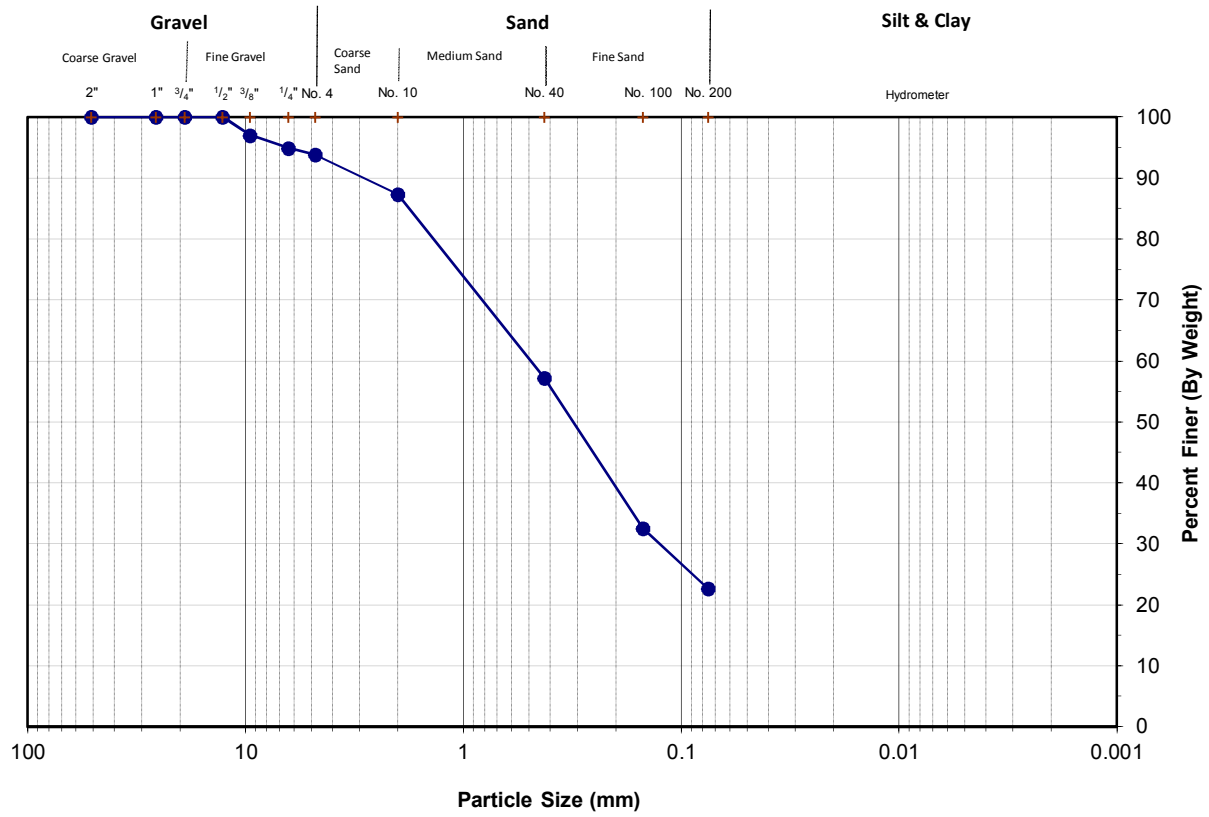
C.T. Male Associates

Sieve Analysis
Geotechnical Engineering Laboratory

Project: *Mahopac Schools*

Location: *Mahopac, NY*
Client: *TetraTech*

Sample ID: MMS AB-20 10'-12'
Date Tested: **7/31/2019**
Lab No:
CTM Project No: **19.9414**
Visual Description : Sand



Sieve	% Passing	Composition						
3 in.	100.00%	Gravel		Sand			Fines	
3/4 in.	100.00%	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
No. 4	93.80%	0.00%	6.20%	6.50%	30.10%	34.60%	22.60%	
No. 10	87.30%							
No. 40	57.20%							
No. 200	22.60%							

Sample Index Properties

D_{10} (mm)	-
D_{30} (mm)	0.13
D_{60} (mm)	0.49

Coefficient of Uniformity, C_u	-
Coefficient of Curvature, C_c	-
Liquid Limit, LL	-
Plastic Limit, PL	-
Plasticity Index, PI	-
Moisture Content (%)	13.5

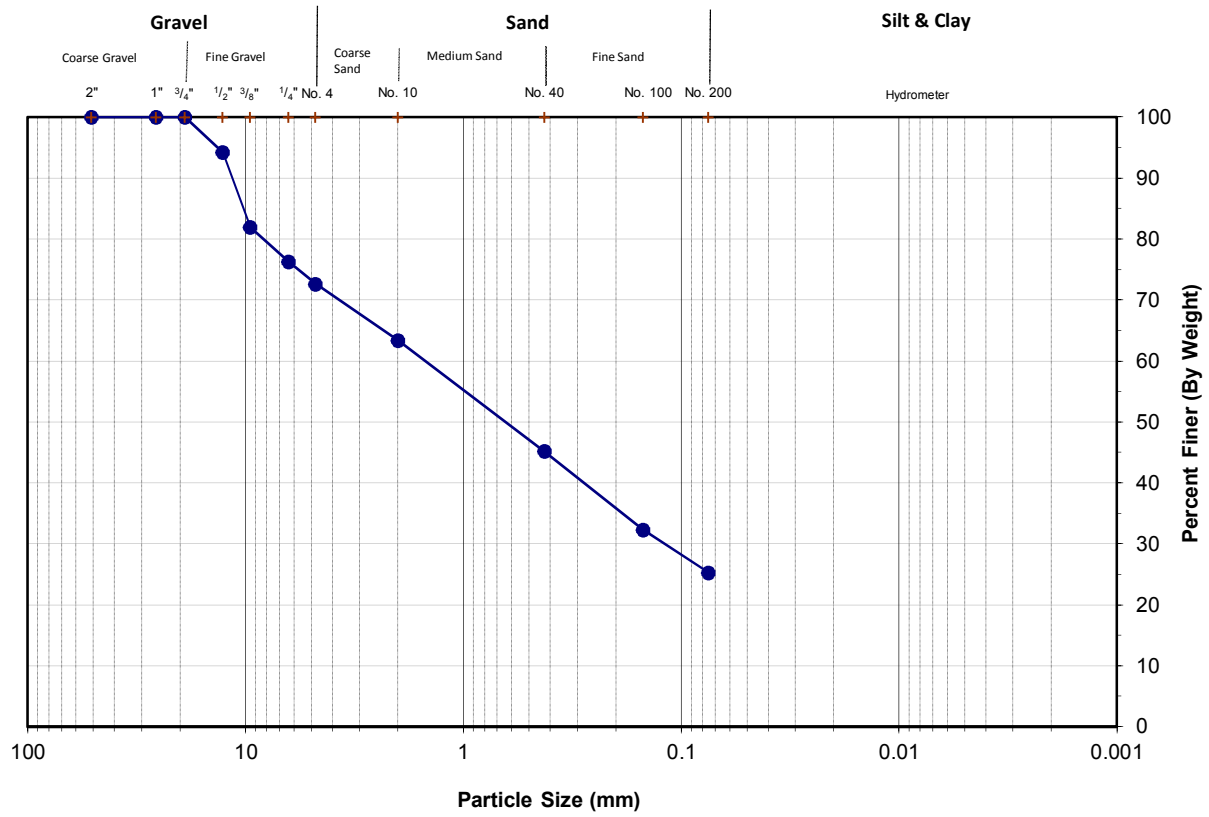
C.T. Male Associates

Sieve Analysis
Geotechnical Engineering Laboratory

Project: *Mahopac Schools*

Location: *Mahopac, NY*
Client: *TetraTech*

Sample ID: MMS AB-20 18'-20'
Date Tested: **7/31/2019**
Lab No:
CTM Project No: **19.9414**
Visual Description : Gravel and Sand



Sieve	% Passing	Composition						
3 in.	100.00%	Gravel		Sand			Fines	
3/4 in.	100.00%	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
No. 4	72.60%	0.00%	27.40%	9.20%	18.20%	19.90%	25.30%	
No. 10	63.40%							
No. 40	45.20%							
No. 200	25.30%							

Sample Index Properties

D_{10} (mm)	-
D_{30} (mm)	0.14
D_{60} (mm)	1.5

Coefficient of Uniformity, C_u	-
Coefficient of Curvature, C_c	-
Liquid Limit, LL	-
Plastic Limit, PL	-
Plasticity Index, PI	-
Moisture Content (%)	9.1

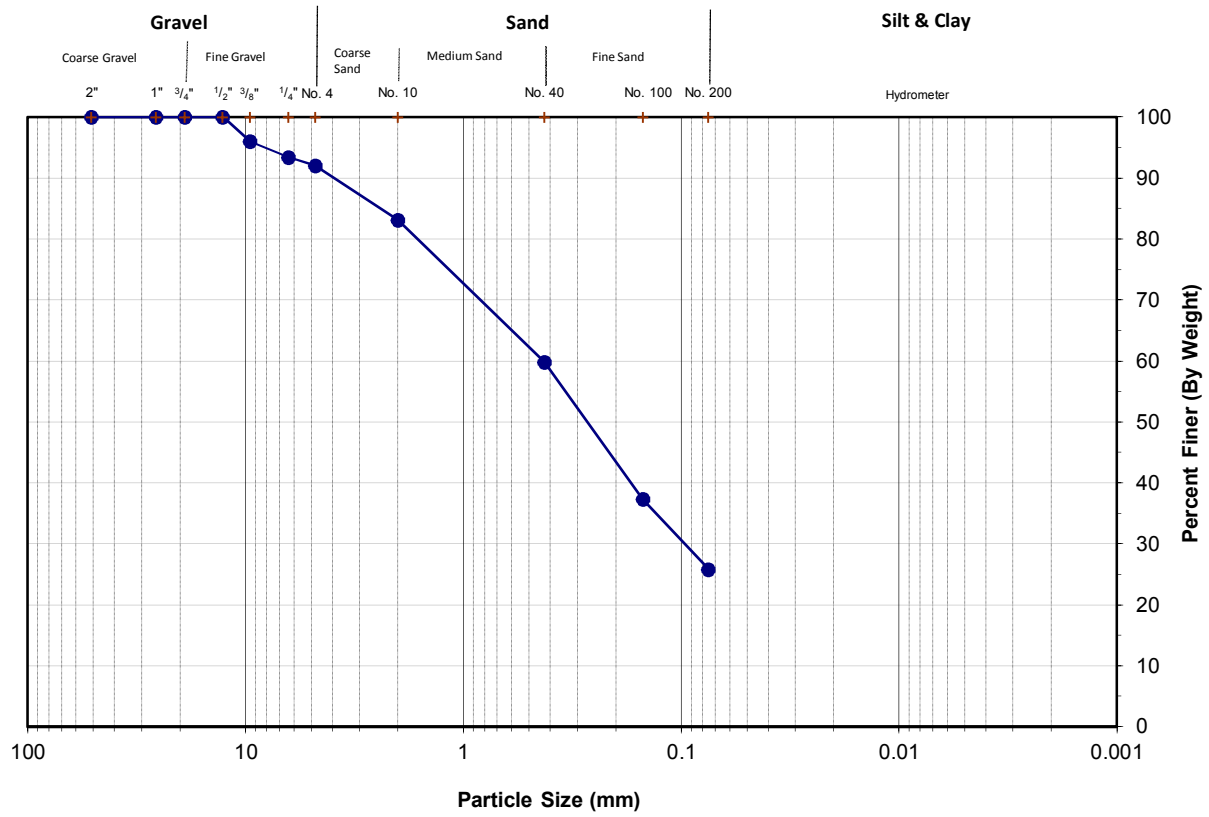
C.T. Male Associates

Sieve Analysis
Geotechnical Engineering Laboratory

Project: *Mahopac Schools*

Location: *Mahopac, NY*
Client: *TetraTech*

Sample ID: MMS B10-1 4'-6'
Date Tested: **7/31/2019**
Lab No:
CTM Project No: **19.9414**
Visual Description : Sand



Sieve	% Passing	Composition						
3 in.	100.00%	Gravel		Sand			Fines	
3/4 in.	100.00%	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
No. 4	92.00%	0.00%	8.00%	8.90%	23.30%	34.00%	25.80%	
No. 10	83.10%							
No. 40	59.80%							
No. 200	25.80%							

Sample Index Properties

D_{10} (mm)	-
D_{30} (mm)	0.08
D_{60} (mm)	0.42

Coefficient of Uniformity, C_u	-
Coefficient of Curvature, C_c	-
Liquid Limit, LL	-
Plastic Limit, PL	-
Plasticity Index, PI	-
Moisture Content (%)	7.1

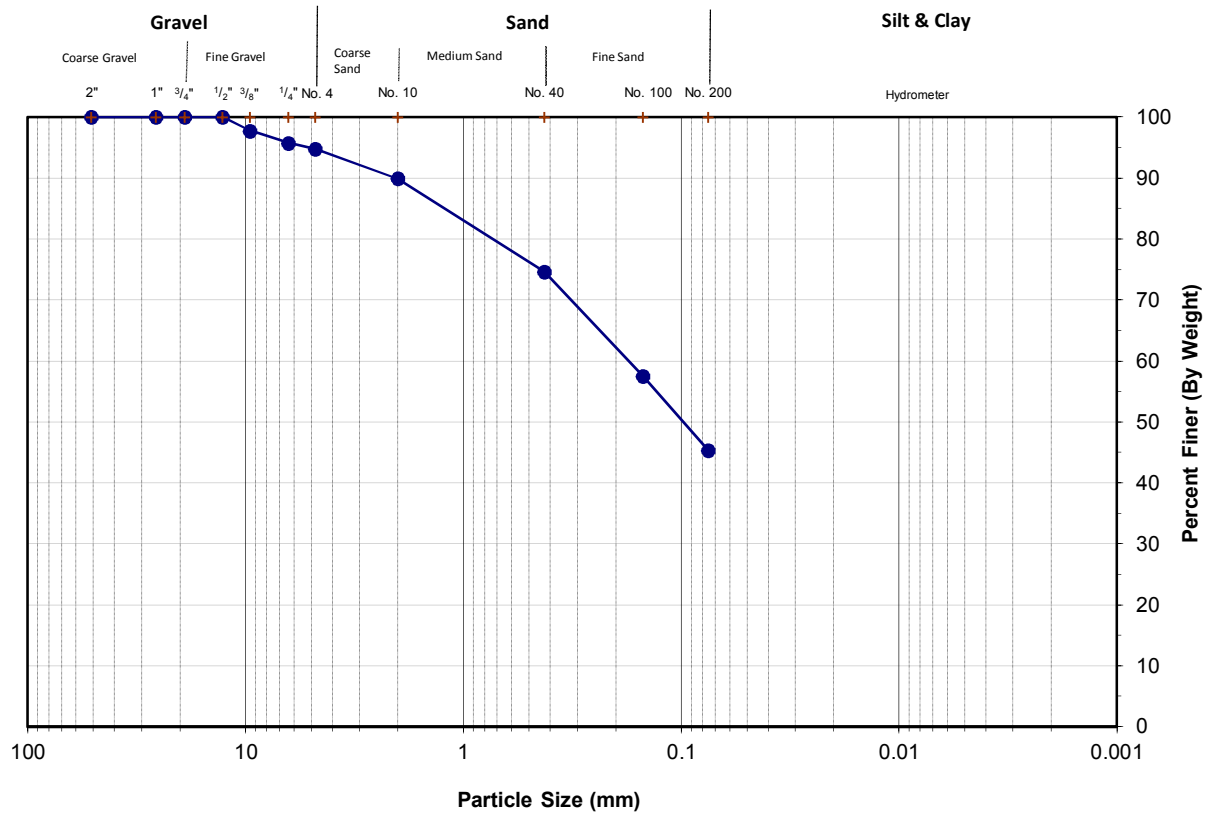
C.T. Male Associates

Sieve Analysis
Geotechnical Engineering Laboratory

Project: *Mahopac Schools*

Location: *Mahopac, NY*
Client: *TetraTech*

Sample ID: MMS B10-2 8'-10'
Date Tested: **7/31/2019**
Lab No:
CTM Project No: **19.9414**
Visual Description : Sand, Some Gravel



Sieve	% Passing	Composition						
3 in.	100.00%	Gravel		Sand			Fines	
3/4 in.	100.00%	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
No. 4	94.70%	0.00%	5.30%	4.80%	15.30%	29.30%	45.30%	
No. 10	89.90%							
No. 40	74.60%							
No. 200	45.30%							

Sample Index Properties

D_{10} (mm)	-
D_{30} (mm)	-
D_{60} (mm)	0.18

Coefficient of Uniformity, C_u	-
Coefficient of Curvature, C_c	-
Liquid Limit, LL	-
Plastic Limit, PL	-
Plasticity Index, PI	-
Moisture Content (%)	14.4

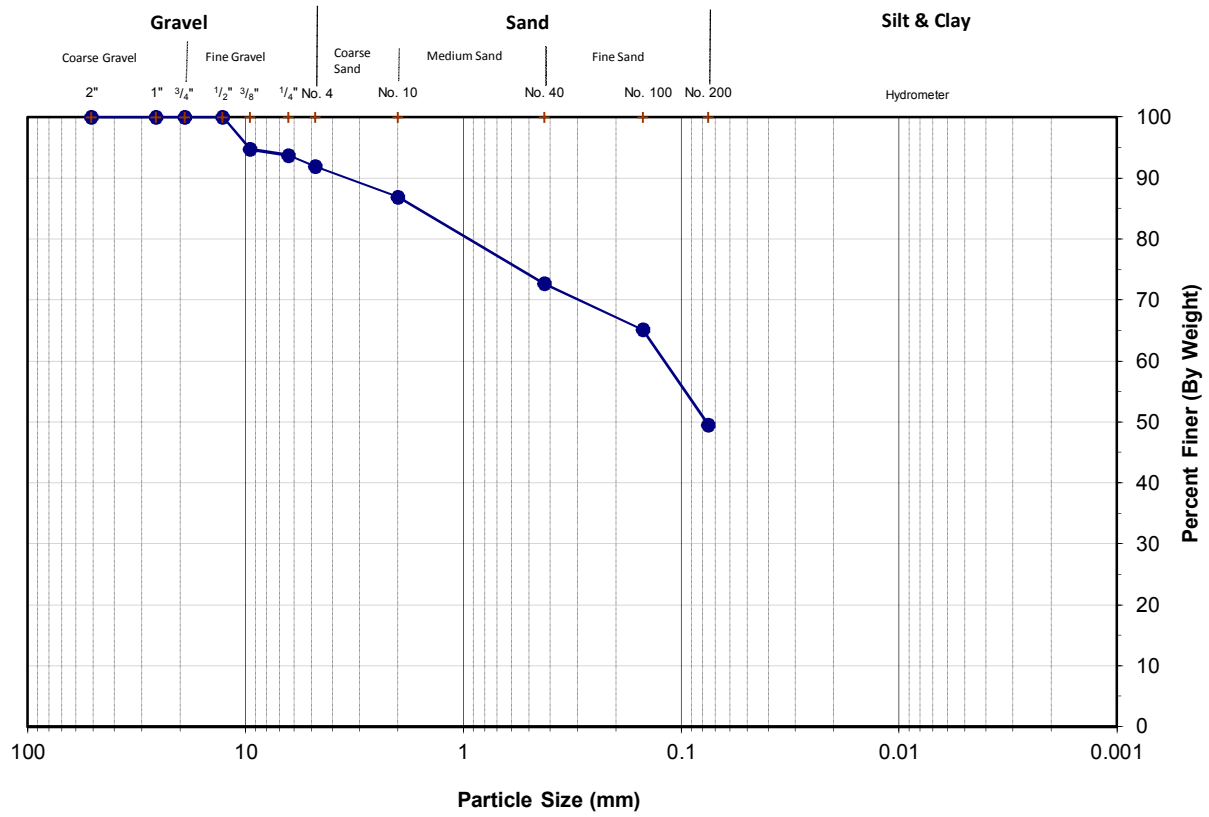
C.T. Male Associates

Sieve Analysis
Geotechnical Engineering Laboratory

Project: *Mahopac Schools*

Location: *Mahopac, NY*
Client: *TetraTech*

Sample ID: MMS B10-3 2'-4'
Date Tested: **7/31/2019**
Lab No:
CTM Project No: **19.9414**
Visual Description : Sand, Some Silt



Sieve	% Passing	Composition						
3 in.	100.00%	Gravel		Sand			Fines	
3/4 in.	100.00%	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
No. 4	91.90%	0.00%	8.10%	5.00%	14.20%	23.20%	49.50%	
No. 10	86.90%							
No. 40	72.70%							
No. 200	49.50%							

Sample Index Properties

D_{10} (mm)	-
D_{30} (mm)	-
D_{60} (mm)	0.13

Coefficient of Uniformity, C_u	-
Coefficient of Curvature, C_c	-
Liquid Limit, LL	-
Plastic Limit, PL	-
Plasticity Index, PI	-
Moisture Content (%)	12.6

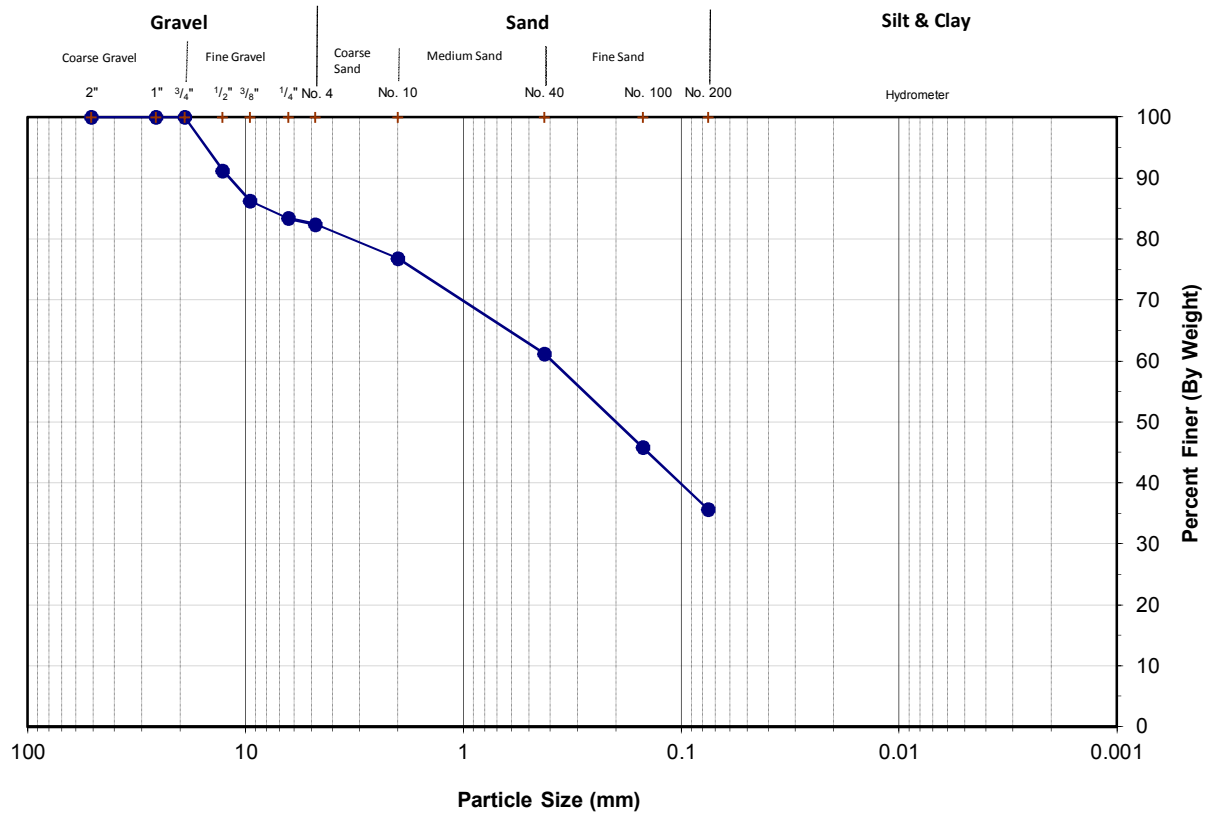
C.T. Male Associates

Sieve Analysis
Geotechnical Engineering Laboratory

Project: *Mahopac Schools*

Location: *Mahopac, NY*
Client: *TetraTech*

Sample ID: MMS B10-3 6'-8'
Date Tested: **7/31/2019**
Lab No:
CTM Project No: **19.9414**
Visual Description : Sand, Some Gravel



Sieve	% Passing	Composition						
3 in.	100.00%	Gravel		Sand			Fines	
3/4 in.	100.00%	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
No. 4	82.40%	0.00%	17.60%	5.60%	15.60%	25.60%	35.60%	
No. 10	76.80%							
No. 40	61.20%							
No. 200	35.60%							

Sample Index Properties

D_{10} (mm)	-
D_{30} (mm)	-
D_{60} (mm)	0.41

Coefficient of Uniformity, C_u	-
Coefficient of Curvature, C_c	-
Liquid Limit, LL	-
Plastic Limit, PL	-
Plasticity Index, PI	-
Moisture Content (%)	9.5

APPENDIX D

Infiltration Test Results

C.T. MALE ASSOCIATES

REPORT OF INFILTRATION TEST

Project:	Mahopac Schools	Test No.:	MMS I-1
Client:	TetraTech	Job No.:	19.9414
Weather & Temperature:	Clear, 90s	Date of Test:	7/30/2019
Performed By:	J. Scheetz	Witness:	—

SUBSURFACE INFORMATION

Soil Types & Depths Encountered: 0-2.0': Brown, dry, fine to coarse SAND, some fine to coarse GRAVEL

INFILTRATION TEST HOLE DATA

Depth to Bottom of Test Pit (Design Bottom of SMP): —

Dimensions of Infiltration Hole: Depth: 2.0' Length: — Width: — Diameter: 4"

Presoak Drainage Time: 7/29 @ 11:45 to 7/30 @ 08:58

TEST DATA

Time required for water level to drop 24 inches within 4" diameter PVC pipe or Drop Height after 1 Hour

Run No.	Start	End	Time	Drop Height (inches)
1	08:58	09:58	60 min	13
2	09:58	10:58	60 min	14
3	10:58	11:58	60 min	12
4	11:58	12:58	60 min	12

Remarks: Infiltration Rate Established @ 12 in/hr

C.T. MALE ASSOCIATES

REPORT OF INFILTRATION TEST

Project:	Mahopac Schools	Test No.:	MMS I-2
Client:	TetraTech	Job No.:	19.9414
Weather & Temperature:	Clear, 90s	Date of Test:	7/30/2019
Performed By:	J. Scheetz	Witness:	—

SUBSURFACE INFORMATION

Soil Types & Depths Encountered: 0-0.2': Topsoil; 0.2-2.0': Brown, damp, fine to coarse SAND, little fine to coarse gravel, trace silt

INFILTRATION TEST HOLE DATA

Depth to Bottom of Test Pit (Design Bottom of SMP): —

Dimensions of Infiltration Hole: Depth: 2.0' Length: — Width: — Diameter: 4"

Presoak Drainage Time: 7/29 @ 12:25 to 7/30 @ 09:12

TEST DATA

Time required for water level to drop 24 inches within 4" diameter PVC pipe or Drop Height after 1 Hour

Run No.	Start	End	Time	Drop Height (inches)
1	09:12	12:12	60 min	8
2	10:12	11:12	60 min	6
3	11:12	12:12	60 min	6
4	12:12	13:12	60 min	5

Remarks: Infiltration Rate Established @ 5 in/hr

C.T. MALE ASSOCIATES

REPORT OF INFILTRATION TEST

Project:	Mahopac Schools	Test No.:	MMS I-3
Client:	TetraTech	Job No.:	19.9414
Weather & Temperature:	Clear, 90s	Date of Test:	7/30/2019
Performed By:	J. Scheetz	Witness:	—

SUBSURFACE INFORMATION

Soil Types & Depths Encountered: 0-0.5': FILL: Brown, damp, fine to coarse SAND, some fine to coarse GRAVEL, trace silt, trace debris (plastic, brick, concrete); 0.5-2.0': Brown, damp, fine to coarse SAND, little fine gravel

INFILTRATION TEST HOLE DATA

Depth to Bottom of Test Pit (Design Bottom of SMP): 2.0'

Dimensions of Infiltration Hole: Depth: 2.0' Length: — Width: — Diameter: 4"

Presoak Drainage Time: 7/29 @ 11:00 to 7/30 @ 07:53

TEST DATA

Time required for water level to drop 24 inches within 4" diameter PVC pipe or Drop Height after 1 Hour

Run No.	Start	End	Time	Drop Height (inches)
1	07:53	08:53	60 min	22
2	08:53	09:53	60 min	20
3	09:53	10:53	60 min	20
4	10:53	11:53	60 min	19

Remarks: Infiltration Rate Established @ 19 in/hr

C.T. MALE ASSOCIATES

REPORT OF INFILTRATION TEST

Project:	Mahopac Schools	Test No.:	MMS I-4
Client:	TetraTech	Job No.:	19.9414
Weather & Temperature:	Clear, 90s	Date of Test:	7/30/2019
Performed By:	J. Scheetz	Witness:	—

SUBSURFACE INFORMATION

Soil Types & Depths Encountered: 0-0.3': Topsoil; 0.3-2.0': Brown, damp, fine to coarse SAND, some silt little fine to coarse gravel

INFILTRATION TEST HOLE DATA

Depth to Bottom of Test Pit (Design Bottom of SMP): —

Dimensions of Infiltration Hole: Depth: 2.0' Length: — Width: — Diameter: 4"

Presoak Drainage Time: 7/28 @ 15:25 to 7/30 @ 11:02

TEST DATA

Time required for water level to drop 24 inches within 4" diameter PVC pipe or Drop Height after 1 Hour

Run No.	Start	End	Time	Drop Height (inches)
1	11:02	12:02	60 min	21
2	12:02	13:02	60 min	19
3	13:02	14:02	60 min	19
4	14:02	15:02	60 min	19

Remarks: Infiltration Rate Established @ 19 in/hr

C.T. MALE ASSOCIATES

REPORT OF INFILTRATION TEST

Project:	Mahopac Schools	Test No.:	MMS I-5
Client:	TetraTech	Job No.:	19.9414
Weather & Temperature:	Clear, 90s	Date of Test:	7/30/2019
Performed By:	J. Scheetz	Witness:	—

SUBSURFACE INFORMATION

Soil Types & Depths Encountered: 0-0.3': Topsoil; 0.3-2.0': Brown, damp, fine to coarse SAND, little fine to coarse gravel, trace silt

INFILTRATION TEST HOLE DATA

Depth to Bottom of Test Pit (Design Bottom of SMP): —

Dimensions of Infiltration Hole: Depth: 2.0' Length: — Width: — Diameter: 4"

Presoak Drainage Time: 7/29 @ 14:32 to 7/30 @ 11:38

TEST DATA

Time required for water level to drop 24 inches within 4" diameter PVC pipe or Drop Height after 1 Hour

Run No.	Start	End	Time	Drop Height (inches)
1	11:38	12:38	60 min	Missed
2	12:38	13:38	60 min	24
3	13:38	14:38	60 min	24
4	14:38	15:38	60 min	24

Remarks: Infiltration Rate Established @ 24 in/hr

C.T. MALE ASSOCIATES

REPORT OF INFILTRATION TEST

Project:	Mahopac Schools	Test No.:	MMS I-6
Client:	TetraTech	Job No.:	19.9414
Weather & Temperature:	Clear, 90s	Date of Test:	7/30/2019
Performed By:	J. Scheetz	Witness:	—

SUBSURFACE INFORMATION

Soil Types & Depths Encountered: 0-0.3': Topsoil; 0.3-2.0': Brown, damp, fine to coarse SAND, little fine to coarse gravel, little silt, 6" cobble @ 1.0'

INFILTRATION TEST HOLE DATA

Depth to Bottom of Test Pit (Design Bottom of SMP): —

Dimensions of Infiltration Hole: Depth: 2.0' Length: — Width: — Diameter: 4"

Presoak Drainage Time: 7/29 @ 13:40 to 7/30 @ 11:41

TEST DATA

Time required for water level to drop 24 inches within 4" diameter PVC pipe or Drop Height after 1 Hour

Run No.	Start	End	Time	Drop Height (inches)
1	11:41	12:41	60 min	9
2	12:41	13:41	60 min	9
3	13:41	14:41	60 min	9
4	14:41	15:41	60 min	9

Remarks: Infiltration Rate Established @ 9 in/hr

C.T. MALE ASSOCIATES

REPORT OF INFILTRATION TEST

Project:	Mahopac Schools	Test No.:	MHS I-1
Client:	TetraTech	Job No.:	19.9414
Weather & Temperature:	Clear, 90s	Date of Test:	7/30/2019
Performed By:	J. Campbell	Witness:	—

SUBSURFACE INFORMATION

Soil Types & Depths Encountered:

INFILTRATION TEST HOLE DATA

Depth to Bottom of Test Pit (Design Bottom of SMP): —

Dimensions of Infiltration Hole: Depth: 2.0' Length: — Width: — Diameter: 4"

Presoak Drainage Time: 7/29 @ 13:55 to 7/30 @ 11:00

TEST DATA

Time required for water level to drop 24 inches within 4" diameter PVC pipe or Drop Height after 1 Hour

Run No.	Start	End	Time	Drop Height (inches)
1	11:00	12:00	60 min	7.75
2	12:00	13:00	60 min	5.75
3	13:00	14:00	60 min	6.0
4	14:00	15:00	60 min	5.25

Remarks: Infiltration Rate Established @ 5.25 in/hr

C.T. MALE ASSOCIATES

REPORT OF INFILTRATION TEST

Project:	Mahopac Schools	Test No.:	MHS I-2
Client:	TetraTech	Job No.:	19.9414
Weather & Temperature:	Clear, 90s	Date of Test:	7/30/2019
Performed By:	J. Campbell	Witness:	—

SUBSURFACE INFORMATION

Soil Types & Depths Encountered: Sandy loam with some gravel

INFILTRATION TEST HOLE DATA

Depth to Bottom of Test Pit (Design Bottom of SMP): —

Dimensions of Infiltration Hole: Depth: 2.0' Length: — Width: — Diameter: 4"

Presoak Drainage Time: 7/29 @ 12:40 to 7/30 @ 10:58

TEST DATA

Time required for water level to drop 24 inches within 4" diameter PVC pipe or Drop Height after 1 Hour

Run No.	Start	End	Time	Drop Height (inches)
1	10:58	11:58	60 min	13
2	11:58	12:58	60 min	9.5
3	12:58	13:58	60 min	10.5
4	13:58	14:58	60 min	10

Remarks: Infiltration Rate Established @ 10 in/hr

C.T. MALE ASSOCIATES

REPORT OF INFILTRATION TEST

Project:	Mahopac Schools	Test No.:	MHS I-3
Client:	TetraTech	Job No.:	19.9414
Weather & Temperature:	Clear, 90s	Date of Test:	7/30/2019
Performed By:	J. Campbell	Witness:	—

SUBSURFACE INFORMATION

Soil Types & Depths Encountered:

INFILTRATION TEST HOLE DATA

Depth to Bottom of Test Pit (Design Bottom of SMP): —

Dimensions of Infiltration Hole: Depth: 2.0' Length: — Width: — Diameter: 4"

Presoak Drainage Time: 7/29 @ 14:25 to 7/30 @ 11:02

TEST DATA

Time required for water level to drop 24 inches within 4" diameter PVC pipe or Drop Height after 1 Hour

Run No.	Start	End	Time	Drop Height (inches)
1	11:02	12:02	60 min	12
2	12:02	13:02	60 min	8.5
3	13:02	14:02	60 min	8
4	14:02	15:02	60 min	7.25

Remarks: Infiltration Rate Established @ 7.25 in/hr

C.T. MALE ASSOCIATES

REPORT OF INFILTRATION TEST

Project:	Mahopac Schools	Test No.:	MHS I-4
Client:	TetraTech	Job No.:	19.9414
Weather & Temperature:	Clear, 90s	Date of Test:	7/30/2019
Performed By:	J. Campbell	Witness:	—

SUBSURFACE INFORMATION

Soil Types & Depths Encountered: Sandy loam with some gravel

INFILTRATION TEST HOLE DATA

Depth to Bottom of Test Pit (Design Bottom of SMP): —

Dimensions of Infiltration Hole: Depth: 2.0' Length: — Width: — Diameter: 4"

Presoak Drainage Time: 7/29 @ 11:45 to 7/30 @ 08:20

TEST DATA

Time required for water level to drop 24 inches within 4" diameter PVC pipe or Drop Height after 1 Hour

Run No.	Start	End	Time	Drop Height (inches)
1	08:20	09:20	60 min	19.5
2	09:20	10:20	60 min	15.25
3	10:20	11:20	60 min	13.25
4	11:20	12:20	60 min	15

Remarks: Infiltration Rate Established @ 14.5 in/hr

C.T. MALE ASSOCIATES

REPORT OF INFILTRATION TEST

Project:	Mahopac Schools	Test No.:	MHS I-5
Client:	TetraTech	Job No.:	19.9414
Weather & Temperature:	Clear, 90s	Date of Test:	7/30/2019
Performed By:	J. Campbell	Witness:	J. Scheetz

SUBSURFACE INFORMATION

Soil Types & Depths Encountered: Sandy loam with some gravel, quartz stone dominant at ~18'

INFILTRATION TEST HOLE DATA

Depth to Bottom of Test Pit (Design Bottom of SMP): —

Dimensions of Infiltration Hole: Depth: 2.0' Length: — Width: — Diameter: 4"

Presoak Drainage Time: 7/29 @ 15:15 to 7/30 @ 15:40

TEST DATA

Time required for water level to drop 24 inches within 4" diameter PVC pipe or Drop Height after 1 Hour

Run No.	Start	End	Time	Drop Height (inches)
1	15:40			
2				
3				
4				

Remarks: Infiltration Rate Established @

Rapid infiltration. 20 gallons added to pipe. Could not achieve 2.0' head. (< 2" above gravel at most and quickly infiltrated)

C.T. MALE ASSOCIATES

REPORT OF INFILTRATION TEST

Project:	Mahopac Schools	Test No.:	MHS I-6
Client:	TetraTech	Job No.:	19.9414
Weather & Temperature:	Clear, 90s	Date of Test:	7/30/2019
Performed By:	J. Campbell	Witness:	—

SUBSURFACE INFORMATION

Soil Types & Depths Encountered: Sandy loam with some gravel

INFILTRATION TEST HOLE DATA

Depth to Bottom of Test Pit (Design Bottom of SMP): 2.0'

Dimensions of Infiltration Hole: Depth: 2.0' Length: — Width: — Diameter: 4"

Presoak Drainage Time: 7/29 @ 11:10 to 7/30 @ 07:55

TEST DATA

Time required for water level to drop 24 inches within 4" diameter PVC pipe or Drop Height after 1 Hour

Run No.	Start	End	Time	Drop Height (inches)
1	07:55	08:55	60 min	0.5
2	08:55	09:55	60 min	0
3	09:55	10:55	60 min	0
4	10:55	11:55	60 min	0

Remarks: Infiltration Rate Established @ 0 in/hr

Hole had ~1" water at bottom at start of test

SECTION 31 23 00 - EXPANDED POLYSTYRENE GEOFOAM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Expanded Polystyrene (EPS) Geofoam.

1.3 REFERENCES

A. ASTM International (ASTM):

1. ASTM D6817 - Standard Specification for Rigid Cellular Polystyrene Geofoam.

1.4 SUBMITTALS, GENERAL

A. Submit all action submittals and informational submittals required by this Section concurrently.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include product data and technical bulletins including materials, profiles, physical properties, and accessories, including:

1. Manufacturing materials and additives.
2. Preparation instructions and recommendations.
3. Installation methods.

B. Shop Drawings: Include the following:

1. Project specific layout plan, profiles and components.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer and installer.
B. Material Test Reports: From a qualified independent agency, submit summary of tests that products comply with specified performance requirements and ASTM D6817.

1.7 CLOSEOUT SUBMITTALS

A. Warranty.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: Minimum 5 years experience manufacturing similar products.
B. Installer Qualifications: Minimum 2 years experience installing similar products of the scope and complexity required for this project.
C. Source Limitation: Obtain geofoam through single source from single manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's ordering instructions and lead time requirements.

B. Deliver products in manufacturer's unopened packaging bearing the brand name and manufacturer's identification until ready for installation.

C. Store and handle materials in accordance with the manufacturer’s instructions to avoid damage.

1. Protect from moisture and sunlight prior to installation.
2. Do not expose to open flame or other ignition sources.
3. Do not expose to organic solvents, petroleum products and their vapors.
4. Provide temporary ballast or other restraint prior to and during installation.

1.10 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

1.11 WARRANTY

A. Warranty: Manufacturer's standard warranty that products will maintain performance values in ASTM D6817.

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

PART 2 - PRODUCTS

2.1 EXPANDED POLYSTYRENE (EPS) GEOFOAM

A. EPS Geofoam: Provide EPS geofoam, structural geotechnical engineering fill blocks, in locations and configurations as shown on the drawings and to meet the following properties:

1. EPS 22, 1.5#, Type II in accordance with ASTM D6817:

    a. Minimum Density: 1.35 pounds per cubic foot.

    b. Compressive Resistance:

        1) At 1% Deformation: Minimum 7.3 psi, 1050 psf.
        2) At 5% Deformation: Minimum 16.7 psi, 2400 psf.
        3) At 10% Deformation: Minimum 19.6 psi, 2820 psf.

    c. Elastic Modulus: 730 psi.

    d. Flexural Strength: 35.0 psi.

    e. Water Absorption, Maximum Total Immersion: 3 percent.

    f. Oxygen Index: 24.0 percent.

    g. Buoyancy Force: 61.1 pounds per cubic foot.

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

1. Insulfoam, A Carlisle Company; Geofoam.
2. Shelter Enterprises, Inc; EPS Geofoam.
3. Thermal Foams Inc; Foam-Control Geofoam.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements to confirm site conditions are within the manufacturer's limits.
B. Proceed with installation only after unsatisfactory conditions have been corrected.
C. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

A. Excavate and prepare subgrade in accordance with the manufacturer's instructions and project documents.
B. Verify engineered depths, product thicknesses, and other conditions which would affect installation.
C. Examine geofoam prior to installation. Reject materials that have been damaged and replace.
D. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install in accordance with the manufacturer's current published instructions, and details and drawings issued for the project.

   1. Conflicts between the manufacturer instructions and project documents shall be resolved in writing prior to construction.

3.4 PROTECTION

A. Protect installed products and surface finishes from damage during construction
B. Remove and legally dispose of construction debris from project site.

END OF SECTION 31 23 00

SECTION 31 25 00 - EROSION AND SEDIMENTATION CONTROLS (SPDES)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Erosion, sediment and pollution controls as shown on the Drawings and as directed by the Engineer (qualified professional) to significantly reduce runoff on downstream properties. This includes temporary control measures to mitigate land disruption by other contractors during construction of this project.

    a. Qualified Professional: Is a licensed professional engineer, a registered landscape architect, or a certified professional in erosion and sediment control.

2. Erosion, sediment and pollution control includes, but is not limited to, the following:

    a. Standard control measures such as storm structure protection, silt fence, silt fence dikes, and rip rap.
    b. Off site sediment tracking controls.
    c. Sedimentation basin.
    d. Seeding, sodding and erosion control fabric.
    e. Rock check dam, sediment trap and detention basin with weir.
    f. Temporary protection for existing vegetation.
    g. Clean up.

3. Comply with the Stormwater Pollution Prevention Plan (SWPPP) for this Project in consultation with appropriate local agencies and soil conservation service. *Any local or State Agency requirements are considered part of these specifications.*

B. Related Sections

1. Section 31 10 00 – Site Clearing
2. Section 31 20 00 – Earth Moving
3. Section 32 12 16 – Asphalt Paving
4. Section 32 92 00 – Turf and Grasses
5. Section 33 41 00 – Storm Utility Drainage Piping

1.3 CODE COMPLIANCE

A. The New York State Department of Environmental Conservation (NYSDEC) requires a SPDES General Permit for Storm Water Discharges from Construction Activity that disturbs one (1) acre of land or more. This Permit GP-0-20-001 is pursuant to the Environmental Conservation Law and has penalties and fines related to violations.

1.4 SUBMITTALS, GENERAL

A. General: Submit all action submittals and informational submittals required by this section concurrently.

1.5 ACTION SUBMITTALS

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

1. Filter fabric and hardware cloth for storm structure protection.
2. Silt fence and silt fence dikes.
3. Stakes.
4. Erosion control blanket.
5. Turf reinforcement matting.
6. Bonded fiber matrix.
7. Soil stabilization fabric for off-site sediment tracking control.
8. Channel drain inlet filter matting
9. Drop-In Inlet Protection.
10. Erosion Control Fiber Roll

B. Material Certificates: Materials certificates showing content/mechanical analysis are required for the following products. Also, provide samples as noted.

1. Granular Backfill: Sample.
2. Granular Base Course Material: Sample.
3. Seeding & Sodding.
4. Rip Rap.
5. No. 4 stone for off-site sediment tracking control.
6. 4,000 psi concrete.

1.6 INFORMATIONAL SUBMITTALS

A. Quality Control Submittals

1. Qualifications Certification: Submit written certification or similar documentation signed by applicable subcontractor, Contractor and manufacturer (where applicable) indicating compliance with applicable “Qualifications” requirements specified below in “Quality Assurance” article.

2. Installer Experience Listing: Submit list of completed projects using products proposed for this Project, including owner's contact and telephone number for each project, demonstrating compliance with applicable "Qualifications" requirements specified below in "Quality Assurance" article.

B. Certification Statement: Submit photocopy of Certification Statement filled out completely and accurately to the Architect. Construction activities shall not begin prior to submitting certification statement. *Certification Statement Form attached to the end of this Section*.

C. Trained Contractor Qualifications: Submit documents identifying the designated Trained Contractor (required by SPDES Permit) and proof of their successful completion of a NYSDEC endorsed 4 hr Training Course within the last three (3) years.

1.7 QUALITY ASSURANCE

A. Perform erosion, sediment and pollution control in compliance with the Contract Documents and applicable requirements of the New York Standards and Specifications Erosion and Sediment Control and other governing authorities having jurisdiction.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Handle and store products according to manufacturer's written instructions.

1.9 NOTICES

A. The Owner will file with the NYSDEC a Notice of Intent (NOI) a minimum of five (5) days prior to start of construction. Unless notified by the NYSDEC to the contrary within five (5) days, a General SPDES Construction Permit is automatically issued which authorizes discharge of storm water on the construction site.

B. Pre-Construction Conference: Within seven days of start of construction, attend Civil/Structural Preconstruction Meeting. Representatives of all Contractors responsible for earthwork operations are required to attend.

C. Each Contractor responsible for soil disturbances shall identify at least one person from their company that will be responsible for implementation of the SWPPP. This person shall be known as the *Trained Contractor.* Each Contractor shall ensure that at least one *Trained Contractor* is on site on a daily basis when soil disturbance activities are being performed.

D. When the site has been finally stabilized, Contractor shall notify the Architect, in writing, that a final inspection be performed. Upon satisfactory completion of this inspection, the Owner will file with the NYSDEC a Notice of Termination (N.O.T.).

E. The Owner is responsible for payment of annual fees related to the SPDES permit. Filing of a NOT shall typically terminate the Owner's fee responsibility.

F. Pay any fines issued by any agency as a result of non-compliance with the SWPPP or SESC Plans.

G. Duty to Comply: The Owner must comply with all conditions of the SPDES General Permit. All contractors and subcontractors associated with the Project must comply with the terms of the SWPPP. Any non-compliance with the permit constitutes a violation of the Clean Water Act (CWA) and the Environmental Conservation Law (ECL) and is grounds for enforcement action against the Owner and/or the contractor/subcontractor; permit revocation, suspension or modification; or denial of a permit renewal application. Upon a finding of significant non-compliance with the permit or the applicable SWPPP, the DEC may order an immediate stop work to all construction activity at the site until the non-compliance is remedied.

1.10 INSPECTIONS AND MAINTENANCE

A. When construction activities are on-going, the Licensed Professional Engineer, Registered Landscape Architect, Certified Professional in Erosion and Sediment Control, or qualified personnel of the Owner shall review disturbed areas of the construction site at least once every seven (7) calendar days. For construction sites where soil disturbance activities have been temporarily suspended (e.g. winter shutdown) and temporary stabilization measures have been applied to all disturbed areas, the qualified inspector shall conduct a site inspection at least once every thirty (30) calendar days. Reviews shall include, but not be limited to discussion of schedule, observation of areas not finally stabilized, effectiveness of control measures, corrective measures and violations. Special attention will be focused on areas not finally stabilized, structural control measures, and locations where vehicles enter or exit the site. Disturbed areas will be inspected for pollutants entering the drainage system. Structural control measures will be reviewed for effectiveness in preventing significant impacts to receiving waters. Locations where vehicles enter or exit the site will be inspected for evidence of off site sediment tracking. A written report of construction reviews shall be produced during construction operations.

B. Provide timely maintenance of vegetation erosion and sediment control measures, and other protective measures, during construction. Keep a written record of maintenance and corrective work in a journal. The journal shall be added to the on site SWPPP.

C. Maintain a field copy of the General Permit, NOI, NOI Acknowledgement Letter, SWPPP, inspection reports, and erosion control maintenance logs at the construction site until all disturbed areas have achieved final stabilization and the NOT has been submitted to the DEC. The documents must be maintained in a secure location, such as a job trailer, on-site construction office, or mailbox with lock. The secure location must be accessible during normal business hours to a representative of the Owner, Engineer, and NYSDEC.

D. Perform corrective measures within three (3) calendar days of the Engineer's or Owner's report at no cost to the Owner. Failure by the Contractor to perform corrective work within this schedule automatically authorizes the Owner to hire others and deduct from the Contract Sum the costs incurred by the Owner for the performance of this Work.

E. The Owner shall provide long term maintenance of the storm water facilities after Notice of Termination has been issued. The designated maintenance personnel shall keep written records of maintenance and corrective work in a journal. The journal shall be added to the on site SWPPP.

F. *The Owner* shall retain a copy of the NOI, NOI Acknowledgment Letter, SWPPP, MS4 SWPPP Acceptance Form, NOT, and any inspection reports that were prepared in conjunction with this permit for a period of at least five (5) years from the date that the site achieves final stabilization.

PART 2 - PRODUCTS

2.1 STORM SEWER PROTECTION

A. 1/2-inch mesh hardware cloth covered with a polypropylene silt fence fabric.

2.2 SILT FENCE

A. Meet the following criteria unless specific type is shown on plans or Architect accepts the change in criteria.

1. Silt Fence: Polypropylene filter fabric supported by non-pressure treated hardwood posts meeting the following requirements.

Property	Unit	Test Method	Value
Grab Tensile Strength (Machine Direction)	lbs	ASTM D 4632	124 min
Grab Tensile Strength (Cross-Machine Direction)	lbs	ASTM D 4632	124 min
Grab Tensile Elongation	%	ASTM D 4632	15 / 15
Trapezoid Tear Strength	lbs	ASTM D 4533	65 min
Mullen Burst Strength	psi	ASTM D 3786	300 min
Puncture Strength	lbs	ASTM D 4833	60
Ultraviolet Stability (Strength Retained)	%	ASTM D 4355	70
Apparent Opening Size (AOS)	U.S. Sieve	ASTM D 4751	30
Permittivity	sec^{1}	ASTM D 4491	0.10
Coeff of Permeability	CM/Sec	ASTM D 4491	0.005 min
Water Flow Rate	$gal/min/ft^2$	ASTM D 4491	25 min

2. Basis of Design Product: Subject to compliance with requirements provide Tencate Geosynthetics Mirafi 100X fabric or comparable product.

3. Reinforced fence: Fabric backed with 14-1/2 gauge by 6-inch square mesh woven wire. See plans and details for specific locations or requirements.

B. 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. DGI Industries.
2. Hanes Geo Components.
3. TenCate Geosynthetics (Mirafi).

2.3 STAKES

A. One of the following:

1. 2-inch by 2-inch nominal by 4-feet long, non-pressure treated hardwood.
2. #4 rebar, 4-feet long min.

B. Maximum post spacing permitted shall be: 8-ft 4-in O.C.

2.4 STONE FILTERS

A. Size shown on the plans meeting the requirements of ASTM C33 or State specifications where applicable.

2.5 PERMANENT SEEDING AND SODDING

A. Refer to applicable section.

2.6 TEMPORARY SEEDING (unless otherwise shown on Drawings):

A. Minimum requirements:

1. Lime: 1/2 ton per acre.
2. Fertilizer: Commercial 5-10-10 or equivalent (600 lbs per acre).
3. Seed: Ryegrass (annual or perennial) (40 lbs. per acre).
4. Mulch: Straw at 2 ton per acre.

2.7 EROSION CONTROL BLANKETS

A. On Slopes 3:1 and Flatter – Netless Biodegradable Blanket: 100% biodegradable stitched excelsior erosion control matting. (Netted erosion control fabric on slopes 3:1 and flatter is not allowed.)

1. Material Characteristics:

a. Soil loss ratio: .063
b. Fiber Size: 80% of fibers min. of 6 inches long
c. Weight: 0.73 lb per square yard.
Channel Flows: Suitable for channel flows up to 3.0 ft./second and 1.0 lb/ft. shear stress.

2. Staples: Use manufacturer provided staples.

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

a. "Curlex NetFree" Erosion Control Blanket manufactured by North American Green.

B. On Slopes Steeper than 3:1 up to 1.5:1 – 100% biodegradable excelsior erosion control matting with polypropylene netting containing a UV degrader additive.

1. Material Characteristics:

a. Fiber Count: 7,000 per square yard.
b. Fiber length: 80% of fibers min. of 6" long
c. Net Openings: 1.0 inch x 2 inches
d. Thickness: 0.411 inch per ASTM D 6525
e. Swell: 49% per ECTC Procedure
f. MD-Tensile Strength Max.: 74.4 lb./ft. per ASTM D 6818
g. TD-Tensile Strength Max.: 36.0 lb./ft. per ASTM D 6818

2. Staples: Use manufacturer provided staples.

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

a. "Curlex I QuickMow" Erosion Control Blanket manufactured by North American Green.

2.8 TURF REINFORCEMENT MATTING

A. Permanent erosion control/turf reinforcement mat constructed of a matrix of polypropylene monofilament yarns woven into uniform configuration of resilient pyramid-like projections.

1. Material Properties:

Property	Test Method	Units	Property Requirement
Thickness	ASTM D-6525	mm (in)	10.2 (0.40)
Resiliency	ASTM D-6524	percent	80
Mass Per Unit Area	ASTM D-6566	G/sq m (oz/sy)	455 (13.5)
Tensile Strength	ASTM D-6818	kN/m (lbs/ft)	58.4 x 43.8 (4,000 x 3,000)
Tensile Elongation	ASTM D-6818	percent	65 (max)
Light Penetration (% Passing)	ASTM D-6567	percent	10
UV Resistance	ASTM D-4355	percent	90 at 6000 hrs

2. Performance Properties: In a vegetated state, the RECP must demonstrate acceptable performance (as defined by the Engineer) when subjected to at least 0.5 hrs of continuous flow producing the following conditions:

   a. Permissible velocity: 7.6 m/sec (25 ft/sec)
   b. Permissible tractive force (shear stress): 0.718 kPa (15 psf)

3. Color: Green.

4. Basis of Design Product: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Pyramat Geotextile System by Propex, Inc.

2.9 BONDED FIBER MATRIX

A. Hydraulically applied continuous layer of biodegradable elongated fiber strands held together by a water-resistant bonding agent with no holes greater than one millimeter in size.

B. Physical Components:

1. Ingredients/Composition:

   a. Gypsum-based, soil beneficial binder
   b. Cellulosic fiber mulch (paper/soft wood)
   c. Plant-based tackifiers (short-term binding agents)
   d. Nonpetroleum-based polymers (long-term binding agents)
   e. Surfactant
   f. Water-holding polyacrylmides (PAM)

C. Physical Properties:

1. Moisture: 10% (+/- 2%)
2. pH: 5.5 – 6.5
3. Mix: 70lbs (+/-10 lbs.) per 100 gallons of water (Recommended)
4. Color: Green
5. Wood/Cellulose Fiber: 70% / 30%
6. Water Holding ASTM D 7367-07: 850-950%
7. Water Holding ASTM Modified Method: 1200 – 1400%

D. 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. “Enviro-Shield” Brand Bonded Fiber Matrix by USG.
2. “Flexterra” by Profile Products, LLC.

2.10 STABILIZED CONSTRUCTION ENTRANCE

A. No. 4 stone meeting the following requirements:

Standard ASTM Sieve Size	Percent Passing by Weight
4 inch	100
3 inch	90-100
2 inch	0-15
Passing No. 50	5-10
Passing No. 100	2-5

B. Soil Stabilization Fabric:

1. Stabilization Fabric: A commercially manufactured, UV stabilized low clogging, high flow, woven geotextile meeting the following requirements.

Property	Unit	Test Method	Value
Grab Strength	lbs	ASTMD-4632	315 min
Tensile Strength	lbs/in	ASTMD-4595	175 min
Grab Elongation	%	ASTMD-4632	15 max
Trapezoid Tear	lbs	ASTMD-4533	120 min
Mullen Burst	psi	ASTMD-3786	600 min
Permittivity	/Sec	ASTMD-4491	.05min
Water Flow Rate	gal/min/ft^2	ASTMD-4491	4 min

2. Basis of Design Product: Subject to compliance with requirements, provide TenCate Geosynthetics, Mirafi 600X fabric or comparable product.

3. 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. DGI Industries.
   b. Hanes Geo Components.
   c. TenCate Geosynthetics (Mirafi).

C. Granular Base Course Material: Shall be as specified in Earth Moving Section.

2.11 TEMPORARY TREE PROTECTION

A. Stakes: 2 inch by 4 inch x 6 foot (min) non-pressure treated hardwood.

B. Top Rail: 2 inch by 4 inch x 8 foot (max) non-pressure treated hardwood fastened to stakes by nails or screws.

C. Fabric:

1. Heavy duty orange construction barrier fencing.
2. Basis of Design Product: Subject to compliance with requirements, provide Tenax Corporation "Sentry HD" fencing or comparable product.
3. Fabric shall be attached to the stakes and top rails with staples or other fasteners.

2.12 OUTLET SEDIMENTATION TRAP

A. Outlet Sedimentation Trap: Constructed of 12 inch pipe, AASHTO M294-Type S or SP corrugated HDPE N-12 pipe and stone as shown in the Drawings. Filter fabric shall be as specified for siltation fence. Hardware cloth shall be ½ inch mesh. Concrete shall be 4,000 psi.

2.13 CONCRETE WASHOUT

A. Provide concrete washout as specified.

2.14 ROCK CHECK DAMS AND SEDIMENT TRAPS

A. Provide stone rip rap as specified. Vegetation shall be as described on the Drawings.

2.15 CHANNEL DRAIN INLET FILTER MATTING:

A. Latex bonded coir (coconut) fiber matting, 4.0 Ounces per Square-Foot, 1-1/2" thickness.

B. Basis-of-Design product and standard of quality for channel drain inlet filter matting for use in existing and proposed channel drains shall be Natural Fiber Inlet Filter Matting, Item #IF1527X75FTB, by Blocksom & Co., Michigan City, Indiana. Telephone: 800-745-1408. Web: www.blocksom.com

C. Physical Properties: (4-inch wide strip specimen)

1. Fiber Material

   a. Latex bonded coir (coconut) fiber matting
   b. Nominal 4.0 ounces / square-foot, 1½" thickness.

2. Sediment Control per ASTM D 5141

   a. Test Material: Sand sieved through No. 10 sieve
   b. Efficiency: 59.1%
   c. Minimum flow rate: 150 liters/minute

3. Tensile Properties per ASTM D 5035/ECTC

   a. MD – Maximum Load: 14.6 ppi
   b. TD – Maximum Load: 18.7 ppi

c. MD – Elongation at Max Load: 19.3%
d. TD – Elongation at Max Load: 27.7%

4. UV Resistance per ASTM D 4355 – 500 hr exposure

a. MD – Maximum Load: 10.2 ppi
b. TD – Maximum Load: 13.8 ppi
c. MD – Elongation at Max Load: 16.9%
d. TD – Elongation at Max Load: 16.6%

5. Smolder Resistance (ECTC)

a. Maximum Burn Distance: 0.29 in

6. Light Penetration (ECTC Guidelines)

a. Baseline Reading: 125
b. Reading with Sample: 10
c. Percentage Light Penetration: < 8%

7. Resiliency per ASTM D 6524

a. Pre-Loading Thickness: 1943 mils
b. Post-Loading Thickness: 326 mils
c. Percentage Change: -83%

8. Swell (ECTC)

a. Dry Thickness: 1984 mils
b. Thickness after Soak: 2098 mils
c. Percentage Change: 6%

9. Water Absorption per ASTM D 1117/ECTC

a. Pre-Soak Weight: 69 grams
b. Post-Soak Weight: 152 grams
c. Weight Change: 82 grams
d. Percentage Weight Change: 119%

10. Mass/Unit Area per ASTM D 6565

a. Mass/unit area: 50.89 oz/sq yd
b. Mass/unit area: 1725 g/sq meter

11. Filter Mat Filter Cable Ties

a. Heavy duty “zip” cable ties provided by filter manufacturer and designed specifically for inlet filter product, and in quantity required for manufacturer recommended installation method.

2.16 DROP-IN INLET PROTECTION

A. Standard of quality for aftermarket inlet protection for use in existing and proposed catch basin, drop inlets, curb box inlets and storm manholes shall be Flexstorm Inlet Filters, by Inlet and Pipe Protection, Inc., Naperville, Illinois.

1. Description of System:

a. An aftermarket drop-in inlet filter system designed to collect silt and sediment from surface storm water runoff at drainage locations shown on the plans, at existing inlets in pavement where adjacent disturbance will allow sediment runoff to occur, in areas where access to the site dictates their use due to phasing issues, or as directed by the Engineer.

b. An aftermarket drop-in inlet filter system comprised of a corrosion resistant steel frame and a replaceable geotextile sediment bag attached to the frame with a stainless steel locking band. The sediment bag hangs suspended from the rigid frame at a distance below the grate that shall allow full water flow into the drainage structure if the bag is completely filled with sediment.

c. The aftermarket drop-in inlet filter frame includes lifting handles in addition to the standard overflow feature. A proprietary Removal Tool engages the lifting bars or handles to allow manual removal of the assembly without machine assistance. The frame suspension system is adjustable in ½" increments up to 5" per side on rectangular designs should the casting or drainage structure have imperfections.

d. Standard woven polypropylene sediment bags with a typical flow rate of 200 gpm / sq ft.

2. Woven Sediment Bag Material Specifications:

		MARV[2]	
PROPERTY	TEST METHOD	ENGLISH	METRIC
Mechanical			
Tensile Strength (Grab)	ASTM D-4632	255 x 275 lbs	1130 x 1220 N
Elongation	ASTM D-4632	20 x 15 %	20 x 15 %
Puncture	ASTM D-4833	135 lbs	600 N
Mullen Burst	ASTM D-3786	420 psi	2890 kPa
Trapezoidal Tear	ASTM D-4533	40 x 50 lbs	175 x 220 N
Endurance			
UV Resistance	ASTM D-4355	90%	90%
Hydraulic			
Apparent Opening Size (AOS)[3]	ASTM D-4751	20 US Std. Sieve	0.850 mm
Percent Open Area (POA)	CW-02215 Mod.[4]	20%	20%
Permittivity	ASTM D-4491	1.50 sec^{-1}	1.50 sec^{-1}
Water Flow Rate	ASTM D-4491	200 gpm/ft^2	8,145 $l/min/m^2$

3. Tested Filtration Efficiency:

a. All testing performed in general accordance with the ASTM D 7351, *Standard Test Method For Determination of Sediment Retention Device Effectiveness in Sheet Flow Application*, with flow diverted into an area inlet. Test Soil used as sediment had the following characteristics with a nominal 7% sediment to water concentration mix:

Soil Characteristics	Test Method	Value
% Gravel	ASTM D 422	2
% Sand		60
% Silt		24
% Clay		14
Liquid Limit, %	ASTM D 4318	34
Plasticity Index, %		9
Soil Classification	USDA	Sandy Loam
Soil Classification	USCS	Silty Sand (SM)

Tested Efficiencies:

Property	Woven Sediment Bag
Filtration Efficiency	82%

2.17 EROSION CONTROL FIBER ROLL

A. Erosion control coir log natural fiber product designed to provide soil stabilization and support along river banks, slopes, steams, hillsides, and other erosion prone areas, with densely packed mattress coir fibers that are placed inside a tubular coir twine netting, with environmentally / wildlife sensitive natural and biodegradable components.

B. Physical Components:

1. Ingredients/Composition:

a. Interior: Coir mattress fiber
b. Exterior: Coir twine
c. Diameter: 12”
d. Weight: 5.5 lbs./ft.
e. Density: 7 lbs./ft^3.
f. Length: 10’ (For longer length, logs may be daisy-chained with coir fiber twine)
g. Outer Net: 80 lbs., 3-ply coir.
h. Net Opening: 2”x2” tubular design
i. Design life-span: Biodegrades over 2-5 yrs.

2. Hardwood wooden stakes

   a. Size: 1.5” x 1.5” nominal
   b. Length: 42” min.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which soil erosion and sediment control is to be installed notify Architect in writing of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

B. Beginning installation constitutes Contractor’s acceptance of conditions.

3.2 SIGNATURE REQUIREMENTS

A. Between the Pre-Construction Meeting and starting site work:

1. Sign the certification statements. Prominently display the statements at the job site.

2. Review inspection and maintenance procedures. Decide where SWPPP will be temporarily stored for review by NYSDEC, Owner and Architect.

3. Designate specific Owner and Contractor personnel responsible for inspection and maintenance.

4. Prior to the start of construction, submit schedule for completion of installation of measures identified in SESC Plan and SWPPP. DO NOT BEGIN EARTHWORK OPERATIONS AT SITE UNTIL MEASURES IDENTIFIED IN SESC PLAN AND SWPPP HAVE BEEN ACCEPTED BY ARCHITECT AND INSTALLED AT SITE.

5. When conditions change during construction, submit revisions to the SWPPP to Owner, the Architect and other agencies identified in the SPDES permit and the SWPPP.

3.3 GENERAL EROSION CONTROL

A. Provide initial construction erosion control features, shown in the SWPPP and as indicated on Drawings and Specifications or as directed by the Architect, prior to disturbing the site with such construction operations as clearing and grubbing, topsoil stripping, earthwork, trenching excavation and removal of existing vegetation. Keep the disturbance to a minimum. Install other features as described in the sequence of erosion, sediment and pollution control on the drawings.

B. Minimize amount of bare soil exposed at one time. Do not disturb five (5) or more acres at one time. Disturbance of five (5) acres or more at one time requires the Contractor to obtain prior written permission from the NYSDEC to vary from the requirement of SPDES Permit GP-0-15-002. Provide written copy of approval from NYSDEC to the Owner and the Architect. Start permanent seeding within seven (7) calendar days of rough grading. When this is not possible, provide temporary seeding of perennial rye grass at the rate of three pounds seed per one thousand square feet. Provide temporary seeding within seven (7) days on non-roof, non-paved areas. When adverse weather conditions prevent good germination, repeat seeding as directed by the Architect until the area is stabilized. Till under temporary grass and fine grade when preparing for final seeding.

C. Until a disturbed area is stabilized, trap runoff sediment by the use of debris basins, sediment basins, silt traps, or other methods acceptable to the Engineer and governing authorities. Construct sediment basins to dimensions shown on plans.

D. Place sediment structures and or devices in accordance with dimensions shown on Drawings. If sediment structures and or devices become plugged or partially plugged, remove and replace. Cleaning of the sediment structures and or devices will only be allowed when method is reviewed by Engineer or Owner Representative and found acceptable.

E. Provide erosion controls on slopes and swales traversing, bordering, or leaving the site. Limit the water flow to a non-erosive velocity.

F. Do not store fill materials within fifty feet of the banks of any streams or water bodies, intermittent or perennial.

G. Provide temporary protection for trees and shrubs as outlined and shown on drawings and described in this Section.

H. Inspect erosion and sediment control measures immediately after each rainfall and at least daily during prolonged rainfall. Make required repairs immediately.

I. Remove sediment deposits before they reach one-half of the height of the total height of the installed sediment structure or device. Dispose sediment in a manner that does not result in additional erosion or pollution.

J. Provide prompt removal and disposal of rubbish and debris in accordance with the governing authorities.

K. Provide temporary grading of drainage channels, slopes, or fills in accordance with Section 31 20 00 “Earth Moving”.

L. Coordinate temporary erosion and sediment control measures with permanent erosion control features specified elsewhere in the Contract Documents to the maximum extent possible to assure economical, effective, and continuous erosion, sediment and pollution control.

M. Provide temporary and permanent dust controls on driving areas such as roads, bus loops, parking lots, haul roads and access points, as well as non-driving areas such as lawns and athletic fields and any other disturbed areas where damage, health hazards or traffic safety problems may occur if dust is not controlled.

N. Temporary measures are to be removed on upon final stabilization, prior to the issuance of the Notice of Termination.

3.4 MUNICIPAL SEWER AND WETLAND EROSION CONTROL

A. Control erosion, siltation and pollution to municipal sewers, water bodies and wetlands by taking appropriate measures such as, but not limited to, the following:

1. Prevent petroleum products and excessive amounts of silt, clay, and muck from entering municipal sewers, waters or wetlands of New York State during construction.

2. Prevent fresh concrete, concrete leachate and washings from equipment and trucks, from entering municipal sewers, waters or wetlands of New York State during construction.

3. Place silt fence to control erosion at the down slope edge of disturbed areas. Place this barrier to sediments before disturbance of the ground occurs and maintain in good condition until disturbed land is heavily vegetated or otherwise permanently stabilized.

4. Seed areas of soil disturbance resulting from this Project with appropriate perennial grass seed and mulched with straw within seven calendar days as described in general erosion control. Maintain mulch until a suitable vegetative ground cover is established.

3.5 STORM STRUCTURE PROTECTION

A. As shown on the Stormwater Pollution Prevention Plan (SWPPP) and the Soil Erosion and Sediment Control Plans (SESC), provide storm structure protection at each inlet as shown on the detail plan. Clean storm structure protection material after each storm event to permit the fabric and/or drainage stone to work effectively. Remove the drainage material when the site is stabilized and certified by the Architect and/or qualified personnel of the Owner.

3.6 SILT FENCE/STRAW BALE DIKES

A. Locate in accordance with plans and details and as directed by the Architect. Excavate trench along the lower perimeter(s) of site, along the contract limit line, and as indicated on the Drawings. The placement of silt fence and/or bales shall consider drainage paths and intercept drainage prior to leaving site or entering storm system. Place excavated material on uphill side of trench for backfilling.

B. Drive stakes securely into the downhill side of the trench. When prefabricated silt fence with fabric attached to stakes is used, drive stakes so that fabric is buried in the ground as detailed.

C. Backfill trench with excavated material, so that fabric is securely buried in the ground to prevent undermining. Tamp soil.

D. Join sections by overlapping fabric between two stakes. Set stakes simultaneously. Overlap by minimum six inches, fold, and staple to prevent sediment bypass.

E. Attach silt fence securely to stakes spaced no more than eight feet on center. Secure fence fabric to stake with minimum three one inch staples.

F. Provide silt fence dikes perpendicular to swale center lines in swales one and one half percent and steeper. Locate dikes at a maximum interval of fifty feet on center unless otherwise shown on drawings.

G. Removal of silt and replacement of silt fence and/or bales shall be on going throughout the duration of the project to maintain an effective silt removing barrier.

3.7 TEMPORARY SEEDING

A. When necessary, provide temporary seeding as described in this Section.

B. Seedbed Preparation:

1. Scarify soil if compacted.
2. Remove debris and obstacles such as rocks and stumps.
3. Apply lime and fertilizer.
4. Apply seed uniformly by mechanical seeder or hydroseeder.
5. Apply straw mulch.

C. Provide permanent seeding as described elsewhere in the Contract Documents.

3.8 EROSION CONTROL MAT

A. Install where indicated on Drawings. Install in accordance with manufacturers' recommendations and design details, including number and location of staples.

3.9 TURF REINFORCMENT MATTING

A. Install where indicated on Drawings. Install in accordance with manufacturers' recommendations and design details, including number and location of staples.

3.10 BONDED FIBER MATRIX

A. Hydraulically install bonded fiber matrix in strict accordance with manufacturer's installation instructions at the maximum rate given.

B. Typical Application Rates:

1. <3:1 Slope: 3,000 lbs./acre
2. 3:1 < 2:1 Slope: 3,500 lbs./acre
3. >2:1 Slope: 4,000 lbs./acre

C. Limitations: Do not use this product in the following conditions. Notify Architect if these conditions exist.

1. Concentrated overland water flow.
2. On soils that display deep-seated instabilities.
3. Where soil compaction problems exist or on soils that are subjected to frost heave and/or surface peeling (loosening of top layer of soil).

D. Store and handle material per manufacturer's requirements.

3.11 OFFSITE SEDIMENT TRACKING CONTROLS

A. Install as detailed and shown on Drawings to eliminate tracking sediment off site. Inspect after each rain storm and at least one time per week. When sediment begins tracking off site, immediately replace stone with clean No. 4 stone to retain sediment on site. Remove fabric and stone at project completion. Complete construction of proposed final surface(s).

B. Provide wash down areas stabilized with stone that drain into Engineer approved sediment trapping device. Do not flush into water bodies, wetlands, on site or municipal systems.

3.12 CONCRETE WASHOUT

A. Materials in or destined for the washout area shall not contact the ground, nor shall water or other liquid discharge from the containment structure.

B. Locate washout area a minimum of 50-ft from open channels, storm drain inlets, wetlands or water bodies.

C. Locate washout area so that it is accessible to concrete equipment (served with a minimum 10-ft wide gravel accessway).

D. Minimum dimensions:

1. For pre-fabricated units are 4-ft by 4-ft by 1-ft deep with a minimum 4-mil polyethylene plastic liner.

2. For constructed concrete washout areas are 6-ft by 6-ft by 3-ft deep, with a minimum 10-mil polyethylene liner, 2H:1V side slopes, and a 1-ft high by 1-ft wide compacted fill berm.

E. The liner must be free of tears or holes and placed over smooth surfaces to prevent puncturing. For excavated washouts, anchor the liner underneath the berm or overtop with sandbags or concrete blocks to hold in place.

F. Provide a sign designating the washout area, and for large construction sides, provide signs throughout directing traffic to its location.

G. Allow washed out concrete mixture to harden through evaporation of the wastewater. Once the facility has reached 75 percent of its capacity, remove the hardened concrete by disposing offsite.

H. Apply a new liner before reusing the station for additional washouts after maintenance has occurred.

3.13 OUTLET SEDIMENTATION TRAP

A. Install as detailed. Remove temporary trap and install permanent end section per detail near end of project when directed by the Architect.

3.14 ROCK CHECK DAMS AND SEDIMENT TRAPS

A. Install rip rap and vegetation as detailed on the Drawings and described elsewhere in the Contract Documents.

3.15 CHANNEL DRAIN INLET FILTER MATTING

A. Install channel drain inlet matting per manufacturer's installation requirements.

B. Cut matting if necessary to allow minimum 3" overlap at each side of the grate. Attach the mat to the topside of the inlet grate using cable ties.

C. Clean silt from around channel inlet matting following each rain event and as required by the Soil Erosion and Sediment Control plans and specifications, and as dictated by the Storm Water Pollution and Prevention Plan (SWPPP). Sweep the top of mat to clear built-up silt and solids, and dispose of. Do NOT allow accumulated sediment to enter the inlet.

3.16 DROP-IN INLET PROTECTION

A. Install channel drain / inlet drain filter matting per manufacturer's installation requirements.

B. Clean silt from filter bag following each rain event and as required by the Storm Water Pollution and Prevention Plan (SWPPP). Do NOT allow accumulated sediment to enter the inlet.

C. The Contractor cannot pierce, cut, remove inlet filter bag to allow discharge of turbid water to the drainage system.

3.17 EROSION CONTROL FIBER ROLL

A. Install fiber roll as indicated and per manufacturer requirements:

1. Clear the installation area of any debris, trees, rocks or large obstructions. Coir logs are designed to come in contact with the soil, so any stumps or potential obstructions must be removed.

2. Dig a trench in the location where the coir logs need to be placed, 1/3 to 1/2 depth of coir log.

3. Place the coir logs in the trench and backfill with soil so that the coir logs are tightly packed against the slope. Adjacent coir logs should be positioned so that the ends fit tightly against each other. Ends should be joined/secured together with coir twine or other suitable ties. Mattress coir fiber may be used to fill spacing between log ends.

4. Stake/anchor the coir logs into position. Coir logs should be anchored according to site requirements or specifications. Typical anchoring shall be 30" minimum anchor height with 3' minimum spacing.

3.18 TREE PROTECTION

A. Temporary Protection for Trees and Shrubs:

1. Provide temporary fencing, barricades or guards as required to protect trees and other plants, which are to remain, from above ground damage.

2. Protect root system from smothering. Do not store construction materials, debris, or excavated material within drip line (outer perimeter of branches). Do not permit vehicular traffic or parking within drip line. Restrict foot traffic to prevent excessive compaction of soil over root systems.

3. Should any trees or shrubs be damaged which are to be saved, arrange to have such damage treated by a licensed arborist or tree surgeon.

4. Trees or shrubs which die because of the Contractor's failure to conform to the Drawings and specifications shall be evaluated by a qualified organization selected by the Owner's Representative. The removal and replacement of the tree, and the evaluation expenses shall be paid for by the Contractor. Contractor shall be required to replace the damaged tree with plant material of comparable size and quality (i.e. damaged 12 inch caliper Red Maple shall be replaced by three 4 inch cal. or four 3 inch cal. Red Maples). Substitutions for variety shall be approved by the Architect

3.19 CLEANING

A. During the Contract and at intervals as directed by the Engineer and as erosion, sediment and pollution control procedures are completed, clear the site of extraneous materials, rubbish, and debris. Leave the site in a clean, safe, well draining, and neat condition.

B. Clean storm ponding areas, catch basins, detention basins, and other buried structures. Clean out contaminants, sediment, rubbish, construction debris, foreign objects and accumulated floatables from chambers and ponding areas thoroughly, immediately prior to final acceptance.

END OF SECTION 31 25 00

Attachment: Certification Statement

CERTIFICATION STATEMENT

Authorized, legally responsible signatures for the General Contractor, Site Earthwork, and Landscaping Subcontractor(s) shall sign and prominently display the following certification statement at the job trailer or office during the life of the project:

"I hereby certify under penalty of law that I understand and agree to comply with the terms and conditions of the Storm Water Pollution Prevention Plan (SWPPP) and agree to implement any corrective actions identified by the qualified inspector during a site inspection. I also understand that the operator (person, persons, or legal entity which owns or leases the property on which the construction activity occurs) must comply with the terms and conditions of the most current version of the New York State Pollutant Discharge Elimination System ("SPDES") General Permit for storm water discharges from construction activities and that it is unlawful for any person to cause or contribute to a violation of water quality standards. Furthermore, I understand that certifying false, incorrect, or inaccurate information is a violation of the referenced permit and the laws of the State of New York and could subject me to criminal, civil, and/or administrative proceedings. "

1. General Contractor

Signature: _____
Name: _____
Company: _____
Title: _____
Address: _____
_____
Phone No.: _____
Fax No.: _____
E-Mail: _____

2. Site Earthwork Contractor

Signature: _____
Name: _____
Company: _____
Title: _____
Address: _____
_____
Phone No.: _____
Fax No.: _____
E-Mail: _____

3. Site Landscape Contractor

Signature: _____
Name: _____
Company: _____
Title: _____
Address: _____
_____
Phone No.: _____
Fax No.: _____
E-Mail: _____

4. Other Prime Contractor(s) *(as determined by the Architect – Make* additional *copies as* n*ecessary)*

Signature: _____
Name: _____
Company: _____
Title: _____
Address: _____
_____
Phone No.: _____
Fax No.: _____
E-Mail: _____

SECTION 32 12 16 - ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.
B. The principle reference for materials and methods is the “New York State Department of Transportation Standard Specifications for Construction and Materials,” latest edition (NYSS).

1.2 SUMMARY

A. Section Includes:

1. Hot-mix asphalt paving.
2. Hot-mix asphalt patching.
3. Pavement-marking paint.

B. Related Sections:

1. Section 31 20 00 "Earth Moving" for subgrade and aggregate base preparation and other requirements.

1.3 SUBMITTALS

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

B. Action Submittals:

1. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

a. Job-Mix Designs: For each job mix proposed for the Work.

C. Qualification Data:

1. Asphalt Paving Installer Experience Listing: Submit list of completed projects using products proposed for this Project demonstrating compliance with applicable requirements specified below in “Quality Assurance” article.

2. Manufacturer’s Certificates: Certify that hot mix asphalt products meet or exceed NYSDOT Standard Specifications:

a. Section 401: Plant Production
b. Section 402: Hot Mix Asphalt (HMA) Pavements
c. Section 407: Tack Coat
d. Section 685: Pavement Markings

1.4 QUALITY ASSURANCE

A. Manufacturer and Mixing Plant Qualifications: A paving-mix manufacturer and mixing plant with NYSDOT approved materials and batch plant equipment complying with the following NYSDOT Standard Specifications:

1. Section 401: Plant Production
2. Section 402: Hot Mix Asphalt (HMA) Pavements.

B. Asphalt Paving Installer: Company specializing in performing work described in this section with minimum experience of three years.

C. Permits: Submit certified copies of all permits obtained from local regulatory agencies and New York State Department of Transportation.

D. Installation Requirements: Work to be performed in accordance with the following NYSDOT Standard Specifications:

1. Section 402: Hot Mix Asphalt (HMA) Pavements
2. Section 407: Tack Coat

1.5 REGULATORY REQUIREMENTS

A. Obtain written permission and required permits from applicable agency prior to start of construction, and submit copies of permits as specified in "Submittals - Quality Control Submittals" above.

1.6 PROJECT CONDITIONS

A. Temperature and Seasonal Limitations: Refer to NYSDOT 402-3.01 Temperature and Seasonal Limitations.

1. Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, if the temperature has not been above 35 deg for 12 hours immediately prior to application or if the following minimum surface temperatures are not met.

2. Minimum Surface Temperatures: Comply with NYSDOT Standard Specifications Section 402, table 402-1 – Temperature Requirements.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature in accordance with NYSDOT Standard Specifications Section 685-3.02 – Atmospheric Conditions.

PART 2 - PRODUCTS

2.1 AGGREGATE SUBBASE AND BASE FOR ASPHALT PAVING

A. Refer to Division 31 Section "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.

2.2 ASPHALT PAVING MIX AGGREGATES

A. Aggregates for binder and top course: Conform to the requirements of NYSDOT Standard Specification 401-2.02, Aggregates.

2.3 ASPHALT MATERIALS

A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes meeting NYSDOT Standard Specifications, Section 402 (70 Series) for each pavement course and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Mixes to be placed at thickness noted on the Drawings.
3. Binder Course (2-in < t < 3-in): NYSDOT No. 402.197903 (Type 3 Binder). Maximum 20% RAP permitted.
4. Binder Course (3-in < t < 5-in): NYSDOT No. 402.257903 (Type 3 Binder). Maximum 20% RAP permitted.
5. Shim Course: NYSDOT No. 402.058903 (Type 5 Shim). Maximum 20% RAP permitted.
6. Top Course: NYSDOT No. 402.127303 (Type 6.) Maximum 20% RAP permitted.
7. Top Course: NYSDOT No. 402.097303 (Type 7.) Maximum 20% RAP permitted.
8. Top Course: NYSDOT No. 402.097103 (Type 7F.) Maximum 20% RAP permitted.

B. Coatings/Fillers: Comply with New York State Department of Transportation Standard Specification, Section 702 for material designations indicated.

1. Tack Coat: Emulsified asphalt

a. Slow setting type; NYSDOT Designation 702-3601 (SS-1h) or 702-4501 (CSS-1h).
b. Medium setting type; NYSDOT Designation 702-3401 (HFMS-2H) or 702-4301 (CMS-2h)

2. Asphalt Cement Filler: NYSDOT Designation 702-0700.

C. Water: Potable.

2.4 PAVEMENT MARKING PAINT

A. Complying with NYSDOT Standard Specifications:

1. Section 727-09: White and Yellow Solvent Borne Acrylic Permanent Traffic Paint

2. Colors:

a. White for asphalt striping and signage

1) Lane Markings for traffic in the same direction

b. Yellow for traffic markings

1) No parking parent / bus drop-off zones
2) No parking fire lanes
3) Lane Markings for opposing traffic
4) Parking Stalls – Confirm with owner

c. Blue for the following locations:

1) ADA Accessible symbol and associated ADA Accessible striping

3. 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. TM 5626 White Setfast Acrylic Traffic Marking Paint, Sherwin Williams Company, Baltimore, MD
b. TM 5627 Yellow Setfast Acrylic Traffic Marking Paint, Sherwin Williams Company, Baltimore, MD
c. TM 2133 Blue Setfast Latex Traffic Marking Paint, Sherwin Williams Company, Baltimore, MD

B. Pavement Striping Blackout Paint: Opaque, high quality, exterior grade primer compatible with existing asphalt surface and pavement marking paint.

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. TM 5629 Black Setfast Acrylic Traffic Marking Paint, Sherwin Williams Company, Baltimore, MD

2.5 AUXILIARY MATERIALS

A. Soil Stabilization Fabric: Refer to Section 31 20 00 "Earth Moving".

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment 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.

2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.

3. 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.

a. Subsurface preparation shall conform to the appropriate section of NYSS.

4. After rolling, test course with straight edge min. 15 ft. long. Satisfactorily eliminate any depression over 1/4" deep.

5. Proceed with paving only after unsatisfactory conditions have been corrected.

C. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

D. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

3.2 SAWCUTTING

A. Saw cut existing pavement perpendicular to the roadway surface in neat lines. If the pavement breaks irregularly along the cut line during removal, saw cut the entire length of pavement again to achieve one uniform, straight, and neat line.

3.3 TACK COAT

A. Apply in accordance with NYSDOT Standard Specifications Section 407-3.02.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

B. Manhole and Catch Basin Frames and Grates:

1. Coat surfaces of frames and grates with oil to prevent asphalt adherence to surfaces. Do not tack coat.

3.4 PATCHING

A. Hot-Mix Asphalt Pavement:

1. Preparation: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending the minimum distance shown on Drawings into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade. Apply tack coat.

2. Patching: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3. Use hot-applied joint sealant to seal new joints. Fill flush with surface of existing pavement and remove excess.

3.5 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.

1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.

1. Clean cracks and joints in existing hot-mix asphalt pavement.
2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.
3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3.6 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

1. Herbicide Application: Obtain approval of Owner before herbicide notification or application. Notify Owner’s designated pesticide representative and all property neighbors not less than 48 hours in advance of any pesticide application including all herbicides, insecticides and fungicides in accordance with the School Pesticide Neighbor Notification Law, Section 409-h of New York State Education Law and Commissioner's Regulation 155.24.

C. Tack Coat: Apply tack coat.

3.7 HOT-MIX ASPHALT PLACING

A. Hot-Mix Asphalt Paving Application: Provide finished surface free from depressions that could collect water. Satisfactorily remove, at Contractor's expense, any depressions over 1/8" when tested with 6-foot straight edge without evidence of patching. Carry all paving to wood stripping, curbing or to location shown on Drawings.

B. Application Over Aggregate Base:

1. Heavy Duty, Auto Duty and Light Duty Asphalt Areas: Apply over aggregate base in 2 courses. Comply with New York State Department of Transportation Standard Specification, Section 401 and Section 402, for asphalt types specified.

C. Placement: Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
2. Spread mix at minimum temperature of 250 deg F.
3. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
4. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

D. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.

E. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.8 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.

2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.

3. Offset transverse joints, in successive courses, a minimum of 24 inches.

4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."

5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.

6. Compact asphalt at joints to a density within 2 percent of specified course density.

7. Use hot-applied joint sealant to seal new joints. Fill flush with surface of existing pavement and remove excess.

3.9 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 96 percent of reference laboratory density according to ASTM D 6927, but not less than 94 percent or greater than 100 percent.
2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent or greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.10 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus 1/2 inch, no minus.
2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch.
2. Surface Course: 1/8 inch.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

C. Pavement Surface Drainage: Pavement is to drain to catch basin, swale or other storm drainage control measure as indicated on Drawings or, if not indicated on drawings, to nearest storm drainage control measure.

D. Pavement Remediation: If pavement surface smoothness and drainage requirements above are not met, correct to meet tolerance and performance requirements. If remediation is not acceptable to Architect, removal and replacement of area will be required. Feather and smooth edges of correction measure so that joint is invisible.

3.11 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Perform work in accordance with NYSDOT Standard Specifications Section 727-09.

C. Sweep and clean surface to eliminate loose material and dust.

D. Surface must be clean, dry and in sound condition. Remove all oil, dust, grease, dirt, loose rust, and other foreign material to ensure adequate adhesion.

E. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended application conditions (temperature, dew point, humidity) and rates to provide a minimum wet film thickness of 15 mils and minimum dry film thickness of 7.5 mils.

F. Do not apply pavement marking paint to concrete surfaces with concrete sealers or efflorescence. Remove by extended weathering, etching, or abrasive blasting.

3.12 FIELD QUALITY CONTROL

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

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.
C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
D. Replace and compact hot-mix asphalt where core tests were taken.
E. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.13 FLOOD TESTING

A. Flood Tests: Prior to substantial completion inspection, perform flood test in the presence of the Architect using water tank truck to confirm that pavement surface smoothness and surface storm drainage requirements are met.

3.14 CLEANING AND DISPOSAL

A. Paver and Equipment Cleaning:

1. Do not clean tools and equipment used for HMA placement on the pavement surface, or near streams, ponds, drainage structures or other areas that are tributaries to waterways.

2. Use an area approved by the Owner's Representative for cleaning all paving equipment and tools.

    a. If possible, remove solid pieces of asphalt by scraping or other mechanical means prior to application of a cleaning agent.

3. If a petroleum product is used for cleaning, contain all liquid products during cleaning operations using tarpaulins, sand pads, pails, or other collection methods to prevent spillage or accidental release.

    a. Use hand sprayers or other similar devices to minimize the amount of petroleum product applied.

4. Properly dispose of sand and collected petroleum products as petroleum contaminated soil at no additional cost to the Owner.

B. Remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

END OF SECTION 32 12 16

SECTION 32 13 13 - CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Sidewalks.
2. Curbs and gutters.
3. Joint Sealant.
4. Concrete Sealer.
5. Curing materials.
6. Joint forming materials.
7. Joint Filler.
8. Sealers
9. Detectable Warning Materials.

B. Related Sections:

1. Section 03 30 00 "Cast-in-Place Concrete" general concrete mix, materials, installation and building-related concrete requirements.

1.3 SUBMITTALS, GENERAL

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

B. Refer to Div 03 concrete section for concrete submittal requirements, material certificates, installer qualification data and other required action and informational submittals.

1.4 ACTION SUBMITTALS

A. Provide Product Data and Testing Information for each type of product indicated.

1. Forms
2. Form release agent
3. Sealer
4. Joint Sealant
5. Curing Compound
6. Expansion Joint Material
7. Expansion Joint Forming System
8. Detectable Warning Materials

1.5 SHOP DRAWINGS

A. Jointing Plan: Provide shop drawing showing concrete joint layout, specifically indicating the locations of expansion, tooled and control joints.

1.6 QUALITY ASSURANCE

A. For Installer and Manufacturer requirements, refer to Div 03 concrete section**.**

B. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockups of full-thickness sections of concrete paving to demonstrate typical joints; surface finish, texture, and color; curing; and standard of workmanship in the location and of the size indicated where directed by Architect and not less than 96 inches by 96 inches.

2. Include full-size detectable warning in mockup.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PREINSTALLATION MEETING

A. Concrete Paving Preinstallation Conference: Conduct conference at Project site.

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place architectural concrete to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete manufacturer.
d. Cast-in-place architectural concrete subcontractor.

2. Review concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction joints, forms and form-removal limitations, reinforcement accessory installation, concrete repair procedures, and protection of cast-in-place architectural concrete.

1.8 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 Refer to Div 03 concrete section for products, unless noted below.

2.2 FORMS

A. Form Materials: Metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less. Do not use notched and bent forms.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.3 CONCRETE MATERIALS

A. Refer to Div 03 concrete section for cementitious material, aggregates, admixtures, and other concrete materials.

2.4 FIBER REINFORCEMENT

A. Refer to Div 03 concrete section for fiber reinforcement materials.

2.5 CURING MATERIALS

A. Standard Concrete Curing Compound: Clear, Waterborne, Membrane-Forming Curing Compound in accordance with ASTM C 309, Type 1-D, Class B, dissipating, with fugitive dye. Minimum 2-coats required.

B. VOC Content: Curing and sealing compounds shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 SEALER

A. Standard Concrete Sealer: Penetrating, Silane Sealer: Single component, 40% silane, waterbased slab sealer that forms chemical bond to the concrete. VOC compliant.

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. BASF Construction Chemicals; MasterProtect H 400.
b. Chem Masters; Aquanil Plus 40.
c. Dayton Superior Corporation; Weather Worker 40% J29WB.

2.7 JOINT SEALANT

A. Joint Sealant: Two-part, elastomeric polyurethane or polysulfide-based pourable self-leveling joint sealant complying with ASTM C 920, Type M, Grade P, Class 25, NT and CRD-C-506, Type 1, Classes A & B.

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. BASF Building Systems; Sonolastic SL 2.

1) Color for uncolored concrete: Limestone.

b. W.R. Meadows, Inc.; Deck-O-Seal Sealant.

1) Color for uncolored concrete: Stone Gray.

2.8 EXPANSION JOINT MATERIALS

A. Expansion/Isolation-Joint-Filler Strips: ½-inch rigid, extruded polystyrene insulation (at exterior walls) ASTM D 1751; asphalt-saturated cellulosic fiber, or ASTM D 1752.

B. Plastic Expansion Joint Forming System ("Zip-Strip"): Plastic joint form plus cap.

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

a. W.R. Meadows, Inc.; Snap-Cap.

2.9 DETECTABLE WARNING MATERIALS

A. Ductile iron detectable warning surface plates - for handicap accessible concrete curb ramps: Ductile iron, permanently embedded, wear and corrosion resistant 18-inch/24-inch/30-inch x 24-inch ductile iron plates with raised truncated domes complying with ADA and the NYS Building Code, having a skid resistance coefficient of friction greater than 0.8.

1. Physical Properties:

a. Slip Resistance ..... 1.10 Dry/1.06 Wet per ASTM C-1028
b. Wear Resistance ..... 7333 per ASTM C-501-84
c. Impact Resistance..... > 238 Newtons per ASTM D-1709
d. Bond Strength Adhesion to Concrete ..... > 5000 lbs per ASTM D-482
e. Tensile Strength..... > 35000 lbs per ASTM A-48
f. Design Compliance ..... Full Compliance with ADAAG / DOT

2. Hardware:

a. Manufacturer approved stainless steel hardware for bolting plates together

3. Coating:

a. Shop-dip applied black asphaltic coating.

b. If lead time precludes shop-dip coating indicated above, prepare and prime detectable warning plates per manufacturer's requirements and provide field-applied ZTech "Z Guard 2505" black dip coating, or equal.

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

a. East Jordan Iron Works, Inc. (EJIW): Duralast Cast Iron Detectable Warning Plates.

2.10 CONCRETE MIXTURES

A. Refer to Div 03 concrete section for concrete mixtures.

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 paving in accordance with Section 31 20 00 "Earth Moving". Identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction and repeat in perpendicular direction.

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

D. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

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 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. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

3.4 STEEL REINFORCEMENT

A. Refer to Div 03 concrete section for steel reinforcement.

3.5 JOINTS

A. General: Form construction, expansion/isolation, and contraction joints and tool edges 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 paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.

2. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Expansion / Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 30 feet maximum unless otherwise indicated.

2. Extend joint fillers full width and depth of joint.

3. Plastic Expansion Joint Forming System (“Zip Strip”). Install so that cap of channel is flush with surrounding concrete pavement. Install per manufacturer’s installation instructions. Remove plastic cap after concrete is cured.

4. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.

5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.

D. Control / 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, to match jointing of existing adjacent concrete paving unless otherwise noted:

1. Tooled / Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

    a. Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels.

2. Tooled / Grooved and Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks. Sawed joints without tooling are not allowed.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

A. Refer to Div 03 concrete section for concrete placement information.

B. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.

C. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

D. 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.

E. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

F. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301, (4.3.2.1 Slump Adjustment).

1. With each concrete mixture submittal, indicate amounts of mixing water to be withheld for later addition at Project site.

2. Water added must not increase the water-cement ratio past the approved mix design ratio.

3. Add additional water reducer or plasticizer to mix instead of adding water to achieve flowable, workable concrete. Do not add water to concrete after adding these admixtures to mixture.

4. Do not add water after truck is more than half empty.

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. Screed paving surface with a straightedge and strike off.

J. 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.

K. Machine-Placed Curbs and Gutters: Allowed only upon Architect approval. Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.

L. Slip-Form Paving: Allowed only upon Architect approval. Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

M. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.

2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture 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 at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in 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. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

3.8 DETECTABLE WARNINGS

A. Ductile Iron Detectable Warning Surface Plates:

1. Connection: Fasten plates together with stainless steel bolts per manufacturer's torque requirements.

2. Setting Plates: Set cast iron detectable warning plates into wet concrete in accordance with ADAAG (American Disabilities Act and Accessibility Guidelines). Tamp plates thoroughly with rubber mallet until concrete seeps through vent holes.

3. Clean off excess concrete from the plate(s) and adjust adjacent concrete to be flush with plates. Finish concrete around plates to match surrounding concrete.

3.9 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 and 305R for hot-weather protection during curing.

B. Slabs: Protect slabs within building from precipitation accumulation. Immediately remove water, snow or ice from surface of slabs within building regardless if source is from precipitation, construction activities, etc.

C. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. 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. Formed Surfaces: Cure formed concrete surfaces, including supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

E. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

F. Cure concrete according to ACI 308.1:

1. 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.

G. After curing, apply penetrating, silicane sealer per manufacturer’s instructions.

3.10 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow concrete paving to cure for a minimum of 28 days and be dry before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.11 FIELD QUALITY CONTROL

A. Refer to Div 03 concrete section for field quality control information.

1. Contractor Requirements:

a. Provide access to concrete construction for representatives of testing agency employed by Owner to perform concrete testing.
b. Notify Architect at least four days in advance of each concrete placement to allow notification of Owner's testing agency.

3.12 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 13 13

SECTION 32 18 13.10 – SYNTHETIC GRASS INFRASTRUCTURE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Aggregate base for Synthetic Turf.
2. Drainage system for Synthetic Turf.
3. Pressure-Treated Wood Nailer at Perimeter Curb

B. Related Sections:

1. Section 01 78 39 “Project Record Documents”
2. Section 31 10 00 “Site Clearing”
3. Section 03 30 00 “Cast-in-Place Concrete”
4. Section 11 68 33 “Athletic Field Equipment”
5. Section 31 20 00 “Earth Moving”
6. Section 33 41 00 “Storm Utility Drainage Piping”

1.2 ALTERNATES

A. Work of this Section is affected by alternates specified in Section 01 23 00 "Alternates.”

1. This Section includes specifications for the base bid system, and includes work indicated under contract alternates.

1.3 SYNTHETIC TURF “INFRASTRUCTURE SYSTEM” DESCRIPTION

A. Design Requirements

1. Labor, materials, tools and equipment necessary to install all infrastructure components required to support the installation of the Synthetic Turf “Grass System” as shown on Drawings and specified in this Section in strict accordance with manufacturer’s installation instructions and all approved shop drawings.

a. Fill material placement and compaction between subgrade and aggregate subbase.
b. Installation of the perimeter field concrete curb anchor system for the installation of the synthetic turf.
c. Filter separation fabric, flat panel drainage components, storm structure, storm manifold perimeter collection piping and appurtenances.
d. Underground storm water collection system.
e. Subbase placement and compaction of aggregate base and choker stone.
f. Fencing and/or Ball stopper netting anchor sleeves installed within or adjacent to the turf system, if applicable.

g. Installation of specified football goal post sleeve, foundation and integral soccer goal clamping system.

2. Provide Quality Control submittals per Quality Control section of this specification.

3. For general fill material requirements, refer to the 31 20 00 – Earth Moving specification. For general storm utility piping requirements, refer to the 33 41 00 – Storm Utility Drainage Piping specification.

B. Synthetic Turf Infrastructure System work includes, but is not limited to, the following.

1. A complete synthetic turf infrastructure system, consisting of a vertical draining gravel blanket and flat panel storm collection system with manifold piping.

2. Written company Warranties:

a. Contractor Infrastructure Warranty: Written two (2) year contractor warranty for infrastructure to support the synthetic turf field, as described in Warranty Section.

3. Where applicable, Field Builder and Base Construction Contractor to coordinate to make sure football goal post anchor sleeve and foundation are installed to permit accurate installation (plumb in all directions and set at correct elevation) for future goal post installation with required ten foot (10-ft) height above finished playing surface, and aligned along the center axis of the field at the specified distance.

4. Where applicable, Site Construction Contractor to coordinate installation of ball stopper chain link perimeter fencing systems, including anchor sleeve foundations.

5. Site Construction Contractor to coordinate installation of storm water piping and structures, and other utilities within the field perimeter.

6. Site Construction Contractor to coordinate installation of perimeter curbing and wood nailer for installation of synthetic grass system (with or without underlayment shockpad), procured via Cooperative Agreement with District. Coordinate with vendor regarding exact synthetic grass system selected, required infill height (curb reveal) and specifically regarding finish installed elevation of nailer board in relation to perimeter curb and selected synthetic turf product.

1.4 REFERENCES

A. Factory Mutual Research Corporation (FM)

1. FM P7825 - Approval Guide; Factory Mutual Research Corporation; current edition.

B. American Society for Testing and Materials (ASTM)

1. ASTM D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity
2. ASTM D7001 – Standard Test Method for Geocomposites for Pavement Edge Drains and Other High Flow Applications

3. ASTM F1551 - Test Methods for Comprehensive Characterization of Synthetic Turf Playing Surfaces and Materials (Water Permeability)

C. Comply with applicable requirements of the following standards. Where these standards conflict with the other specified requirements, the most restrictive requirements shall govern.

1. American Sports Builders Association (ASBA)

2. Synthetic Turf Council (STC): Suggested Guidelines for the Essential Elements of Synthetic Turf Systems, latest edition and Guidelines for Crumb Rubber Used in Synthetic Turf Fields, latest edition.

1.5 SUBMITTALS

A. Comply with requirements of SECTION 01 33 00 – Submittal Procedures and as modified below.

B. Submit the following within 48 hours of bid opening, as requested:

1. Copy of most recent installation/reference list for all projects of similar scope to this project completed in the last three (5) years.

2. Copy of most recent independently audited financial statements.

3. Copies of the following warranties:

a. Copy of sample 2-yr Contractor Synthetic Turf Infrastructure warranty, demonstrating that all the requirements outlined in Section 1.7 Warranty are met.

4. Certified letter indicating that all quality assurance requirements outlined in Section 1.6 will be met, including a detailed field description and contact information for the Owner must be submitted as required.

5. List <u>any</u> substitutions of any components of the specified products. If a substitution is made, provide detailed description of synthetic turf system components to be utilized, product data and testing documents demonstrating that proposed system meets or exceeds all specified requirements.

6. **Note: If these submittal items are requested and deemed to be insufficient, the Site Contractor will not be approved.**

C. Product Data

1. Submit manufacturer's product literature, technical specifications, product characteristics, performance characteristic, installation instructions and similar information demonstrating compliance with specified requirements.

a. Coordinate with synthetic grass systems vendor procured via Cooperative Agreement with District. Each fill material certificate must be stamped and checked as approved by the synthetic turf manufacturer's representative <u>before</u> submittal to the Architect.

b. Prior to order of materials, the Contractor shall submit any details of construction, which deviate from the plans and specifications.

c. Prior to order of materials, the Contractor shall submit a sample copy of non-prorated contractor's infrastructure warranty information.

2. Action Submittals:

a. Product Data: For each type of the following manufactured products required:

1) Geotextile Filter Fabric

2) Drainage Products

a) Flat Panel Composite Drain Pipe
b) Flat Panel End Cap Fitting
c) Flat to Round Transition Coupling
d) Final Perimeter Manifold Collector Connection.

3) Pressure-Treated Wood Nailer at Perimeter Curb

1. Material Test Reports: For each import fill soil material proposed for synthetic turf vertical drainage system, as follows:

a. Vertical Drainage Base Aggregate

1) Classification according to ASTM D 2487.
2) Laboratory compaction curve according to ASTM D 1557.
3) Submitted material testing and analysis shall demonstrate that no unsuitable soil groups are present.
4) Submitted material testing and analysis shall demonstrate that no absorbent clays are present.

b. Vertical Drainage Choker Aggregate

1) Classification according to ASTM D 2487.
2) Laboratory compaction curve according to ASTM D 1557.
3) Submitted material testing and analysis shall demonstrate that no unsuitable soil groups are present.
4) Submitted material testing and analysis shall demonstrate that no absorbent clays are present.

D. Samples

1. Fill Materials: Submit samples of each type of gravel and stone specified for fill, naming source for each material and including sieve-analysis indicating compliance with specified gradation requirements for specific fill material. Submit three (3) one-half gallon by volume of material in sturdy container of each type of fill, naming type and source of material.

a. Coordinate with synthetic grass systems vendor procured via Cooperative Agreement with District. Each fill material must be stamped and checked as approved for use by the synthetic turf manufacturer's representative prior to submission for Architect review.

b. Obtain Architect's approval of fill materials before beginning fill material placement.

E. Quality Control Submittals

1. Most recent installation/reference list for all projects of similar scope to this project completed in the last three (3) years.

2. Copy of required Contractor's Infrastructure Warranty demonstrating that all the requirements outlined in Section 1.7 are met.

3. Copy of the resume of proposed installation foreman. Installation crew must meet or exceed all requirements outlined in Section 1.6.

4. Copies of independent laboratory test reports and informational data for system or components outlined in Section 1.6.

a. Copy of certified permeability testing report performed by independent testing agent.
b. Copy of certified choker course elevation verification survey performed by independent licensed land surveyor.

F. Contract Closeout Submittals:

1. Provide as-built drawings as specified.

1.6 QUALITY ASSURANCE

A. Qualifications

B. Installer Qualifications: Qualified Installers as defined below:

1. Earthwork Contractor Experience Requirements: Provide a list of at least (5) five earthwork projects of comparable size, scope, and quality completed successfully by the proposed Site Contractor within the past two years that includes the date completed, project Owner's name and current contact information, including telephone numbers and e-mail addresses.

2. Synthetic Turf Infrastructure installation experience requirements: Installation of a minimum five (5) comparable synthetic turf infrastructure system installation projects in the last (5) years, including installation of vertical drainage blanket, drainage collection system, perimeter curbing, ball stopper and fencing systems, and curbing turf nailer.

C. Pre-Installation Meeting: Schedule and conduct Pre-Installation Meeting at least one (2) weeks before beginning installation of synthetic grass infrastructure including Architect, Site engineer and/or Landscape Architect, Owner's representative, Cooperative Agreement Contractor representative, applicable Subcontractor representatives, and Synthetic turf manufacturer's representative.

D. Permeability Testing: Contractor to provide independent, certified testing report showing base aggregate and choker course is free draining and meets required permeability rates, for both the new softball field infield installation, as well as testing of the existing drainage system at both replacement synthetic turf fields. Testing agency to comply with BS 7044, Method 4 testing methodology. Independent testing firm providing such services includes Leading Design and Development, LLC., Cortland, New York. Telephone: 607-351-8254. Web: www.lddsports.com

E. Choker Course Elevation Verification Survey: Contractor is to provide independent certified topographic survey showing spot elevations at 20-ft on center (minimum) for entire field area. Licensed surveyor is to use equipment with integrated laser technology.

F. Coordinate with synthetic grass systems vendor procured via Cooperative Agreement with District regarding sign-off and acceptance of field planarity, compaction and pressure-treated wood nailer at perimeter curb installation. Provide certification letter indicating acceptance of aforementioned improvements, including curb nailer elevation.

1.7 WARRANTY

A. Synthetic Turf "Infrastructure System" Warranty: Contractor is to provide a written two (2) year warranty which warrants against any defects or malfunction of the Synthetic Turf "Infrastructure System" (as defined above) not covered by the manufacturer's warranty and includes all infrastructure beneath the turf system (carpet, infill and underlayment pad). Warranty shall include, but not limited to, coverage against differential settlement, over / under compaction of subbase materials, and areas of the turf that are not free-draining due to infrastructure installation issues and/or product defects. *NOTE: This 2-yr. warranty applies to the required infrastructure beneath the proposed synthetic turf installation.*

1. Warranty to be from a single source covering workmanship and all materials, which after installation shall meet or exceed the product specifications.

2. Cover defects in the installation and workmanship. Assure the installation was done in accordance with both the manufacturer's recommendations and any written directives of the manufacturer's on-site representative.

3. Repair or replace such portions of the installed materials that are no longer serviceable to maintain a serviceable and playable surface, and to allow a free-draining base. Repair or replacement shall be limited to the affected areas, and shall include all necessary materials, labor, transportation costs, etc. to complete said repairs. Coverage shall include labor / materials for partial or full removal / reinstallation of turf system carpet, infill and underlayment pad (if applicable) required for infrastructure access.

4. Assure the availability of exact or substantially the same replacement materials for the synthetic turf infrastructure installed for the full warranty period.

5. Specifically note any exclusion to the warranty (vandalism, etc.).

1.8 PROJECT/SITE CONDITIONS

A. Field Measurements: Verify measurement shown on Contract Documents in field before ordering or installing materials.

B. Existing Conditions.

1. If synthetic grass surfacing system is to be placed on a new base of porous aggregate, repair any damage to subbase after placement, compaction and testing prior to installation of synthetic grass surfacing system.

1.9 SEQUENCING AND SCHEDULING

A. Coordinate with Owner to ensure removal of existing football goal posts or similar equipment or items required to facilitate installation of synthetic turf infrastructure.

B. Coordinate with synthetic grass systems vendor procured via Cooperative Agreement with District to ensure perimeter edge details, underground storm sewer piping and connections, other underground utilities, and goal post foundations required for system as detailed and recommended by manufacturer and approved by Architect are provided.

1.10 DELIVERY, STORAGE AND HANDLING

A. Deliver products to project site in wrapped condition and store products under cover and elevated above grade.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Fill and Backfill: Provide fill materials free of rock or gravel larger than stated size, debris, waste, frozen materials, vegetable matter, and other deleterious substances.

1. Vertical Drainage Base Course: The synthetic turf Base Contractor is required to focus on achieving the planarity, porosity and compaction requirements to provide a sound crushed stone base for synthetic turf installation.

a. Vertical Drainage Base Aggregate (Open Graded Stone): The free-draining base aggregate base layer shall consist of a consistent depth of open graded material. Base drainage aggregate used must achieve a 95% minimum overall compaction rate. Material shall conform to the ASSHTO #57 limestone classification. Subgrade must achieve 95% compaction level and pass a proof roll, witnessed by an independent geotechnical engineer, before placement of the drainage stone can commence. The open graded aggregate material shall conform to the following criteria:

1) Depth: 5-in

2) Provide aggregate blends complying with the following gradation requirements:

	SIEVE DESIGNATION	% BY WEIGHT PASSING SQUARE MESH SIEVES
a)	1 ½-in	100%
b)	1-in	95-100%
c)	½-in	25-60%
d)	#4	0-10%
e)	#8	0-5%

b. Vertical Drainage Choker Aggregate (Stone Dust) shall be layer of porous, free draining material, number 1 stone sand or similar material, that will provide a 95% minimum overall compaction rate. Material shall be a special blend of crushed limestone 1A's and 1B's. Typically, a 50/50 mix is required. Material must be washed.

1) Depth: 1-in Min

2) Provide aggregate blends complying with the following gradation requirements:

	SIEVE DESIGNATION	% BY WEIGHT PASSING SQUARE MESH SIEVES
a)	1/2"	100%
b)	3/8"	95-100%
c)	#4	70-85%
d)	#8	45-60%
e)	#16	25-40%
f)	#100	8-15%
g)	#200	0-5%

c. Restrictions for Aggregate Base and Choker Course:

1) To Ensure Structural Stability: $D_{60}/D_{10} > 5$ and $1 < D^2_{30}/D_{10}\ D_{60} < 3$. Fragmentation must be 100 percent.

2) To Ensure Separation of Both Stones: D_{85} of choker stone / D_{15} of base aggregate > 2 and 3 < D_{50} of base aggregate / D_{50} of choker stone <6

3) To Ensure Proper Drainage:

a) Permeability of base aggregate > 500 in/hr (3.5 X 10^{-1} cm/sec)
b) Permeability of choker stone > 20 in/hr (1.4 X 10^{-2} cm/sec)
c) Porosity of both stones > 25 percent (When stone is saturated and compacted to 95% Proctor.)
d) "D_x" in preceding subparagraphs = Size of sieve (in mm) that lets pass x percent of stone.

B. Geotextile Filter Fabric (for all areas to receive synthetic grass surface) *(Refer to BASE BID)*: Non-woven polypropylene geo-textile fabric shall be chemically and biologically inert and shall be equivalent to the following:

1. Mirafi 140N, Mirafi Inc., Pendergrass, GA (888) 795-0808
2. Poly Filter-X, Carthage Mills (800) 543-4430.
3. Supac-5P, Phillips Fibers Corp.

C. Flat Panel Composite Drain:

1. Flat Panel Composite Drain Pipe and Fittings

a. Piping: 1-in x 12-in polyethylene multi-channeled edge drain factory wrapped with polypropylene filter fabric sock. Provide all fittings and connections required for installation fabricated by manufacturer of drainage piping used. Equal to "AdvanEdge Pipe" by Advanced Drainage Systems.

b. Pipe

1) Pipe Properties (unbedded)

a) Water Inlet Area (approx.): 15 in^2/ft
b) Compressive Strength (ASTM D-695): 6,000 psf (41.7 psi) minimum.
c) Flow Rate (ASTM D-4716): 11gpm/sf.
d) Peel Strength (ASTM D-1876): 35 lbs/ft minimum.
e) Core Thickness: 0.80-in
f) Oblong corrugated pipe with internal bracing (ASTM D-7001, Class B Pipe Product)

2) Drainage Fabric Properties

a) Grab Tensile Strength (D-4632): 120 lbs.
b) Grab Elongation Strength (ASTM D-4632): 60%.
c) Mullen Burst Strength (ASTM 3786): 90 psi.
d) Puncture Strength (ASTM 4833):30 lbs.
e) Trapezoid Tear Strength (ASTM D-4533): 40 lbs.
f) U.V. Resistence (ASTM D-4355): 70% strength retained.
g) A.O.S. (U.S. Sieve Size) (ASTM D-4751): 60
h) Permeability (ASTM 4491): K Fabric > K Soil
i) Permitivity (ASTM 4491): 0.7

3) Fittings:

a) End Cap # Start: 12” end cap, equal to AdvanEDGE Part#1432-AA.

b) Flat to round transition: 12” flat outlet to 4” HDPE coupling, equal to AdvanEDGE Part#1432-AN by Advanced Drainage Systems.

c) Final perimeter manifold collector connection: 4” (100mm) ADS “InsertaTee” three-piece corrugated polyethylene bell/spigot gravity service connection, model 4N12MF12-15N12, or equal, by Advanced Drainage Systems.

D. Pressure-Treated Wood Nailer:

1. Pressure treated wood nailer shall meet AWPA U1, Category UC4B Heavy Duty for exterior construction with direct contact with the ground.

a. Dimensions: 2-in x 6-in nominal.

b. Preservative Chemicals: Acceptable to authorities having jurisdiction and one of the following:

1) Ammoniacal copper zinc arsenate (ACZA)
2) Ammoniacal, or amine, copper quat (ACQ)
3) Copper bis (dimethyldithiocarbamate) (CDDC)
4) Oxine copper (copper-8-quinolinolate) in a light petroleum solvent

c. Acceptable material shall be kiln-dried after preservative treatment to maximize moisture content of 19% for lumber.

d. Use of material that is warped or does not comply with requirements for untreated wood is not acceptable.

e. Each pressure-treated item shall indicate a treatment quality mark of an inspection agency approved by the American Lumber Standards Committee Board of Review.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine conditions under which earthwork is to be accomplished in coordination with this Section and notify Architect in writing of any conditions detrimental to proper and timely accomplishment. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

1. Arrange for Installer of synthetic turf to inspect sub-base and accept in writing sub-base surface planarity and compaction. Arrange for Installer to have dimensions of field and locations for markings measured by registered surveyor to verify conformity to specifications and applicable standards and make record of finished field as-built measurements.

2. Verify aggregate base compaction is 95 percent, according to Modified Proctor procedure (ASTM D1557), and surface tolerance does not exceed 1/4 inch over 10 feet and 0 to 1/2-inch from design grade.

3.2 INSTALLATION

A. Excavation: Existing natural grass field shall be excavated to the depth established by the architect and as shown on the excavation plan. The sub grade shall be shaped to achieve a 0.5% (one half of one percent) slope from the center of the field to each sideline in order to mirror the grade of the finished synthetic turf surface. The subgrade shall also be compacted, and proof rolled to a minimum of a 95% compaction rate.

B. The synthetic grass infrastructure installation contractor shall strictly adhere to the installation procedures outlined under this section. Any variance from these requirements must be accepted in writing, by the manufacturer's on-site representative, and submitted to the Architect/Owner, verifying that the changes do not in any way affect the warranty.

C. Install geotextile fabric over excavated and prepared sub-grade in accordance with synthetic turf installer’s recommendations. Provide a 36-inch minimum overlap at all seams. Fabric shall first be installed in the drainage trenches prior to installation of perimeter collector lines. After backfilling of all trenches is complete, the entire field shall be covered with fabric prior to the base aggregate application.

D. Trenching, Drainage Pipe Installation and Backfilling: All piping shall be as specified and connected by manufacturer's couplers, plugs etc.

1. The base grade shall be shaped to mirror the finished grade where applicable and approved by the Architect and/or Owner's Representative. The synthetic grass infrastructure installation Contractor shall begin layout and trenching for the drainage network as indicated on the drainage plan and all details that apply. Collector lines shall be installed before lateral lines and shall begin with the deepest elevations. Collector lines shall be connected to discharge outlet at the onset of operations. Trenching progress shall work upward in elevation to allow for immediate discharge of water from the entire field in the event of a rainfall.

2. No trenches, with or without pipe, shall be permitted, to remain unfilled overnight and/or while crews are not progressively working on site.

3. All perimeter trenches must be dug in accordance with the field drainage plan details.

4. After all collector and lateral lines have been installed, the contractor shall repair any sub grade undulations prior to installing geotextile fabric.

E. Concrete Header Perimeter Curb and Wood Nailer: The synthetic turf perimeter fastening structure shall be installed before the drainage aggregate.

1. The concrete header curb shall be installed in accordance with the Drawings and/or Shop Drawings and these Specifications. The foundation of the concrete header curb shall be a compacted free draining aggregate. Future water entering the foundation shall have a free draining path directly to the perimeter collector pipe.

2. Provide 2-in x 6-in pressure treated wood nailer fastened to concrete header perimeter curb.

   a. Set top of wood nailer 1.5" *(confirm actual required elevation of selected synthetic turf system (with or without underlayment shock pad) with synthetic grass system vendor)* below top of the curb by means of a Tapcon every 12 inches. This shall be the responsibility of the site contractor. See synthetic turf edge attachment detail.

3. See synthetic turf edge attachment details.

F. Base Drainage Aggregate: The installation of the base drainage aggregate shall only begin after the drainage pipe installation has been inspected and approved by the synthetic turf system supplier. Installation of the Base Aggregate shall follow procedures that protect the base grade soils and drainage pipe. The drainage pipe network and its existing elevations shall not be disrupted through ground pressures from trucks, dozers or by any other means.

1. The base grade subsoil shall be dry before undertaking the placement of base aggregate.

2. Delivery trucks shall enter the field only from the designated entrance point. Base course stone shall be dumped closest to the entrance first and continuously worked towards the furthest point of the field. Extreme care must be taken not to disturb sub grade or drainage network.

3. Track-type dozers shall push out the stone from behind the pile onto and toward the field center. Dozers shall only traffic the aggregate they are spreading.

4. Bulldozer blades shall be equipped with a laser-guided hydraulic system. Care shall be taken not to disturb or contact the base grade soils with the dozer blades or tracks. All equipment trafficking over the drainage aggregate shall insure there is a minimum depth of 4-in of aggregate between the geo-textile fabric and the dozer track ground contact position.

5. When the aggregate spreading is completed, the surface shall be further firmed by a 5-ton roller. Static vibration shall not be part of this process.

6. The stone shall be left firm, but not over-compacted as to protect the porosity and drainage capabilities of the aggregate profile.

7. After the drainage stone has been uniformly spread throughout the surface, the surface shall receive a final laser finished grade. This process shall be accomplished using a turf-type tractor, or lightweight grader, equipped with high flotation tires and a hydraulically controlled laser blade.

8. The free draining base course must be installed to a depth of 5-inches nominal and shall be independently tested for an overall compaction rate of 95% proctor.

G. Choker Levels: The base drainage stone final elevations shall mirror the proposed choker layer final grade material. Care shall be taken not to allow the coarser aggregate to surface into the profile or finished grade of the choker layer.

1. The choker layer shall be applied using high flotation grading equipment. The choker material shall be evenly spread throughout the proposed field surface to the final pre-pad or pre-turf elevations.

2. After the choker material has been uniformly spread throughout the surface by the described method, the surface shall receive a final laser finish grade. This process shall be accomplished using a turf-type tractor, or lightweight grader, equipped with high flotation tires and a hydraulically controlled laser blade.

3. Care shall be taken throughout the installation not to force the choker material into the porosity of the base aggregate below.

4. Final choke layer must be graded by means of a laser within 0 to 1/2 inch from design grade. The finished surface tolerance must not exceed ¼ inch over 10 feet in all directions. The Contractor must provide a topographical survey with a minimum of 200 shots demonstrating finished grade meets all written requirements, with secondary string line verification that elevations are in compliance.

5. Final layer of stone must be installed at a depth of 1-inches nominal. Finished aggregate base must be proof rolled by means of 2 to 5-ton roller. The finished aggregate base must achieve an overall compaction rate of 95% proctor in accordance with ASTM D1557. It shall also be flush with top of pressure treated wood nailer.

H. Choker / Base Course Drainage Testing: Provide choker course drainage testing per Quality Assurance article. Test results are to be provided to the Owner, Architect and Synthetic Turf Manufacturer for review before the base will be accepted.

I. Base Acceptance: It is the responsibility of the synthetic turf manufacturer's representative to verify and approve the base before turf installation can begin. Provide written acceptance by synthetic turf manufacturer's representative to Architect.

J. Synthetic Turf Perimeter Attachment:

1. Verify that wood curb nailer is correct elevation for installation of selected synthetic turf grass system.

K. Athletic Equipment Installation:

1. Contractor to make sure football goal post foundation and anchor sleeves are adjusted to be plumb in all directions and achieve a finished 10-ft. height from finished playing surface to top of crossbar when goal post is installed. See specifications for required goal post dimensions (actual goal post not in contract).

3.3 CLOSEOUT

A. The turf contractor must verify that a qualified representative has inspected the installation and that the finished field surface conforms to the manufacturer's requirements.

B. Synthetic Turf "Infrastructure System" Warranty: Submit three (3) copies of the final *(reviewed and approved by Owner's legal representative)* two (2) year Contractor Infrastructure Warranty for the synthetic turf system infrastructure from the date of Substantial Completion as described in Warranty Section to the Owner.

C. Maintenance Manual: Submit three (3) copies of maintenance manual to the owner.

3.4 ADJUSTING/CLEANING

A. Provide final cleaning of synthetic grass subbase surfacing installation and maintain area clean and free from debris during installation. Clean surfaces, recesses, enclosures, and similar areas as required to leave area of installation in clean, immaculate condition ready for immediate installation of synthetic turf by turf installer, and occupancy and use by Owner.

B. Protect installed synthetic grass subbase surfacing from subsequent construction operations. Do not permit traffic over unprotected surfacing.

C. During the contract and at intervals as directed by the Architect and as synthetic grass infrastructure is completed, clear the site of all extraneous materials, rubbish, or debris and leave the site in a clean, safe, well-draining, neat condition.

END OF SECTION 32 18 13.10

SECTION 32 31 13 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Chain-link fences.
2. Chain link fence cap
3. Gates: Swing.
4. Barbed wire supports and barb wire

B. Related Sections:

1. Section 03 30 00 “Cast-in-Place Concrete”
2. Section 31 20 00 "Earth Moving"

1.3 REFERENCES

A. ASTM A392 Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
B. ASTM F552 Standard Terminology Relating to Chain Link Fencing.
C. ASTM F567 Standard Practice for Installation of Chain Link Fence.
D. ASTM F626 Specification for Fence Fittings.
E. ASTM F900 Specification for Industrial and Commercial Swing Gates.
F. ASTM F1083 Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
G. ASTM F1184 Specification for Industrial and Commercial Horizontal Slide Gates.
H. CLFMI WLG2445 Chain Link Fence Wind Load Guide for the Selection of Line Post and Line Post Spacing.

1.4 PERFORMANCE REQUIREMENTS

A. Design Wind Load: Comply with applicable requirements of building code in effect for Project including applicable portions of ASCE 7 for Wind Load Pressure and CLFMI WLG 2445 Wind Load Guide for the Selection of Line Post Spacings.

1.5 SUBMITTALS

A. General: Submit all action submittals (except Samples for Verification) and informational submittals required by this Section concurrently.

B. Action Submittals:

1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chain-link fences and gates.

   a. Fence and gate posts, rails, and fittings.

   b. Chain-link fabric, reinforcements, and attachments.

   c. Polymer and polyester coatings.

      1) Note: Polymer and polyester coated samples and product data are to be submitted simultaneously.

   d. Accessories:

      1) Chain link fence cap.

   e. Gates and hardware.

   f. Barbed wire support and barbed wire.

2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Show accessories, hardware, gate operation, and operational clearances.

3. Samples for Verification:

   a. Polymer and Polyester Coated Components: In 6-inch lengths for components and on full-sized units for accessories.

      1) Note: Polymer and polyester coated samples and product data are to be submitted simultaneously.

   b. Manufacturer's color charts.

4. Warranty:

   a. Sample of special warranty
   b. Sample of manufacturer warranty

C. Informational Submittals:

1. Qualification Data: Submit list of completed projects using products proposed for this Project, including owner's contact and telephone number for each project, demonstrating compliance with "Quality Assurance" article.

2. Product Test Reports: For framing strength according to ASTMF 1043.

D. Closeout Submittals:

1. Operation and Maintenance Data: For the following to include in operation and maintenance manuals:

a. Polymer and polyester finishes.
b. Gate hardware.

2. Warranty: Executed special warranty.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Minimum five (5) years' experience in installing chain link fences and gates similar in material, design, and extent to that indicated for this Project in accordance with ASTM F 567, whose work has resulted in construction with a record of successful performance.

B. Mockups: If required by Architect, build mockups to set quality standards for fabrication and installation.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.8 WARRANTY

A. Special Warranty: Contractor's warranty to repair or replace components of chain-link fences and gates that fail in materials or workmanship within the specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure of any component of fence to perform as designed.
b. Faulty operation of gate(s) to perform as designed.

2. Warranty Period: Five (5) years from date of Substantial Completion.

B. Manufacturer warranty: Manufacturer's standard form in which Contractor agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of metals, metal finishes, coatings and other materials of the fence components, including fabric, framework and fittings.

2. Warranty Period: Fifteen (15) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle. Comply with CLFMI Product Manual and with requirements indicated below:

1. Fabric Height: As indicated on Drawings.

2. Steel Wire Fabric:

a. General Use: Wire with a core diameter of 0.148 inch (9 gauge) minimum. For polymer-coated fabric, wire with a core diameter of 0.148 inch core (9 gauge core) and polymer-coated finished wire size of 0.162 (8 gauge) minimum.

b. At perimeter of Synthetic Turf Field Area: At perimeter 4'-Height and 6'-Height fencing and gates, provide wire with a core diameter of 0.148 inch (6 gauge) minimum. For polymer coated fabric, wire with a core diameter of 0.192 inch (9 gauge core) and polymer-coated finished wire size of 0.207 (5 gauge) minimum.

3. Mesh Size:

a. General Use: 2 inches, unless noted otherwise.

4. Coatings:

a. Polymer-Coated (Vinyl) Fabric: ASTM F 668, Table 4, Class 2b, fused and adhered over zinc-coated steel wire.

1) Color: Black, complying with ASTM F 934.

2) Basis of Design Manufacturer: Subject to compliance with requirements, polymer coating that may be incorporated into the Work include, but are not limited to, the following:

a) Merchants Metals Brighton Colorcoat II fused and adhered polymer coating.

5. Selvage: Knuckled at both selvages.

2.2 FRAMEWORK MATERIALS

A. Posts and Rails: Comply with ASTM F 1043 for minimum dimensions and wall thickness of framing, including rails, braces, and line; terminal; and corner posts, meeting the following criteria:

1. Heavy Industrial Strength: ASTM F 1043 Group I-C, SS40, round steel electric-resistance-welded pipe galvanized with hot-dip process in accordance with ASTM A653/A653M and ASTM A924/A924M.

2. Manufactured to meet minimum yield strength of 50,000 psi and coated in accordance with the following standards:

   a. ASTM F1043, Group IC, Electrical Resistance Welded Round Steel Pipe, heavy industrial weight.

   b. M181, Type I, Grade 2, Electrical Resistance Welded Steel Pipe

   c. RR-R 191/3, Class 1, Grade B, Electrical Resistance Welded Steel Pipe.

B. Coatings:

   1. PVC / Polyester Coating Over Zinc Coating:

      a. Thermoplastic vinyl finish to be 10 mils (minimum) thick.

      b. Cleaning and Surface Preparation: Consists of a four-stage pretreatment/wash, an iron phosphate coating and immersion in a water based epoxy primer.

      c. PVC Coating Application: Coating is thermally fused to heated pipe meeting the following standards:

         1) ASTM F1043 Group I-C, Heavy Industrial.
         2) Federal specification RR-F-191/3E, Class 1
         3) Shows satisfactory adhesion in cross-hatch test, Method B, ASTM D3359.
         4) Finish shall not crack, blister or split under normal use.

   2. Color: Match chain-link fabric, complying with ASTM F 934, Standard Colors for Polymer-Coated Chain Link Fence Materials.

C. Basis of Design Manufacturer: Subject to compliance with requirements, framework and coatings that may be incorporated into the Work include, but are not limited to, the following:

   1. Merchants Metals Colorbond Chain Link Fence Framework and Coating System.
   2. Master Halco Permafused II Heavy Mil PVC Chain Link Fence Framework and Coating System.
   3. Ameristar PermaCoat PC-40 (industrial weight), manufactured by Ameristar Fence Products (www.ameristarfence.com) Chain Link Fence Framework and Coating System.

2.3 FRAMEWORK SIZES

A. Line Post Size (determined by height):

1.	4 feet up to and including 6 feet high:	2 inches o.d.
2.	7 feet up to and including 9 feet high:	2-1/2 inches o.d.
3.	10 feet up to and including 12 feet high:	3 inches o.d.
4.	Over 12 feet to 16 feet high:	4 inches o.d.

B. End, Corner and Pull Post:

1. 4 feet up to and including 6 feet high: 2-1/2 inches o.d.

2. 7 feet up to and including 9 feet high: 3 inches o.d.

3. 10 feet up to and including 12 feet high: 4 inches o.d.

4. Over 12 feet to 16 feet high: 4 inches o.d.

5. Horizontal Framework Members: Intermediate, top and bottom rails complying with ASTM F 1043. Size in accordance with the following guidelines unless otherwise indicated on drawings:

6. Top, Intermediate and Bottom Rail: 1.66 inches in diameter.

a. Bottom Rail: Provide bottom rail for:

1) Fence 9 feet high and over

b. Intermediate Rail: Provide intermediate rail for:

1) Fencing 10 feet high and over,

7. Brace Rails: Comply with ASTM F 1043.

2.4 TENSION WIRE

A. Polymer-Coated Steel Wire: For use on fencing with polymer coated fence fabric. 0.177-inch-diameter (7 gauge core), tension wire complying with ASTM F 1664, Class 2b over zinc-coated steel wire.

1. Color: Match chain-link fabric, complying with ASTM F 934.

2.5 FITTINGS

A. General: Comply with ASTM F 626.

B. Post Caps: Provide for each post. Post caps to be weather-tight, securely fastened and vandal-resistant.

1. Provide line post caps with loop to receive tension wire or top rail.

C. Rail and Brace Ends: For each gate, corner, pull, and end post.

D. Rail Fittings: Provide the following:

1. Top Rail Sleeves: Pressed-steel or round-steel tubing not less than 6 inches long.

2. Rail Clamps: Line and corner boulevard clamps for connecting intermediate and bottom rails in the fence line-to-line posts.

E. Tension and Brace Bands: Pressed steel.

F. Tension Bars: Steel. Length not less than 2 inches shorter than full height of chain-link fabric with minimum cross-section of 3/16 inch x 3/4 inch. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

G. Truss Rod Assemblies: Steel, hot-dip galvanized after threading. Provide rod and turnbuckle or other means of adjustment.

H. Tie Wires, Clips, and Fasteners: According to ASTM F 626.

1. Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:

a. General Use Fencing.

1) Aluminum: ASTM B 211; Alloy 1350-H19; 0.148-inch-diameter, mill-finished wire. Coating to match chain-link fence fabric. (Provide coating to match framework.)

2. Hog Rings: For attaching chain link fabric to bottom tension wire.

a. Material: Aluminum per ASTM B 211; Alloy 1350-H19; 0.192 inch (6 gauge), mill-finished wire.

I. Fitting Finish:

1. Steel or cast iron: Galvanized Coating for Pressed Steel or Cast Iron - Not less than 1.2 oz. /sq. ft. zinc.

a. Coating - Coating to match framework.

2. Aluminum: Mill finish with coating to match framework.

3. Color: To match color of fence fabric.

J. Fasteners:

1. Material to be stainless steel.

a. Coating - Coating to match framework.

2. Color: To match color of fence fabric.

3. Finish: Install fasteners that are no more than ¼ Inch long.

2.6 SWING GATES

A. General: Comply with ASTM F 900 for gate posts and single and double swing gate types.

1. Gate Leaf Width: 48 inches unless otherwise noted on drawings.
2. Gate Fabric Height: As indicated on drawings.

B. Pipe and Tubing:

1. Coating and finish to match fence framing.

2. Gate Post Size:

a. For gate heights over 6', and if gate height is equal to fence height, then standard fence framing end post requirements shall apply. Refer to Post and Rail requirements.

b. Gate Leaf up to 6 feet Wide: 2.875 inches o.d.; 4.64 lbs./l.f.

c. Gate Leaf over 6 feet and under 12 feet wide: 4 inches o.d.; 6.56 lbs./lin. ft. (weight applicable to Group IC SS40 framework only)

d. Gate Leaf over 12 feet Wide: 6.625 inches o.d.; 19 lbs./lin. ft.; or 4.5 inches o.d. (applicable to Group IC SS40 material complying with ASTM F 1043 only and upon approval of framework material by Architect.)

C. Frame Corner Construction: Welded.

D. Swing Gate Hardware:

1. Hinges: 180-degree inward swing unless otherwise noted on Drawings.

2. Latches: Commercial latch permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.

3. Padlock and Chain: Owner furnished.

4. Keeper: Provide keeper for all vehicular gates, which automatically engages gate leaf and holds it in open position until manually released. Provide sleeve to insert keeper. For concrete paving, set sleeve directly into concrete. For asphalt paving set sleeve into concrete collar.

5. Double Gates: Provide drop bar for all double gates, consisting of hot-dipped galvanized rod that drops into concrete collar. Provide locking device and padlock eyes as an integral part of the latch, requiring one padlock for locking both gate leaves.

6. Closer: Manufacturer's standard.

7. Color: To match fence fabric.

E. Barbed wire system

1. Barbed wire support arms: Shall be Single arm type, for three barbed wire strands. When installed, the barbed wire support arms shall project at an angle of 45° from the plane of the fence line and the outer strand of barbed wire shall be positioned 12-inches nominal distance horizontally from the fence line. Design shall allow intermediate strands of barbed wire to be uniformly spaced between the strand on the end of the support arm and the fabric. All support arms shall be fitted with clips or slots for attaching the barbed wire to the support arm. Support arms shall be capable of withstanding a vertical load of 250 pounds (lbs) where the outer strand of barbed wire connects to the arm. Finish and color: Match PVC fence fabric.

2. Barbed wire: Three strands per support arm.

a. Wire strands shall consist of two (2) minimum 12.5-gauge, 0.099" twisted line wires with minimum 14-gauge, 0.080" round barbs. Barbed wire shall be aluminum coated steel, aluminum alloy, or PVC over zinc-coated steel as specified below. All barbs shall consist of four points with spacing of barbs at 5" O.C along the strand.

1) Aluminum-coated steel barbed wire: Aluminum-coated steel barbed wire shall have an aluminum coating of at least 0.30 ounces per square foot of coated surface area and comply with ASTM A 428. Solid aluminum barbs are acceptable.

2) Aluminum alloy barbed wire. Aluminum alloy barbed wire and barbs shall conform to the chemical composition of ASTM B 211, Alloy 6061-T94.

3) PVC coated steel barbed wire: PVC coated steel barbed wire and barbs shall have a PVC coating of at least 0.007" thickness. Wire shall be coated with a minimum of 0.30 ounces of zinc per square foot of coated surface area. PVC color to match fence fabric.

2.7 CHAIN LINK FENCE CAP

A. Description:

1. Basis-of Design-Product: Subject to compliance with requirements, provide "Premium Fence Guard" Fence Cap (Product #01166); or equivalent product supplied by: Mid-America Sports Advantage, Inc. M.A.S.A. / Osborne Innovative Products, 1413 S. Meridian Road, Jasper, Indiana 47546 Telephone: 1-800-264-4519, Web: www.sportsadvantage.com

2. Product Specification:

a. Material: Polyethylene
b. Size: 3-inch wide, 4½-inch tall
c. Shape: Professional teardrop shaped profile
d. Weather-treated and UV protected

e. Color: Architect to select from manufactures catalog
f. Installation: On top of chain link fencing. Secure with matching color UV resistant, plastic fence cap ties, installed every two (2) feet
g. Thickness: 0.10 inch Wall Thickness
h. Warranty: Minimum 5-Year

2.8 CONCRETE

A. Concrete Footings: Refer to Division 03 concrete section for cast-in-place concrete, ASTM F 567 Section 5 and Drawings and Details for footing size. Bottom of footing must not be smaller than the top to prevent frost heaving.

2.9 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107 and compatible with galvanized and clear coatings. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer, for exterior applications. To be compatible with galvanized and clear coatings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.

1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

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

C. Beginning installation constitutes Contractor’s acceptance of substrates and conditions.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 INSTALLATION, GENERAL

A. Install chain-link fencing to comply with ASTM F 567 and more stringent requirements indicated.

1. Install fencing on established boundary lines inside property line.

3.4 CHAIN-LINK FENCE INSTALLATION

A. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

B. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil. Mechanically driven posts only allowed if shown on Drawings or specifically approved by Architect.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.

a. Concrete Fill: Minimum 28-day compressive strength 4,000 psi. Refer to Division 03 Section "Cast-in-Place Concrete."
b. Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

C. Types of Post Footings: As indicated on Drawing or as approved by Architect.

1. Exposed Concrete: Extend 2 inches above grade; shape and smooth to shed water.

2. Concealed Concrete: As indicated on Drawings to allow covering with surface material.

3. Posts Set into Concrete in Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.

D. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.

E. Line Posts:

1. General Use Fencing: Space line posts uniformly at 10 feet o.c. unless otherwise indicated on Drawings.

F. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.

1. Locate horizontal braces at midheight of fabric 72 inches or higher, on fences with top rail and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

G. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with hog rings spaced a maximum of 24 inches o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:

1. Extended along bottom of fence fabric. Install bottom within 6 inches of bottom of fabric and tie to each post with tie wires.

H. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps / loop caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps / loop caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer. Connection sleeves to be located / supported by post caps / loop caps.

I. Intermediate and Bottom Rails: Install and secure to posts with fittings.

J. Chain-Link Fabric: Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

1. Height of fabric between finished grade and bottom selvage.

a. General Use: Leave 2 inches between finished grade or surface and bottom of selvage unless otherwise indicated.

2. Fabric installation on fence posts relative to adjacent use:

a. General Use: Apply fabric to inside of enclosing fence posts / framework as indicated on Drawings.

K. Tension or Stretcher Bars: Thread bar through first row of diamonds of fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches o.c.

L. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric per ASTM F 626. Aluminum ties: Both ends of the tie are to make two complete wraps around wire pickets. Bend ends of wire to minimize hazard to individuals and clothing.

1. Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches o.c.

3.5 FENCE INSTALLATION ADJACENT TO BUILDING WALL OR COLUMN

A. Install fencing and gates with maximum 2” gap between fence post and building wall or column unless otherwise noted.

3.6 SWING GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.7 BARBED WIRE SYSTEM (Support Arms and Wire)

A. Provide at all water tank and water tank building area perimeter 8'-ht. fencing and gates.

B. Barbed wire support arms: Base of support arm shall be clamped securely. Permanent deflection of vertical 250-lb load where the outer strand of barbed wire connects to the arm, is cause for rejection.

C. Three strands of barbed wire shall be uniformly spaced, and attached with bands, clips or eyebolts. Stretch chain link fence and fabric prior to stretching barbed wire system.

3.8 CHAIN LINK FENCE CAP

A. Provide at all synthetic turf area perimeter 4'-ht. fencing and gates.
B. Install per manufacturer's requirements.

3.9 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain chain-link fences and gates.

3.11 COMPLETION AND CLEAN UP

A. Leave the area of installation free of debris and excess soil, concrete, and gravel resulting from installation of the fence. Clean fencing of concrete slurry, hydroseeding overspray and any other excess material. Provide fine grade adjustments, seed and mulch all areas around the fencing where bare earth is left exposed.

END OF SECTION 32 31 13

SECTION 32 32 23 - SEGMENTAL RETAINING WALLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes segmental retaining walls with soil reinforcement.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design segmental retaining walls, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated. Include factors affecting the wall design, including adjacent fence posts, railings, fence post foundation systems and adjacent loading in the design and structural calculations.

B. Structural Performance: Engineering design shall be based on the following loads and be according to NCMA's "Design Manual for Segmental Retaining Walls."

1. Gravity loads due to soil pressures resulting from grades and sloped backfill indicated.
2. Superimposed loads (surcharge) indicated on Drawings.

C. Seismic Performance: Engineering design shall be based on the following loads and factors and be according to NCMA's "Segmental Retaining Walls - Seismic Design Manual."

1. Gravity loads due to soil pressures resulting from grades and sloped backfill indicated.
2. Superimposed loads (surcharge) indicated on Drawings.
3. Applicable Horizontal Peak Ground Acceleration (A)

1.4 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform the following preconstruction testing if required for delegated design:

1. Test soil reinforcement and backfill materials for pullout resistance according to ASTM D 6706.
2. Test soil reinforcement and backfill materials for coefficient of friction according to ASTM D 5321.

1.5 ACTION SUBMITTALS

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

1. SRW units, including wall, capstone, and endwall units.

a. Include freeze-thaw durability, shear strength according to ASTM D 6916 and connection strength according to ASTM D 6638.

2. Geotechnical soil reinforcement.

B. Samples for Initial Selection: For concrete units.

1. Only required if product is not specified as Basis-of-Design manufacturer below.

C. Samples for Verification: For each color and texture of concrete unit required. Submit sections of units not less than 3 inches square.

D. Delegated-Design Submittal: For segmental retaining walls indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified professional engineer.

1.7 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects.

1. Build mockup of segmental retaining wall approximately 72 inches long by not less than 36 inches high.

a. Include typical soil reinforcement.
b. Include typical base and cap or finished top construction.
c. Include backfill to typical finished grades at both sides of wall.
d. Include typical end construction at one end of mockup.
e. Include 36-inch return at 1 end of mockup, with typical corner construction.

2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store and handle concrete units and accessories to prevent deterioration or damage due to contaminants, breaking, chipping, or other causes.

B. Store geosynthetics in manufacturer's original packaging with labels intact. Store and handle geosynthetics to prevent deterioration or damage due to sunlight, chemicals, flames, temperatures above 160 deg F or below 32 deg F, and other conditions that might damage them. Verify identification of geosynthetics before using and examine them for defects as material is placed.

PART 2 - PRODUCTS

2.1 SEGMENTAL RETAINING WALL UNITS

A. Concrete Units: ASTM C 1372, Normal Weight, except that maximum water absorption shall not exceed 7 percent by weight and units shall not differ in height more than plus or minus 1/16 inch from specified dimension.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product listed or comparable product by a licensee of one of the following:

    a. Unilock / Risi Stone
    b. Redi-Rock International.
    c. Techo-Block
    d. Belgard Hardscapes, Inc.

B. Products:

1. Segmental Wall System

    a. Machine placed wall modules:

        1) Standard “500” Unit – 7.25” x 47.25” x 20” Nominal

            a) Weight – 570 lbs.

        2) Standard “333” Unit – 7.25” x 47.25” x 13” Nominal

            a) Weight – 379 lbs.

        3) Standard “925” Unit – 7.25” x 47.25” x 36” Nominal

            a) Weight – 1102 lbs.

        4) Coping Unit – 7.25” x 47.25” x 20” Nominal

            a) Weight – 425 lbs.

    b. Wall batter: 1H : 8V

    c. Basis-of-Design Product: Subject to compliance with requirements, provide Unilock Risi Stone “SienaStone Colossal Wall” Gravity Retaining Wall System or comparable product.

C. Maximum moisture absorption rate: 5%

D. Minimum 28-day compressive strength: 5000 psi as tested in accordance with ASTM C 140.

E. Provide units that interlock with courses above and below by means of integral lugs or lips.

F. Color: As selected by Architect from manufacturer's full range.

G. Shape and Texture: Provide units matching basic shape, dimensions, and face texture indicated by referencing manufacturer's pattern designation.

H. Batter: Provide units that offset from course below to provide batter as indicated by referencing manufacturer's pattern designation.

I. Cap Units: Provide cap units manufactured for specific product type with smooth, as-cast top surfaces, designed to be exposed on all sides.

J. Special Units: Provide corner units, end units, and other shapes as needed to produce segmental retaining walls of dimensions and profiles indicated and to provide texture on exposed surfaces matching face unless otherwise indicated by referencing manufacturer's pattern designation.

2.2 INSTALLATION MATERIALS

A. Cap Adhesive: Product supplied or recommended by segmental retaining wall unit manufacturer for adhering cap units to units below.

B. Leveling Base: Comply with requirements for Type 2 Granular Fill in Section 31 20 00 "Earth Moving" for base material.

1. Leveling Course: Contractors option - to use lean concrete with a compressive strength of not more than 500 psi.

C. Drainage Fill: Comply with requirements in Section 31 20 00 "Earth Moving."

D. Reinforced-Soil Fill: Unless otherwise indicated by delegated design, provide soil that is free of debris, waste, frozen materials, vegetation, and other deleterious matter; meeting the following gradation according to ASTM C 136: 20 to 100 percent passing No. 4 sieve, 0 to 60 percent passing No. 40 sieve, 0 to 35 percent passing No. 200 sieve, and with fine fraction having a plasticity index of less than 20.

E. Nonreinforced-Soil Fill: Unless otherwise indicated by delegated design, comply with requirements in Section 312000 "Earth Moving" for satisfactory soils.

F. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent.

1. Apparent Opening Size: No. 70 to 100 sieve, maximum; ASTM D 4751.
2. Minimum Grab Tensile Strength: 110 lb; ASTM D 4632.
3. Minimum Weight: 4 oz./sq. yd..

G. Subdrainage Pipe and Pipe Filter Fabric: Comply with requirements in Section 33 41 00 "Storm Utility Drainage Piping."

H. Soil Reinforcement: Product specifically manufactured for use as soil reinforcement, is compatible with the product being used and as follows:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mirafi Construction Products; Ten Cate Nicolon or comparable product.

I. Direct manufacturer to test and inspect each roll of soil reinforcement at the factory for minimum average roll values for geosynthetic index property tests, including the following:

1. Weight.
2. Roll size.
3. Grab or single-rib strength.
4. Aperture opening.
5. Rib or yarn size.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for excavation tolerances, condition of subgrades, and other conditions affecting performance of segmental retaining walls.

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

3.2 RETAINING WALL INSTALLATION

A. General: Place units according to NCMA's "Segmental Retaining Wall Installation Guide" and segmental retaining wall unit manufacturer's written instructions.

1. Lay units in running bond.
2. Form corners and ends by using special units.

B. Leveling Base: Place and compact base material to thickness indicated and with not less than 95 percent maximum dry unit weight according to ASTM D 698.

1. Leveling Course: At Contractor's option, unreinforced lean concrete may be substituted for upper 1 to 2 inches of base. Compact and screed concrete to a smooth, level surface.

C. First Course: Place first course of segmental retaining wall units for full length of wall. Place units in firm contact with each other, properly aligned and level.

1. If using lean concrete leveling course, tamp units into leveling base as necessary to bring tops of units into a level plane.

D. Subsequent Courses: Remove excess fill and debris from tops of units in course below. Place units in firm contact, properly aligned, and directly on course below.

1. For units with lugs designed to fit into holes in adjacent units, lay units so lugs are accurately aligned with holes, and bedding surfaces are firmly seated on beds of units below.

E. Cap Units: Place cap units and secure with cap adhesive.

3.3 FILL PLACEMENT

A. General: Comply with requirements in Section 312000 "Earth Moving" NCMA's "Segmental Retaining Wall Installation Guide," and segmental retaining wall unit manufacturer's written instructions.

B. Fill voids between and within units with drainage fill. Place fill as each course of units is laid.

C. Place, spread, and compact drainage fill and soil fill in uniform lifts for full width and length of embankment as wall is laid. Place and compact fills without disturbing alignment of units. Where both sides of wall are indicated to be filled, place fills on both sides at same time. Begin at wall and place and spread fills toward embankment.

1. Use only hand-operated compaction equipment within 48 inches of wall, or one-half of height above bottom of wall, whichever is greater.

2. Compact reinforced-soil fill to not less than 95 percent maximum dry unit weight according to ASTM D 698.

a. In areas where only hand-operated compaction equipment is allowed, compact fills to not less than 90 percent maximum dry unit weight according to ASTM D 698.
b. In areas where fill height exceeds 15 feet compact reinforced-soil fill that will be more than 15 feet below finished grade to not less than 98 percent.

3. Compact nonreinforced-soil fill to comply with Section 312000 "Earth Moving."

D. Place drainage geotextile against back of wall and place layer of drainage fill behind drainage geotextile to within 12 inches of finished grade. Place another layer of drainage geotextile between drainage fill and soil fill. Refer to Drawings for depth of drainage fill.

E. Wrap subdrainage pipe with filter fabric and place in drainage fill as indicated, sloped not less than 0.5 percent to drain unless otherwise noted on Drawings.

F. Slope grade at top of wall away from wall unless otherwise indicated. Slope grade at base of wall away from wall. Provide uniform slopes that will prevent ponding.

G. Place soil reinforcement in horizontal joints of retaining wall where indicated and according to soil-reinforcement manufacturer's written instructions. Embed reinforcement a minimum of 8 inches into retaining wall and stretch tight over compacted backfill. Anchor soil reinforcement before placing fill.

1. Place additional soil reinforcement at corners and curved walls to provide continuous reinforcement.
2. Place geosynthetics with seams, if any, oriented perpendicular to segmental retaining walls.
3. Do not dump fill material directly from trucks onto geosynthetics.
4. Place at least 6 inches of fill over reinforcement before compacting with tracked vehicles or 4 inches before compacting with rubber-tired vehicles.
5. Do not turn vehicles on fill until first layer of fill is compacted and second layer is placed over each soil-reinforcement layer.

3.4 WALL CONSTRUCTION TOLERANCES

A. Variation from Level: For bed-joint lines along walls, do not exceed 1-1/4 inches in 10 feet, 3 inches maximum.
B. Variation from Indicated Batter: For slope of wall face, do not vary from indicated slope by more than 1-1/4 inches in 10 feet.
C. Variation from Indicated Wall Line: For walls indicated as straight, do not vary from straight line by more than 1-1/4 inches in 10 feet.

3.5 FIELD QUALITY CONTROL

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

B. Comply with requirements in Section 31 20 00 "Earth Moving" for field quality control.

1. In each compacted backfill layer, perform at least 1 field in-place compaction test for each 24 inches of fill depth and each 50 feet or less of segmental retaining wall length.

3.6 ADJUSTING

A. Remove and replace segmental retaining wall construction of the following descriptions:

1. Broken, chipped, stained, or otherwise damaged units. Units may be repaired if Architect approves methods and results.
2. Segmental retaining walls that do not match approved Samples and mockups.
3. Segmental retaining walls that do not comply with other requirements indicated.

B. Replace units so segmental retaining wall matches approved Samples and mockups, complies with other requirements, and shows no evidence of replacement.

END OF SECTION 32 32 23

SECTION 32 50 00 - BOLLARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pre-fabricated bollards.
2. Bollard covers.

1.3 SUBMITTALS, GENERAL

A. General: Submit all action submittals (except Samples for Verification) and informational submittals required by this Section concurrently.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Bollard components and materials
2. Bollard covers.

B. Shop Drawings: Show fabrication and installation details for bollards.

1. Include plans, elevations, sections, and details of bollards and their connections. Show anchorage and accessory items.

1.5 QUALITY ASSURANCE

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

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of construction contiguous with bollards by field measurements.

1.7 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.2 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
B. Steel Tubing: ASTM A 500, cold-formed steel tubing.

2.3 NONFERROUS METALS

A. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.

2.4 FASTENERS

A. General: Unless otherwise indicated, provide Type-316 stainless-steel fasteners. Select fasteners for type, grade, and class required.

2.5 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Acrylic Primer: Thermoplastic acrylic primer compatible with topcoat.

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. Rust-Oleum Corporation; 3200 System Clear Blue Undercoat.

C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

D. Concrete: Comply with requirements in “Section 03 30 00 "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3,000 psi.

2.6 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

2.7 BOLLARD COVERS

A. Plastic Bollard Cover: Heavy duty plastic bollard cover that fits over standard site-fabricated steel bollard.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Ideal Shield, Plastic Bollard Cover, ¼" thick polyethylene or comparable product.
2. Materials: 1/4" thick UV resistant and anti-static LDPE plastic sleeve, domed at top.
3. Sleeve for pipe diameter: 6-inch.
4. Color: Yellow. Color warrantied for five-years min.

2.8 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
B. Finish metal fabrications after assembly.
C. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.9 STEEL AND IRON FINISHES

A. Baked-Enamel, Powder-Coat Finish: Manufacturer's standard, baked, polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

C. Primer: Provide high performance shop primer in conformance with Section 09 96 00, "High Performance Coatings".

D. Painting: Apply high performance coatings in conformance with Section 09 96 00, "High Performance Coatings".

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

C. Coordinate location to avoid utilities.

D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

E. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

G. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 INSTALLING PLASTIC BOLLARD COVERS

A. Install with manufacturer’s neoprene adhesive tape per manufacturer’s installation guidelines.

3.3 ADJUSTING AND CLEANING

A. Clean all surfaces thoroughly and protect until acceptance.

END OF SECTION 32 50 00

SECTION 32 92 00 - TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Seeding.
2. Hydroseeding.
3. Turf planting soil.
4. Turf planting soil amendments and fertilizers.
5. Turf renovation.
6. Turf
7. Turf maintenance.

1.3 SUBMITTALS, GENERAL

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.4 ACTION SUBMITTALS

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

1. Seed.
2. Fertilizer.
3. Compost.
4. Imported Topsoil.

B. Samples for Verification: For the following products, in sizes or quantities indicated below:

1. Imported and On-Site Topsoil: One-half gallon by volume of material in sturdy container of each type of topsoil, naming source for each material.
2. Compost: One-quart container of material.

C. Warranty: Sample of special warranty.

1.5 INFORMATIONAL SUBMITTALS

A. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

B. Qualification Data: For qualified landscape Installer.

C. Product Certificates: For soil amendments and fertilizers, from manufacturer.

D. Material Test Reports:

1. Imported Topsoil: Before delivery, submit written statement giving location of properties from which topsoil is to be obtained, names and addresses of property owners, analysis of topsoil, depth to be stripped, and any crops grown during the previous 5 years.

2. Compost: Before delivery, submit a recent US Composting Seal of Testing Assurance Program data sheet.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required initial maintenance periods.

B. Warranty: Executed special warranty.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf establishment.

1. Turf Installer: Engage an experienced turf installation firm to perform work of this Section that has installed at least seven (7) acceptable projects of the type specified within past 5 years. Provide location and reference contacts for each of the submitted projects.

2. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.

3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor with certifications outlined below on Project site when work is in progress.

4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:

a. Certified Turfgrass Professional, designated CTP.
b. Certified Turfgrass Professional of Cool Season Lawns, designated CTP-CSL.

B. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; available nutrients; deleterious material; pH and recommendations to obtain optimal pH factor; mineral and plant-nutrient content of the soil; map with locations where each sample was collected; date, time and weather when samples were collected; and name of person who collected the samples.

1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.

2. The soil-testing laboratory shall oversee soil sampling, with depth, location, and number of samples to be taken per instructions from Architect. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.

3. Report suitability of tested soil for turf growth.

a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1,000 sq. ft. or volume per cu. yd. 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, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

1.8 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. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

3. Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.

1.9 PROJECT CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting completion.

1. Spring Planting: March 15 to May 15.
2. Fall Planting: August 15 to September 15.

B. Hydroseeding Restrictions: Do not hydroseed without prior written permission of the Architect.

C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

1.10 SEQUENCING AND REVIEW

A. Notify Architect no fewer than **72-**hours in advance of proposed seeding to allow review of topsoil finish grading.

B. Do not proceed with seeding without Architect's written permission.

1. Architect’s written permission does not alleviate Contractor from conforming to the required grades indicated on Drawings.

1.11 MAINTENANCE

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, as determined by the Architect, but for not less than the following periods:

1. Seeded Turf: Five (5) documented mowings.

a. Document mowings in writing via fax or email to Owner and Architect on the day each mowing is performed. Failure of notification may subject Contractor to further mowings at no additional cost to Owner.

2. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

B. Water: Provide all water required to properly irrigate temporary, permanent, and renovated turf areas. Include all facilities including, but not limited to, hoses, sprinklers, water cannons and reels, as long as it takes to establish and maintain turf. When adequate water supply or pressure is not available, supply water from offsite, including trucking.

1.12 WARRANTY

A. Special Warranty: Installer agrees to repair or replace turf that fails in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner, or incidents that are beyond Contractor's control.

2. Warranty Period:

a. Turf: 12 months, after acceptable turf is established, as determined by the Architect.

3. Include the following remedial actions as a minimum:

a. Immediately remove dead turf and replace unless required to plant in the succeeding planting season.
b. Replace with seed as originally specified.

B. Provide extended warranty for period equal to original warranty period, for replaced turf material.

PART 2 - PRODUCTS

2.1 SEED

A. Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Blends: Seed blend with not less than 95 percent germination, not less than 85 percent live seed, and not more than 0.5 percent weed seed.

1. If premixed blend, follow manufacturer’s recommended maximum seeding rate unless otherwise noted.

C. Lawn Seed:

1. Varieties: Premier varieties of Kentucky bluegrass, perennial ryegrass, tall fescue and fine fescue with a mean ranking of 6.0 or higher on the National Turfgrass Evaluation Program (NTEP) current list of tested varieties for the Northeast United States.

D. Seed Blends: Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:

1. General Lawn Mixture-Tall Fescue/Kentucky Bluegrass Blend: Proportioned by weight as follows:

   a. 85 percent tall fescue (Festuca arundinacea).
   b. 15 percent Kentucky bluegrass (Poa pratensis).

2. Athletic Field Blend (Tall fescue/Kentucky Bluegrass): Proportioned by weight as follows:

   a. 75 percent tall fescue.
   b. 25 percent Kentucky Bluegrass

3. Conservation / Detention Basin Seed Blend: Provide native grass and forb seed mix containing the following varieties: Panicum clandestinum (Deertongue, "Tioga"); Carex vulpinoidea (Fox Sedge); Elymus virginicus (Virginia Wildrye); Panicum virgatum "Shawnee" (Switchgrass, "Shawnee"); Agrostis perennans (Autumn Bentgrass); Agrostis scabra (Rough Bentgrass); Juncus effuses (Soft Rush); Juncus tenuis (Path Rush); Scirpus atrovirens (Green Bulrush).

   a. Basis-of-Design Product: Subject to compliance with requirements, provide product manufactured by Ernst Conservation Seeds, Inc. "Native Detention Area Mix", or comparable product.

2.2 INORGANIC SOIL AMENDMENTS

A. Perlite: Horticultural perlite, soil amendment grade.
B. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.
C. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.

2.3 ORGANIC COMPOST

A. Compost: Organic product manufactured through the controlled aerobic, biological decomposition of biodegradable materials which involves mesophilic and thermophilic temperatures to reduce weed seeds and stabilize carbon content. Manufacturing facility is to be registered and/or permitted by New York State Department of Environmental Conservation and is to comply with their requirements.

B. Compost requirements:

Parameters	Units of Measure	Range	Analysis Method
pH	pH units	5.8-7.8	TMECC 04.11-A
Soluble Salts Concentration (electrical conductivity)	dS/m (mmhos/cm)	Maximum 6	TMECC 04.10-A

Moisture Content	%, wet weight basis	20-50	TMECC 03.09-A
Organic Matter Content	%, dry weight basis	Minimum 60	TMECC 05.07-A
Particle Size	% passing a selected mesh size, dry weight basis	97-100% Passing 3/8”	TMECC 02.02-B or ASTM D 2977
C:N Ratio	Ratio, dry weight basis	5:1 – 30:1	TMECC 05.02-A
Physical Contaminants (man-made inerts)	%, dry weight basis	<.50	TMECC 03.08

C. Mix with existing and imported topsoils in ratio designated in “Turf Planting Soil” Article below. Compost must be provided for both existing and imported topsoil, with the exception of topsoil with 10% of organic content and above.

D. Compost testing is to be in accordance with the US Composting Seal of Testing Assurance Program.

E. Basis-of-Design Product: Subject to compliance with requirements, provide one of the following or a comparable product:

1. Naturcycle Compost, Naturcycle LLC
2. WeCare Compost, WeCare Organics
3. Sustane Concentrated Compost 2-6-3, Sustane Natural Fertilizer, Inc.
4. Agresource, Inc. - Agresoil Compost

2.4 FERTILIZERS

A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 20 percent phosphoric acid.

B. 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, unless otherwise indicated:

1. Spring Fertilization: 10 percent nitrogen, 6 percent available phosphorous, and 4 percent water-soluble potash (10-6-4).

2. Fall Fertilization: 5 percent nitrogen, 10 percent available phosphorous, and 5 percent water-soluble potash (5-10-5).

3. Final Fertilization:

   a. Spring: Granular slow release fertilizer with high nitrogen (38 percent), Uramite or other Architect-approved material.
   b. Fall: "Fall Fertilization" composition above.

4. Follow requirements regarding fertilization recommended in soil reports from a qualified soil-testing laboratory.

2.5 TURF PLANTING SOILS

A. General: Provide turf planting soil consisting of existing and/or imported topsoil with amendments and fertilizers noted in this Section. Unamended existing or imported topsoil is not acceptable as turf planting soil.

1. Where quantities of existing topsoil are insufficient to provide 6 inch depth turf planting soil, supplement with imported topsoil, at no additional cost to Owner.

B. Topsoil Requirements: Free of subsoil, stones 1 inch or larger in any dimension, dense material, hardpan, slag, clay, cinders, sod, roots, sticks, poison ivy, crabgrass, cough grass, noxious weeds, and foreign matter, including but not limited to glass, screws, asbestos, toxins, hazardous wastes, petroleum product contamination, lead and chemicals (such as atrizene and muriatic acid) that may be injurious to humans, animals and plant materials.

1. Mechanically screen topsoil to conform to following gradations:

Sieve Designation	Percent Passing
1 inch	100
1/4 inch	97-100
#200	20-65 of the 1/4-inch sieve

2. No more than 60 percent of material passing #100 mesh shall consist of clay as determined by Bouyoucous hydrometer or by decantation method.

3. Topsoil to comply with the following:

   a. Organic Matter Content: Not more than 10 percent.
   b. Corrected to pH Value: 6.5 to 7.5 on that portion passing 1/4-inch sieve.
   c. Soluble Salt Content: Not to exceed 500 parts per million.

C. Existing Topsoil: Existing, native surface topsoil formed under natural conditions with the duff layer retained during excavation process and stockpiled on-site. Verify suitability of native surface topsoil to produce viable planting soil.

1. Provide soil analysis per requirements in Part 1 of this Section.

D. Imported Topsoil: Imported topsoil obtained from local sources or from areas having similar soil characteristics as Project site. Obtain topsoil displaced from naturally well-drained sites where topsoil occurs at least 6 inches deep; do not obtain from agricultural land, bogs or marshes.

1. Additional Properties of Imported Topsoil or Manufactured Topsoil: Screened and free of stones 1 inch or larger in any dimension; free of roots, plants, sod, clods, clay lumps, pockets of coarse sand, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials harmful to plant growth; free of obnoxious weeds and invasive plants including quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass; not infested with nematodes, grubs, other pests, pest eggs, or other undesirable organisms and disease-causing plant pathogens; friable and with sufficient structure to give good tilth and aeration. Continuous, air-filled, pore-space content on a volume/volume basis shall be at least 15 percent when moisture is present at field capacity. Soil shall have a field capacity of at least 15 percent on a dry weight basis.

2. Provide soil analysis per requirements in Part 1 of this Section.

E. Required Amendments: Mix existing and imported topsoil with the following soil amendments in the following quantities to produce planting soil:

1. Organic Compost:

a. Ratio of Loose Compost to Blended Topsoil: For bidding purposes, provide 1-part compost to 5-parts blended topsoil, or as directed by soil testing analysis if compost is required as part of soil amendments. For natural turf athletic fields, tailor amount to achieve 8% organics. This amount of compost is required regardless of organic content of native or imported topsoil.

b. Regardless of topsoil organic content, add organic compost to all turf planting soils, including topsoils placed on slopes and in stormwater basins, swales and biofiltration areas.

2. pH Adjustment: Apply approved calcium or sulfur compounds to correct pH level to be between 6.5 and 7.5 or as recommended by soil analysis report.

3. Soil Analysis Recommendations: Provide nutritional and other amendments recommended in the soil analysis report, as approved by Architect.

4. Provide fertilizer per “Fertilizer” Article above.

2.6 TOPDRESSING SAND

A. Provide processed sand tested to meet the following requirements per ASTM-F-1632.

B. Processed Sand: The sand shall meet the following particle size criteria:

	Sieve Mesh	Diameter of Sieve (mm)	Allowable Range % retained
Coarse Gravel	5	4.00	0%
Fine Gravel	10	2.00	0-5%
Very Coarse Sand	18	1.00	0-20% combined with gravel
Coarse	35	0.50	20-50%
Medium	60	0.25	20-40%
Fine	100	0.15	20% maximum
Very Fine	270	0.50	5% maximum
Silt & Clay			3% maximum

1. Sand is to have a coefficient of uniformity not exceeding 3.5 (D60/D10).
2. Maximum of 5% combined very fine sand, silt and clay allowable.
3. Minimum of 60% in the medium and coarse size fractions required.

2.7 BIORETENTION PLANTING SOIL

A. Bioretention Planting Soil: Screened, natural, fertile, sandy loam or loamy sand per USDA standards capable of sustaining vigorous plant growth, from well drained site free of flooding, not in frozen or muddy condition, not less than 3 percent organic matter, and pH value of 5.9 to 7.0. Free from subsoil, slag, clay, stones, lumps, live plants, roots, sticks, crabgrass, coughgrass, noxious weeds, and foreign matter. Comply with the following requirements:

Item	Percent By Weight	Test Method
Sand (2.0 – 0.050 mm)	40 – 85	AASHTO T88
Silt (0.050 – 0.002 mm)	20 – 50	AASHTO T88
Clay (less than 0.002 mm)	10 – 20	AASHTO T88
Organic Matter	1.5 – 10	AASHTO T194

ASTM E11 Sieve Size	Min. Percent Passing by Weight
2 inch	100
No. 4	90
No. 10	80

Item	Criteria	Test Method
Corrected pH	5.5 – 7.5	ASTM D4972
Magnesium	Minimum 32 ppm	
Phosphorus (Phosphate - P_2O_5)	Not to exceed 69 ppm	
Potassium (K_2O)	Minimum 78 ppm	

2.8 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

2.9 HYDROSEEDING MATERIALS

A. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

B. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

2.10 EROSION-CONTROL MATERIALS

A. Refer to Section 31 25 00 “Erosion and Sedimentation Controls.”

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.

2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.

3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.

4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

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

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

D. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
2. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

A. Limit turf subgrade preparation to areas to be planted.

B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 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.

C. Bulk-mix screened topsoil, soil amendments, organic compost and fertilizer, and thoroughly blend planting soil.

1. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
2. If soil testing recommendations do not provide fertilizer application quantities, provide application rate of 1 lb. of nitrogen per 1,000 square feet.
3. If liming is required, mix lime with dry soil before mixing fertilizer.

D. If topsoil is to remain in place, thoroughly incorporate the additives into the top 6 inches of topsoil.

E. 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.

1. Spread approximately 1/3 the thickness of planting soil over loosened subgrade. Mix thoroughly into top 2 inches of subgrade. Spread remainder of planting soil.

F. Unchanged Subgrades: If topsoil is to remain in place, prepare surface soil as follows:

1. Cut neat line between existing turf to remain and new turf.

2. Remove existing grass, vegetation, and turf. Do not mix into surface soil.

3. Loosen surface soil to a depth of at least 6 inches. Uniformly apply the soil amendments, organic compost and fertilizer over the entire area using a compost spreader or similar equipment that will achieve a uniform application, according to planting soil mix proportions and mix thoroughly into top 5 inches of soil. Till soil to a homogeneous mixture of fine texture.

    a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.

4. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.

5. Legally dispose of waste material, including grass, vegetation, and turf.

G. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 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.

H. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

I. Before planting, obtain Architect's written permission; restore planting areas if topsoil finish grading is eroded or otherwise disturbed after finish grading.

3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

A. Erosion Control Matting: If specified, install amended topsoil and seed before erosion control matting is installed. Follow manufacturer’s installation recommendations.

B. Turf reinforcement matting: If specified, install planting soil in two lifts. First lift is installed before the matting is placed. Second lift is placed after the matting is installed by filling the cells of the matting with planting soil. Lightly compact soil before seeding. Follow manufacturer’s installation recommendations.

3.5 SEEDING

A. Timing: Provide seeding within planting times indicated.

1. Seed at earliest possible date to achieve mature turf prior to Owner occupancy.
2. Sow Tall Fescue varieties preferably in fall.

B. Sow seed with Brillion spreader or similar seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in three passes: second pass at 90 degrees to the first, third pass at 45 degrees to second.

1. Do not use wet seed or seed that is moldy or otherwise damaged.
2. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

C. Sow seed at a total rate of 6 lb/1,000 sq. ft., or as directed by soil analysis recommendations.

D. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

E. Protect seeded areas with slopes not exceeding 1:4 as follows:

1. In small areas adjacent to buildings, at parking islands and narrow strips of seeding along paving, spread straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment. Avoid areas of thick mulch that will prevent seed determination.

2. In larger areas, including athletic fields if approved by Architect, mulch by hydromulching.

F. Water newly planted areas and keep moist until new turf is established.

3.6 HYDROSEEDING

A. Prior Permission: Request permission of Architect for hydroseeding. Do not hydroseed without prior written permission of the Architect. Equipment and materials must be submitted and approved before permission to hydroseed will be given.

B. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

1. Mix slurry with fiber-mulch manufacturer's recommended tackifier.

2. Apply slurry uniformly to all areas to be seeded in a **two-step process**.

a. Apply first slurry coat containing mulch and seed at a rate so that mulch component is deposited at not less than 500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.

b. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of 1,000 lb/acre. For slopes greater than 10 percent, apply second coat at 1,500 lb/acre.

3. When hydromulching, avoid overspray on buildings, pavements, signs and other site features. If overspray occurs, clean mulch from all surfaces.

C. Water newly planted areas and keep moist until new turf is established.

3.7 EXISTING TURF RENOVATION/REPAIR – GENERAL (NON-ATHLETIC FIELD) AREAS

A. Renovate existing turf indicated on Drawings, turf areas disturbed as part of Project, and areas damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles. Reestablish turf where settlement or washouts occur or where minor regrading is required and install new planting soil and turf as required below.

1. In areas where turf has been removed, killed, damaged or contaminated:

    a. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.

    b. Remove topsoil containing foreign materials such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.

    c. Till stripped or bare areas thoroughly to a soil depth of 4 inches.

    d. Install new planting soil to fill low spots and meet finish grades.

    e. Apply soil amendments and initial fertilizers required for establishing new turf and mix thoroughly into top 4 inches of soil.

    f. Apply seed and protect with straw mulch as required for new turf.

    g. Water newly planted areas and keep moist until new turf is established.

    h. For other maintenance required, refer to Turf Maintenance section.

2. In areas where existing turf remains:

    a. Mow to height of 2-1/2".
    b. Core aerate in two to three passes at a rate of nine holes minimum per square foot to a minimum depth of 4 inches, and rake existing turf.
    c. Remove weeds.
    d. Remove waste and foreign materials, loose vegetation, and legally dispose of them off Owner's property.
    e. Drag to break up cores or remove them.
    f. Topdress with fine topsoil and overseed if there is less than 90% healthy turf coverage.

3.8 EXISTING TURF RENOVATION/REPAIR – ATHLETIC FIELD AREAS

A. Renovate existing athletic field turf indicated on Drawings or athletic field turf areas disturbed as part of Project as required below:

1. Determine areas that are too high and low to drain properly or that affect playability. Remove sod from those areas and shave down high spots and fill in low spots.

2. Install new planting soil to fill low spots.

3. Remove weeds.

4. Mow to height of 2-1/2".

5. Core aerate with an aerator equipped with ¾" spoons in two to three passes at a rate of thirty holes minimum per square foot to a minimum depth of 4 inches.

6. Apply 50/50 mixture of Topdressing Sand and finely screened or granular Organic Compost (3/8" minus or less) evenly over turf surface using a top dresser or other suitable equipment in a uniform depth of ½".

7. Break up cores and smooth grade with a York rake, weighted chain link fence fabric or other acceptable equipment.

8. Apply seed to bare areas and areas with thin turf coverage per seeding specification.

9. Work should be done in late spring or early fall.

3.9 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.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Use hand weeding to control weeds. Schedule weedings throughout the year to maintain turf as free of weeds as possible.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.

2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

1. Mow turf to a height of 2-1/2 to 3 inches.
2. Neatly trim edges and hand clip where necessary.
3. Immediately after each mowing (same day), carefully remove excess clippings to prevent damage to turf.

D. Turf Postfertilization: Apply fertilizer after initial mowing and when grass is dry.

3.10 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.

B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

C. Warranty period does not begin until satisfactory turf is established, as determined by the Architect.

3.11 CONSERVATION GRASSES

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.

1. Do not use wet seed or seed that is moldy or otherwise damaged.

B. Sow seed at a total rate recommended by manufacturer and approved by Architect.

C. Brush seed into top 1/16 inch of soil, roll lightly, and water with fine spray.

D. Mulch in accordance with manufacturer's recommendations.

E. Water newly planted areas and keep moist until meadow is established.

3.12 CONSERVATION GRASSES MAINTENANCE

A. Maintain and establish conservation grasses by watering, weeding, mowing, trimming, replanting, and performing other operations as required to establish a healthy, viable grasses. Roll, regrade, and replant bare or eroded areas and remulch. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.

B. Watering: Install and maintain temporary piping, hoses, and watering equipment to convey water from sources and to keep planting uniformly moist.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.

2. Water planting with fine spray at a minimum rate of 1/2 inch per week for eight weeks after planting unless rainfall precipitation is adequate.

3. If water is not available or accessible on-site, provided equivalent required quantities via tanker truck.

3.13 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

C. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION 32 92 00

SECTION 32 93 00 - PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Plants.
2. Planting soils.
3. Tree stabilization.
4. Mulch.

1.3 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

C. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required.

D. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

E. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

F. Finish Grade: Elevation of finished surface of planting soil.

G. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

H. 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.

I. 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.

J. Planting Area: Areas to be planted.

K. Planting Soil: Manufactured topsoil that is modified with soil amendments and fertilizers to produce a soil mixture best for plant growth.

L. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

M. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

N. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

O. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

P. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

Q. 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.

1.4 SUBMITTALS, GENERAL

A. General: Submit all action submittals and informational submittals required by this Section concurrently.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, including soils.

1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.

2. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to the Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 20 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.

B. Samples for Verification: For each of the following:

1. Organic Compost Mulch: 1-pint volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.

2. Shredded Bark Mulch: 1-pint volume in sealed plastic bag

3. Weed Control Barrier: 12 by 12 inches.

C. Warranty: Sample of special warranty.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.

B. Material Test Reports:

1. For existing native surface topsoil and imported topsoil.
2. Manufactured planting soil.

C. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before start of required maintenance periods.

1.7 CLOSEOUT SUBMITTALS

A. Warranty: Executed special warranty.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful establishment of plants.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.

2. Experience: Five (5) years of experience in landscape installation in addition to requirements in Section 01 40 00 "Quality Requirements."

3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

4. Personnel Certifications: Installer's field supervisor shall have certification in the following categories from the Professional Landcare Network:

    a. Certified Landscape Technician - Exterior, with installation and maintenance areas, designated CLT-Exterior.

B. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of the soil.

1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.

2. The soil-testing laboratory shall oversee soil sampling; with depth, location, and number of samples to be taken per instructions from Architect. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.

3. Report suitability of tested soil for plant growth.

    a. Based upon the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. or volume per cu. yd. 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, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

    c. Provide recommendations for planting soil amendments and fertilizer types and ratios.

C. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

D. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.

2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

E. Plant Material Observation: Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1. Notify Architect of sources of planting materials seven days in advance of delivery to site.

1.9 DELIVERY, STORAGE, AND HANDLING

A. 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 if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

3. Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.

C. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

D. Handle planting stock by root ball.

E. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F until planting.

F. Deliver plants after preparations for planting have been completed and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.

2. Do not remove container-grown stock from containers before time of planting.

3. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly-wet condition.

1.10 PROJECT CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by Owner or others.

C. Planting Restrictions: Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion. Adjust planting period for plant species that require a specific planting period per industry standards.

D. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

E. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.

1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.11 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Death and unsatisfactory growth, except for defects resulting from incidents that are beyond Contractor's control.
b. Structural failures including plantings falling or blowing over.
c. Faulty performance of tree stabilization and/or other landscaping products provided.
d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Periods from Date of written acceptance of planting by Architect:

a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.

3. Include the following remedial actions as a minimum:

    a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
    b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
    c. A limit of one replacement of each plant will be required except for losses or replacements due to failure to comply with requirements.
    d. Replace plants with material of the same species, quantity and size unless a substitution is approved by the Architect.
    e. Provide extended warranty for period equal to original warranty period, for replaced plant material.

1.12 MAINTENANCE SERVICE

A. Initial Maintenance Service for Trees, Shrubs, Ground Covers and other plants: Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance period below.

1. Maintenance Period: 12 months from date of written acceptance of planting by Architect.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots will be rejected.

2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.

C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

D. Labeling: Label each plant with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature from "Standardized Plant Names" listing by American Joint Committee of Horticulture for hybrid, variety, or cultivar, if applicable for the plant as shown on Drawings.

E. If formal arrangements or consecutive order of plants is shown on Drawings, select stock for uniform height and spread.

2.2 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: T, with a minimum of 99 percent passing through No. 8 sieve and a minimum of 75 percent passing through No. 60 sieve.

2. Provide lime in form of ground dolomitic limestone if additional magnesium is determined by soil testing to be required; provide calcitic limestone or mollusk shells if additional magnesium is not required.

B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent sulfur, with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Aluminum Sulfate: Commercial grade, unadulterated.

E. Perlite: Horticultural perlite, soil amendment grade.

F. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.

G. Sand: Clean, washed, natural or manufactured, and free of toxic materials.

H. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.

2.3 ORGANIC SOIL AMENDMENTS

A. Compost: Well-decomposed, stable, and weed-free organic matter derived from agricultural, food, or industrial residuals; biosolids; animal manures; yard trimmings; or source-separated or compostable mixed solid waste, meeting the following requirements:

Parameters	Units of Measure	Range	Analysis Method
pH	pH units	5.8-7.8	TMECC 04.11-A
Soluble Salts Concentration (electrical conductivity)	dS/m (mmhos/cm)	Maximum 7	TMECC 04.10-A
Moisture Content	%, wet weight basis	20-45	TMECC 03.09-A
Organic Matter Content	%, dry weight basis	40-90	TMECC 05.07-A
Particle Size	% passing a selected mesh size, dry weight basis	97-100% Passing 3/8"	TMECC 02.02-B or ASTM D 2977
C:N Ratio	Ratio, dry weight basis	5:1 – 30:1	TMECC 05.02-A
Physical Contaminants (man-made inerts)	%, dry weight basis	<1	TMECC 03.08

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. Sustane 2-6-3 Concentrated Compost, Sustane Natural Fertilizer, Inc.
    b. WeCare Compost, manufactured by WeCare Organics, LLC; www.wecareorganics.com.
    c. Agresoil Compost, manufactured by Agresource, Inc; www.agresourceinc.com

2.4 FERTILIZERS

A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 1 percent nitrogen and 10 percent phosphoric acid.

B. 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 or as recommended in soil-testing reports.

C. Chelated Iron: If recommended in soil-testing report, provide commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.

2.5 PLANTING SOILS

A. Native Planting Soil: Existing, native surface topsoil formed under natural conditions with the duff layer retained during excavation process and stockpiled on-site. Verify suitability of native surface topsoil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.

1. Supplement with imported planting soil when quantities are insufficient.

2. Mix existing, native surface topsoil with the following soil amendments and fertilizers in the following quantities to produce planting soil:

   a. Compost: Ratio of loose compost to topsoil by volume: 1:4. Compost is required to be added to planting topsoil regardless of organic content of topsoil.
   b. Weight of Commercial Fertilizer per 1,000 Sq. Ft.: Ratio as determined by soil analysis.
   c. Weight of Lime per 1,000 Sq. Ft.: To be determined by pH and nutritional testing of soils provided by Contractor. Ratio as determined by soil analysis.
   d. Weight of Sulfur per 1,000 Sq. Ft.: To be determined by pH and nutritional testing of soils provided by Contractor. Ratio as determined by soil analysis.
   e. Weight of Agricultural Gypsum per 1,000 Sq. Ft.: Ratio as determined by soil analysis.
   f. Volume of Sand Plus 10 Percent Diatomaceous Earth per 1000 Sq. Ft.: Ratio as determined by soil analysis.
   g. Weight of Bonemeal per 1,000 Sq. Ft.: Ratio as determined by soil analysis.

B. Imported Planting Soil: ASTM D 5268 topsoil, with pH range of 5.5 to 7, a minimum of 6 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.

1. For quantity of soil amendments and fertilizers, see requirements for Native Topsoil above, including compost and commercial fertilizer.

2. Additional Properties of Imported Topsoil or Manufactured Topsoil: Screened and free of stones 1 inch or larger in any dimension; free of roots, plants, sod, clods, clay lumps, pockets of coarse sand, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials harmful to plant growth; free of obnoxious weeds and invasive plants including quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass; not infested with nematodes; grubs; or other pests, pest eggs, or other undesirable organisms and disease-causing plant pathogens; friable and with sufficient structure to give good tilth and aeration. Continuous, air-filled pore space content on a volume/volume basis shall be at least 15 percent when moisture is present at field capacity. Soil shall have a field capacity of at least 15 percent on a dry weight basis.

2.6 MULCHES

A. Shredded Hardwood Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs complying with requirements below. Shredded former wood products are not allowed (ex., wood pallets).

1. Type: Shredded hardwood
2. Size Range: 3 inches maximum, 1/2 inch minimum.
3. Color: Natural (no added color).

2.7 WEED-CONTROL BARRIERS

A. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. minimum, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric shall be inert to biological degradation and resist naturally-encountered chemicals, alkalis, and acids.

2.8 TREE STABILIZATION MATERIALS

A. Stakes and Guys:

1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood or softwood with specified wood pressure-preservative treatment, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated, pointed at one end.

2. Flexible Ties: Wide rubber or elastic bands or straps of length required to reach stakes, turnbuckles or compression springs.

3. Tree-Tie Webbing: UV-resistant polypropylene or nylon webbing with brass grommets.

2.9 MISCELLANEOUS PRODUCTS

A. Wood Pressure-Preservative Treatment: AWPA C2, with waterborne preservative for soil and freshwater use, acceptable to authorities having jurisdiction, and containing no arsenic; including ammoniacal copper arsenate, ammoniacal copper zinc arsenate, and chromated copper arsenate.

B. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

C. Burlap: Non-synthetic, biodegradable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.

2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.

3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.

4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

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

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

D. Beginning installation constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Stake locations of individual tree and shrub locations and areas for multiple plantings. Notify architect a minimum of one week prior to planting. Staked location to be approved by architect prior to installation, excavation of pits or preparation of beds. Make minor adjustments as required.

D. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.

1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.

E. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

3.3 PLANTING AREA ESTABLISHMENT

A. Loosen subgrade of planting areas to a minimum depth of 12 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. Spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil.

    a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
    b. If liming is required, mix lime with dry soil before mixing fertilizer.

B. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

C. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.

1. Excavate approximately three times as wide as ball diameter for balled and burlapped and container-grown stock.
2. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
3. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
4. Maintain required angles of repose of adjacent materials as shown on the Drawings. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
5. Maintain supervision of excavations during working hours.
6. Keep excavations covered or otherwise protected at all times.

B. Subsoil removed from excavations may not be used as planting soil.

C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

D. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

3.5 TREE, SHRUB, AND VINE PLANTING

A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

B. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Set balled and burlapped stock plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.

1. Use planting soil for backfill.

2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.

3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.

4. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.

5. Continue backfilling process. Water again after placing and tamping final layer of soil.

D. Set container-grown stock plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.

1. Use planting soil for backfill.

2. Carefully remove root ball from container without damaging root ball or plant.

3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.

4. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.

5. Continue backfilling process. Water again after placing and tamping final layer of soil.

E. Set and support bare-root stock in center of planting pit or trench with root flare 1 inch above adjacent finish grade.

1. Use planting soil for backfill.

2. Spread roots without tangling or turning toward surface, and carefully work backfill around roots by hand. Puddle with water until backfill layers are completely saturated. Plumb before backfilling, and maintain plumb while working backfill around roots and placing layers above roots.

3. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside soil-covered roots about 1 inch from root tips; do not place tablets in bottom of the hole or touching the roots.

4. Continue backfilling process. Water again after placing and tamping final layer of soil.

F. When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.6 MECHANIZED TREE SPADE PLANTING

A. Trees may be planted with an approved mechanized tree spade at the designated locations. Do not use tree spade to move trees larger than the maximum size allowed for a similar field-grown, balled-and-burlapped root-ball diameter according to ANSI Z60.1, or larger than the manufacturer's maximum size recommendation for the tree spade being used, whichever is smaller.

B. When extracting the tree, center the trunk within the tree spade and move tree with a solid ball of earth.

C. Cut exposed roots cleanly during transplanting operations.

D. Use the same tree spade to excavate the planting hole as was used to extract and transport the tree.

E. Plant trees as shown on Drawings, following procedures in "Tree, Shrub, and Vine Planting" Article.

F. Where possible, orient the tree in the same direction as in its original location.

3.7 TREE, SHRUB, AND VINE PRUNING

A. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

B. Do not apply pruning paint to wounds.

3.8 TREE STABILIZATION

A. Install trunk stabilization only when trees are subjected to windy or other conditions that increases the likelihood of tipping or leaning:

1. Upright Staking and Tying:

a. For trees of 2-inch through 5-inch caliper. Stake trees of less than 2-inch caliper only as required to prevent wind tip out. Refer to Drawings for trunk stabilization requirements. Allow enough slack to avoid rigid restraint of tree or support trees with two strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

2. Staking and Guying: Stake and guy trees more than 14 feet in height and more than 3 inches in caliper unless otherwise indicated. Securely attach no fewer than three guys to stakes 30 inches long, driven to grade.

a. Site-Fabricated Staking-and-Guying Method: For trees more than 6 inches in caliper, anchor guys to wood deadmen buried at least 36 inches below grade. Provide turnbuckle or compression spring for each guy wire and tighten securely. Support trees with one of two systems below:

1) Support trees with bands of flexible ties at contact points with tree trunk and reaching to turnbuckle or compression spring. Allow enough slack to avoid rigid restraint of tree.

2) Support trees with strands of cable or multiple strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk and reaching to turnbuckle or compression spring. Allow enough slack to avoid rigid restraint of tree.

3) Paint turnbuckles and compression springs with luminescent white paint.

3.9 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated in even rows with triangular spacing.
B. Use planting soil for backfill.
C. Dig holes large enough to allow spreading of roots.
D. For rooted cutting plants supplied in flats, plant each in a manner that will minimally disturb the root system but to a depth not less than two nodes.
E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.10 PLANTING AREA MULCHING

A. Install weed-control barriers before mulching according to manufacturer's written instructions. Completely cover area to be mulched, overlapping edges a minimum of 6 inches and secure seams with galvanized pins.

B. Mulch backfilled surfaces of planting areas and other areas indicated.

1. Trees and Tree-like Shrubs in Turf Areas: Apply organic mulch ring with radius as indicated in planting details around trunks or stems. Do not place mulch within 3 inches of trunks or stems.

2. Mineral Mulch in Planting Areas: Apply mineral mulch extending 12 inches beyond edge of individual planting pit or trench and over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 6 inches of trunks or

3.11 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.

B. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated past management practices whenever possible to avoid the use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.12 CLEANUP AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.

B. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance period. Treat, repair, or replace damaged plantings.

C. After installation and before Substantial Completion, nursery stakes, tie tape, wire, burlap, and other debris from plant material, planting areas, and Project site.

1. Nursery tags to be removed only after Architect’s Substantial Completion review of plant materials.

3.13 DISPOSAL

A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

END OF SECTION 32 93 00

SECTION 33 11 13 – POTABLE WATER SUPPLY WELLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Submersible well pumps.

1.3 ACTION SUBMITTALS

A. Product Data: Submit certified performance curves and rated capacities of selected well pumps and furnished specialties and accessories for each type and size of well pump indicated.

1. Column pipes.
2. Submersible well pumps.

1.4 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Reports:

1. For each well pump, include the following:

a. Water levels.
b. Laboratory water analysis.
c. Performance test data.

2. New York State Department of Environmental Conservation “Well Completion Report.”

1.5 CLOSEOUT SUBMITTALS

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

1. Project Record Documents: Record the following data for each water supply well:

a. Pumping Test: Static water level, maximum safe yield, and drawdown at maximum yield.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Certified by the EPA or State to analyze drinking water for compliance monitoring.

1.7 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 Owner no fewer than seven days in advance of proposed interruption of water service.
2. Do not proceed with interruption of water service without Owner's written permission.

PART 2 - PRODUCTS

2.1 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.

B. Comply with the following standards for water supply wells:

1. NYCRR Part 5, Appendix 5-B, “Standards for Water Wells.”
2. AWWA A100-15 “Water Wells.”

2.2 COLUMN PIPE (DROP TUBE)

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:

1. Cresline-West, Inc.
2. J-M Eagle Manufacturing Co.
3. North American Pipe Corp.

B. Description: ASTM D1785, Schedule 120, PVC pipe with threaded ends and Schedule 120 threaded bell ends. 304 Stainless steel female thread NPT x female thread NPT couplings may also be used.

2.3 SUBMERSIBLE WELL PUMPS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Grundfos; submersible pump or a comparable product by one of the following:

1. ITT Industries; Goulds Pumps.
2. Lancaster Pump; a Division of C-B Tool Co.
3. Pentair Pump Group; Myers, F. E.

B. Description: Submersible, vertical-turbine well pump.

C. Standards: HI 2.1-2.2 and HI 2.3.

D. Valve Casing: Cast stainless steel.

E. Impeller Material: Stainless steel.

F. Motor: Capable of continuous operation under water, with protected submersible power cable.

G. Capacities and Characteristics: Refer to Schedule on Drawings.

2.4 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 22 05 13 "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.
2. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install submersible well pumps according to HI 2.4 and provide access for periodic maintenance.

1. Before lowering permanent pump into well, start pump to verify correct rotation.

2. Securely tighten discharge piping joints.

3. Connect motor to submersible pump and locate near well bottom.

a. Connect power cable while connection points are dry and undamaged.
b. Do not damage power cable during installation; use cable clamps that do not have sharp edges.
c. Install water-sealed surface plate that will support pump and piping.

3.2 CONNECTIONS

A. Piping installation requirements are specified in Section 22 11 13 "Facility Water Distribution Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

1. Connect piping between well pump and water piping.

B. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Division 26 specification sections.

3.3 FIELD QUALITY CONTROL

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

B. Perform the following tests and inspections:

1. Prepare reports on static level of ground water and level of water for various pumping rates.

2. Performance Test Preparation: Start well pump and adjust controls and pressure setting. Replace damaged and malfunctioning controls and equipment.

3. Performance Testing: Conduct final pumping tests after pumps have been installed, cleaned, and tested.

a. Arrange to conduct tests, with seven days' advance notice, after test pump and auxiliary equipment have been installed. Note water-level elevations referred to for each assigned datum in wells.

b. Provide discharge piping to conduct water to locations where disposal will not create a nuisance or endanger adjacent property. Comply with requirements of authorities having jurisdiction.

c. Provide and maintain equipment of adequate size and type for measuring flow of water, such as weir box, orifice, or water meter.

d. Measure elevation to water level in wells.

e. Perform two bailer or air-ejection tests to determine expected yield. Test at depths with sufficient quantity of water to satisfy desired yields.

f. Test Pump: Variable capacity test pump with capacity equal to maximum expected yields at pressure equal to drawdown in wells, plus losses in pump columns and discharge pipes.

g. Start and adjust test pumps and equipment to required pumping rates.

h. Record readings of water levels in wells and pumping rates at 30-minute maximum intervals throughout 24-hour minimum period.

i. Record maximum yields when drawdown is 60 inches above top of suction screens after designated times.

j. Operate pumping units continuously for eight hours after maximum drawdown is reached.

k. Record returning water levels in wells and plot curves of well recovery rates.

l. Remove sand, stones, and other foreign materials that may become deposited in wells after completing final tests.

C. Prepare test and inspection reports.

3.4 CLEANING

A. Disinfect water supply wells according to AWWA A100 and AWWA C654 before testing well pumps.

3.5 PROTECTION

A. Water Quality Protection: Prevent well contamination, including undesirable physical and chemical characteristics.
B. Provide casings, seals, sterilizing agents, and other materials to eliminate contamination; shut off contaminated water.
C. Exercise care to prevent breakdown or collapse of strata overlaying that from which water is to be drawn.
D. Protect water supply wells to prevent tampering and introducing foreign matter. Retain temporary well cap until installation is complete.

END OF SECTION 33 11 13

SECTION 33 41 00 - STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Non-pressure transition couplings.
3. Pressure pipe couplings.
4. Perforated Edge Drains.
5. Cleanouts.
6. Drains.
7. Frames and grates/lids
8. Channel drainage systems.
9. Catch basins.
10. Stormwater Manholes.
11. Stormwater Outlet Control structures.
12. Diversion Structures
13. Pipe outlets.
14. Stormwater disposal systems.
15. Flared End Sections

B. Related Sections:

1. Section 01 78 39 “Project Record Documents”
2. Section 31 20 00 "Earth Moving"

1.3 SUBMITTALS

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

B. Shop Drawings:

1. Stormwater Manholes: Include plans, elevations, sections, details, frames, covers, and grates.

2. Catch basins. Include plans, elevations, sections, details, frames, covers, and grates.

3. Outlet Control and Diversion Structures: Include plans, elevations, sections, details, frames, covers, design calculations, and concrete design-mix reports.

4. Stormwater disposal systems: Include plans, elevations, sections, details, frames, covers, design calculations, and material component design reports.

5. Stormwater Treatment Devices: Include plans, elevations, sections, details, frames, covers, design calculations, and material component design reports.

    a. The contractor shall be provided with dimensional shop drawings showing details for construction and reinforcing. Shop drawings shall be annotated to indicate all materials to be used and all applicable standards for materials, required tests of materials, and design assumptions for structural analysis. Shop drawings shall be prepared at a scale of not less than ¼ inch per foot.

C. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

D. Quality Control Submittals

1. Qualifications Certification: Submit written certification or similar documentation signed by applicable subcontractor, Prime Contractor and manufacturer (where applicable) indicating compliance with applicable "Qualifications" requirements specified below in "Quality Assurance" article.

2. Installer Experience Listing: Submit list of completed projects using products proposed for this Project, including owner's contact and telephone number for each project, demonstrating compliance with applicable "Qualifications" requirements specified below in "Quality Assurance" article.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Perform work, including shoring, in compliance with the applicable requirements of governing authorities having jurisdiction.

B. Comply with applicable Utility Company Regulations. Municipal Sewer Connection: Coordinate connection to existing municipal sewer with local sewer authority. Pay for all fees associated with connection to municipal sewer.

1. Local sewer authority contact:

    Richard Franzetti, PE, LEED.
    Town Engineer
    Town of Carmel Department of Engineering
    60 McAlpin Avenue
    Mahopac, NY 10541
    Telephone: (845)628-1500 x181
    Fax: (845)628-7085

2. Install connections to municipal sewer in accordance with local sewer authority standards and OSHA regulations. Provide materials complying with local sewer authority standards.

1.5 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 stormwater manholes according to manufacturer's written rigging instructions.
D. Handle catch basins according to manufacturer's written rigging instructions.
E. Handle outlet control / diversion structures according to manufacturer's written instructions.

1.6 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 Owner no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Owner's written permission.

PART 2 - PRODUCTS

2.1 SOLID DOUBLE WALL HDPE SMOOTH INTERIOR PIPE:

A. Interior Diameter, 4" to 36": Corrugated polyethylene circular pipe with an integrally formed smooth interior complying with the following specifications:

1. Applicable Standards:

a. 4 inch to 10 inch pipe: AASHTO M 252-Type S or SP
b. 12 inch to 36 inch pipe: AASHTO M294-Type S or SP

2. Mannings “n” Value: 0.012.

3. ASTM D3034 for maximum allowable deflection.

4. Fittings: Meet performance requirements of ASTM D 3034 and ASTM F 1336. Gaskets to comply with ASTM F477.

5. Manufacturer: Similar to "N-12 Smooth Interior Pipe” by Advanced Drainage Systems, Inc.; London, Ohio.

B. Interior Diameter, 42" to 60": Corrugated polyethylene circular pipe with an integrally formed smooth interior complying with the following specifications:

1. Applicable Standards

a. 42 inch to 48 inch pipe: AASHTO MP6
b. 60 inch pipe: AASHTO MP7

2. Mannings “n” Value: 0.012.

3. ASTM D3034 for maximum allowable deflection.

4. Fittings to meet performance requirements of ASTM D 3034 and ASTM F 1336. Gaskets to comply with ASTM F477.

5. Manufacturer: Similar to "N-12 HC High Capacity Large Diameter Pipe" by Advanced Drainage Systems, Inc.; London, Ohio.

C. Interior Diameter, 4" to 30": Corrugated polyethylene circular pipe with silt-tight joints and an integrally formed smooth interior complying with the following specifications:

1. Applicable Standards

a. 4 inch to 10 inch pipe: AASHTO M 252-Type S or SP
b. 12 inch to 36 inch pipe: AASHTO M 294-Type S or SP

2. Mannings "n" Value: 0.010.

3. Fitttings: AASHTO M252 or M294.

4. Joints: Meeting AASHTO Standard Specification for Highway Bridges, Section 26 paragraph 26.4.2.4(e). Silt tight – meeting ASTM D1056 Grade 2A2.

5. Materials: ASTM 3350 minimum cell classification 324420C (4" to 10") or 335420C (12" to 30").

6. Similar to "Hi-Q Pipe" by Hancor, Inc.; Findlay, Ohio.

D. Interior Diameter, 36" to 60": Corrugated polyethylene circular pipe with an integrally formed smooth interior complying with the following specifications:

1. Applicable Standard: AASHTO M 294-Type S or SP
2. Mannings "n" Value: .010.
3. Fitttings: AASHTO M294.
4. Joints: "Sure-Lok" joints meeting AASHTO M294.
5. Materials: ASTM 3350 minimum cell classification 335420C.
6. Similar to "Sure-Lok F477 Pipe" by Hancor, Inc.; Findlay, Ohio.

2.2 PERFORATED SINGLE WALL HDPE CORRUGATED PIPE:

A. Interior Diameter, 3" to 24": Corrugated perforated single wall polyethylene circular pipe with uniform slots and drilled holes complying with the following specifications:

1. Applicable Standards:

a. 3 inch to 10 inch pipe: AASHTO M 252
b. 12 inch to 24 inch pipe: AASHTO M294

2. Fittings: Meet performance requirements of ASTM D 3034 and ASTM F 1336. Gaskets to comply with ASTM F477.

3. Manufacturer: Similar to “Perforated Single Wall Plastic Corrugated Pipe” by Advanced Drainage Systems, Inc.; London, Ohio.

2.3 NONPRESSURE TRANSITION COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:

1. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
2. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
3. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded, Flexible 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. Dallas Specialty & Mfg. Co.
   b. Fernco Inc.
   c. Mission Rubber Company; a division of MCP Industries, Inc.
   d. NDS Inc.
   e. Plastic Oddities; a division of Diverse Corporate Technologies, Inc.

2. Description: Elastomeric sleeve with corrosion-resistant-metal tension band and tightening mechanism on each end.

2.4 PERFORATED FLAT PANEL PIPE

A. Perforated flat panel pipe: 1"x12" polyethylene multi-channeled edge drain with polypropylene filter fabric sock. Provide all fittings and connections required for installation fabricated by manufacturer of drainage piping used. Provide “AdvanEdge Pipe” by Advanced Drainage Systems, or equal.

1. Pipe Properties

   a. Compressive Strength (ASTM D-695):..... 6,000 psf (41.7 psi) minimum.
   b. Flow Rate (ASTM D-4716): ..... 11gpm/sf.
   c. Peel Strength (ASTM D-1876):..... 35 lbs/ft minimum.
   d. Core Thickness:..... 0.80"

2. Drainage Fabric Properties

   a. Grab Tensile Strength (D-4632):..... 120 lbs.
   b. Grab Elongation Strength (ASTM D-4632):... 60%.
   c. Mullen Burst Strength (ASTM 3786): ..... 90 psi.

d. Puncture Strength (ASTM 4833): ..... 30 lbs.
e. Trapezoid Tear Strength (ASTM D-4533): ..... 40 lbs.
f. U.V. Resistence (ASTM D-4355): ..... 70% strength retained.
g. A.O.S.: ..... Per ASTM D-4751
h. Permeability (ASTM 4491): ..... K Fabric > K Soil
i. Permitivity (ASTM 4491): 0.7

B. Cast-Iron Cleanouts:

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.
c. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

2. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover with vandal proof screws. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.

3. Top-Loading Classification(s): Heavy Duty.

4. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

C. Plastic Cleanouts:

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. NDS Inc.
b. Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
c. Zurn Light Commercial Products Operation; Zurn Plumbing Products Group.

2. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.5 FLARED END SECTIONS

A. Galvanized Steel End Sections: Flared end sections manufactured in accordance with New York State Department of Transportation Standard Specification, Item 707-10.

2.6 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R, 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: 4,000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

C. Ballast and Pipe Supports: Portland cement design mix, 3,000 psi minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

2.7 CHANNEL DRAINAGE SYSTEMS

A. Channel Drainage Systems – 8" Nominal Trench Drain System

1. Trench Drain (Sloped-Invert, Polymer–Concrete System): Precast polyester or vinyl ester resin, interlocking channel unit, with built-in 0.5% slope and recesses for lock down devices, and stainless steel edge rail. Equivalent to "KS200 KlassikDrain" by ACO Polymer Products, Inc. in Chardon, Ohio. Telephone: (800)543-4764 Web: www.acousa.com

a. Trench drain channel:

1) Compressive Strength: 14,000 P.S.I.
2) Flexural Strength: 4,000 P.S.I.
3) Water Absorption Rate: 0.07%
4) Edge Rail thickness: 3/32-in min.
5) Wall thickness: 0.50-in min.
6) Internal slope: 0.5%
7) Unit Width: 10.24-in
8) Internal Width: 8.00-in
9) Unit invert depth: (Varies) 7.87-in to 15.75-in
10) Unit length: 39.37-in (1-Meter)
11) Full radius trench bottom.
12) Frost proof, salt proof, dilute acid and alkali resistant.

b. Trench drain grates: Resin composite grate, equivalent to "ACO Type 660D Ductile Iron Slotted Grate" by ACO Polymer Products, Inc. in Chardon, Ohio. Telephone: (800)543-4764 Web: www.acousa.com

1) Independently certified to meet Load Class C to EN 1433 – 56,000 lbs – 967 psi
2) Material: Ductile iron to ASTM A 536-84, Grade 65-45-12
3) Size: 9.41-in Width by 19.69-in Length each unit, 1.18-in thick. Slots to measure at a maximum of 0.43-in.

4) "QuicklLok" or equivalent boltless locking system
5) Intake area of 56.4 sq. in per half meter of grate
6) E-Coated for improved rust resistance

2. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.

3. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

2.8 CATCH BASINS

A. Inside Dimension: 30-inch by 30 inch clear inside area, unless otherwise indicated.

B. Description: ASTM C 913, precast, reinforced concrete, of depth indicated, with provision for sealant joints.

C. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.

D. Riser Sections: 4-inch minimum thickness, Length, Width and Depth as indicated.

E. Top Section: Flat-slab-top type is indicated.

F. Joint Sealant: ASTM C 990, bitumen or butyl rubber.

G. 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.

H. Grade Rings: Include two or three reinforced-concrete rings, of 6 to 9-inch total thickness, that match the frame and grate, and height as required to adjust manhole frame and cover to indicated elevation and slope.

I. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

2.9 CATCH BASIN FRAMES AND GRATES

A. Heavy Duty Ductile Iron Frame and Grate:

1. Description: Heavy-duty 30-in by 30-in (nominal clear opening) ductile iron frame and grate.

2. Material Requirements:

a. Material: ASTM A 536, Grade 70-50-05, ductile iron designed for A-16, structural loading. Meets AASHTO M306

b. Grade style: Bar, Flat

c. Frame style: Top Flange, Reversible, Bottom Flange

d. Coating: Asphaltic shop coated, or field-applied approved coating.

1) Color: Black

2) Field-applied casting coating material properties

a) High-performance "Z Guard 2505 Black Dip Coating" by Z Technologies Corporation, or Equal.
b) Solids: 60-64%
c) Volume % solids: 50-54%
d) Weight/gal.: 10.5 ± 0.8 lbs./gal
e) Viscosity: 10-12 Seconds
f) Characteristics: Firm/flexible
g) V.O.C. (less water) 0.0
h) Sag: 5 mils
i) Dry-to-touch: 20 minutes Air dry
j) Performance: Per Gravel-o-meter (ambient) SAE J400 5A
k) Corrosion Resistance per ASTM B117 10 mils DFT 528 hours: Pass
l) 15 mils DFT 744 hours: Pass
m) 20 mils DFT 888 hours: Pass
n) Water Resistance: ASTM D2247 MOD
o) Test Method: 15 min. air dry, one-quart tap water, 1 ft. drop: Pass
p) 100% Humidity, ASTM D 4748 1000 hrs.: Pass

e. Origin of manufacture: USA

f. Clear opening depth: 30-in minimum, unless otherwise indicated

g. Clear opening length: 30-in minimum, unless otherwise indicated

h. Cover/Grate opening depth: 2-in

i. Cover/Grate opening width: 30-in

j. Cover/Grate opening length: 30in

k. Flange inner length: 26-in

l. Flange inner width: 26-in

m. Flange outer length: 32-in

n. Flange outer width: 32-in

o. Frame height: 6-in

p. Frame outside length: 27.5-in

q. Frame outside width: 27.5-in

r. Grate thickness: 2-in

s. Grate length: 25.75-in

t. Grate width: 27.75-in

u. Grate open area: 321 sq. in.

v. Grate wetted perimeter: 103-in

w. Slot width: 1.5-in

x. Tag Text: “Drains To Waterways Dump No Waste!”

3. Basis-of-Design Product: Subject to compliance with requirements, provide EJ Group Inc., Product No. 45726033C03 – “Classic Series V5626-2 REV 6” V5726 EXHD DI GR SET” by EJ Group Inc. (East Jordan Iron Works), 301 Spring Street, East Jordan, MI 49727 Telephone: 1-800-874-4100.

B. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include flat grate with small square or short-slotted drainage openings.

1. Size: 30-in by 30-in minimum unless otherwise indicated.
2. Grate Free Area: Approximately 50 percent unless otherwise indicated.

2.10 STORMWATER MANHOLE

A. Standard Precast Concrete Stormwater Manholes:

1. Diameter: 48 inches minimum unless otherwise indicated.

2. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.

3. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.

4. Riser Sections: 4-inch minimum thickness, 48-inch diameter, and lengths to provide depth indicated.

5. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.

6. Joint Sealant: ASTM C 990, bitumen or butyl rubber.

7. 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.

8. Grade Rings: Include two or three reinforced-concrete rings, of 6 to 9-inch total thickness, that match 24-inch diameter frame and grate, and height as required to adjust manhole frame and cover to indicated elevation and slope.

9. Steps: Individual FRP steps; FRP ladder; or ASTM A 615/A 615M, deformed, 1/2-inch 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 intervals. Omit steps if total depth from floor of catch basin to finished grade is less than 60-inches.

10. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.

11. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

2.11 STORMWATER MANHOLES / DRYWELL – FRAMES AND GRATES / COVERS

A. Frames and Grates (Open Grates):

1. Description: Castings of uniform quality, free from blow holes, porosity, hard spots, shrinkage defects, cracks, or other injurious defects. Manufactured true to pattern and free from surface imperfections. Provide machined horizontal bearing surfaces on heavy duty round frames and grates and fabricate round frames and grates in pavement of non-rocking design or with machined bearing surfaces. Grinds finish other units to proper fit.

   a. Frame and Grate

      1) Material: Class 35B Cast Iron
      2) Loading Requirements: AASHTO M306 (Meets or Exceeds H20 Loading)

   b. Coating: Shop Dipped Black Asphaltum, or field-applied approved coating.

      1) Color: Black

      2) Field-applied casting coating material properties

         a) High-performance “Z Guard 2505 Black Dip Coating” by Z Technologies Corporation, or Equal.
         b) Solids: 60-64%
         c) Volume % solids: 50-54%
         d) Weight/gal.: 10.5 ± 0.8 lbs./gal
         e) Viscosity: 10-12 Seconds
         f) Characteristics: Firm/flexible
         g) V.O.C. (less water) 0.0
         h) Sag: 5 mils
         i) Dry-to-touch: 20 minutes Air dry
         j) Performance: Per Gravel-o-meter (ambient) SAE J400 5A
         k) Corrosion Resistance per ASTM B117 10 mils DFT 528 hours: Pass
         l) 15 mils DFT 744 hours: Pass

m) 20 mils DFT 888 hours: Pass
n) Water Resistance: ASTM D2247 MOD
o) Test Method: 15 min. air dry, one-quart tap water, 1 ft. drop: Pass
p) 100% Humidity, ASTM D 4748 1000 hrs.: Pass

2. Frame:

a. Frame Depth: 7-inches
b. Clear open width: 24 inches
c. Overall frame width: 36 inches diameter

3. Grate – Non-ADA Flat Grate:

a. 26-inch open diameter
b. Grate Open Area: 190 square inches
c. Lettering: "Dump No Waste"

4. Grate – ADA Flat Grate:

a. 26-inch open diameter
b. Grate Open Area: 130 square inches
c. Lettering: "Dump No Waste"

5. Basis of Design: Similar to Frame "Model #1045 (#00104510) and Grate "Type M3 ADA Grate" (#00104036) by East Jordan Iron Works, Inc.

6. 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. Neenah Foundry Co.
b. East Jordan Iron Works, Inc (EJ Group, Inc.)
c. Campbell Foundry
d. General Foundries

B. Frames and Covers (Solid Cover):

1. Description: Castings of uniform quality, free from blow holes, porosity, hard spots, shrinkage defects, cracks, or other injurious defects. Manufactured true to pattern and free from surface imperfections. Provide machined horizontal bearing surfaces on heavy duty round frames and covers and fabricate round frames and covers in pavement of non-rocking design or with machined bearing surfaces. Grinds finish other units to proper fit.

a. Coating: Asphaltic shop coated, or field-applied approved coating.

1) Color: Black

2) Field-applied casting coating material properties

a) High-performance "Z Guard 2505 Black Dip Coating" by Z Technologies Corporation, or Equal.

b) Solids: 60-64%
c) Volume % solids: 50-54%
d) Weight/gal.: 10.5 ± 0.8 lbs./gal
e) Viscosity: 10-12 Seconds
f) Characteristics: Firm/flexible
g) V.O.C. (less water) 0.0
h) Sag: 5 mils
i) Dry-to-touch: 20 minutes Air dry
j) Performance: Per Gravel-o-meter (ambient) SAE J400 5A
k) Corrosion Resistance per ASTM B117 10 mils DFT 528 hours: Pass
l) 15 mils DFT 744 hours: Pass
m) 20 mils DFT 888 hours: Pass
n) Water Resistance: ASTM D2247 MOD
o) Test Method: 15 min. air dry, one-quart tap water, 1 ft. drop: Pass
p) 100% Humidity, ASTM D 4748 1000 hrs.: Pass

2. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."

3. Material: Heavy Duty Round Frame and Covers, weight at least 350 lbs, meeting ASTM A 48/A 48M, Class 35 gray iron unless otherwise indicated.

4. 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. Neenah Foundry Co.
   b. East Jordan Iron Works, Inc (EJ Group, Inc.)
   c. Campbell Foundry
   d. General Foundries

2.12 STORMWATER DISPOSAL SYSTEMS

A. Chamber Systems:

1. Basis-of-Design Product: Subject to compliance with requirements, provide SC-740 chamber system by StormTech / ADS, or comparable product by one of the following:

   a. StormTech / Advanced Drainage Systems.
   b. CULTEC Stormwater Management Solutions
   c. Triton Stormwater Solutions
   d. Infiltrator Water Technologies.

2. Storage and Leaching Chambers: Molded PE with perforated sides and open bottom. Include number of chambers, distribution piping, end plates, and other standard components as required for system total capacity.

3. Filtering Material: ASTM D 448, Size No. 24, 3/4- to 2-1/2-inch washed, crushed stone or gravel.

4. Filter Mat: Geotextile woven or spun filter fabric, in one or more layers, for minimum total unit weight of 4 oz./sq. yd.

   a. Basis-of-design product: Mirafi 140N, or equal.
   b. Material Properties:

MECHANICAL PROPERTIES	TEST METHOD	UNIT	MINIMUM AVERAGE ROLL VALUE (MD/CD)
Grap Tensile Strength	ASTM D4632	lbs (N)	120 (534) / 12 (534)
Grab Tensile Elongation	ASTM D4632	%	50 / 50
Trapezoid Tear Strength	ASTM D4533	lbs (N)	50 (223) / 50 (223)
CBR Puncture Strength	ASTM D6241	lbs (N)	310 (1380)
			Maximum Opening Size
Apparent Opening Size (AOS)	ASTM D4751	1 U.S. Sieve (mm)	70 (0.212)
			Minimum Roll Value
Permittivity	ASTM D4491	sec^{-1}	1.7
Flow Rate	ASTM D4491	$gal/min/ft^2$ ($l/min/m^2$)	135 (5500)
			Minimum Test Value
UV Resistance (at 500 hours)	ASTM D4355	% strength retained	70
Physical Properties	**Unit**	**Roll Sizes**	
Roll Dimensions (W x L)	ft (m)	12.5 x 360 (3.8 x 110)	15 x 360 (4.5 x 110)
Roll Area	yd^2 (m^2)	500 (418)	600 (502)

2.13 STORMWATER TREATMENT DEVICES

A. Basis of Design: Product to be Aqua-Swirl XCelerator XC-5 CCW STD Stormwater Treatment System by AquaShield, Inc. Water Treatment Solutions, Inc., 2705 Kanasita Drive, Chattanooga, TN (888-344-9044), or equal, and shall adhere to the following material and performance specifications at the specified design flows and storage capacities.

B. Materials

1. Stormwater Treatment System shall be made from Polymer Coated Steel (PCS) corrugated pipe meeting the following requirements:

   a. Steel shall be zinc-coated (galvanized) and conform to ASTM A929 with a coating weight of 2 oz/ft² of surface (total both sides) to provide zinc coating thickness of 43µm (0.0017 in.) on each surface. Corrugations shall conform to the requirements stated in Specification A929/A 929M.

   b. The polymer coating shall conform to ASTM A742. Polymer coating shall be a film coating comprised of at least 85% ethylene acrylic acid copolymer and be capable of being applied to the galvanized steel sheet. After application, the polymer coating shall be free of holes, tears, and discontinuities, and shall be sufficiently flexible so that it will withstand corrugating, forming, lock seaming operations, and punching of holes.

2. Requirements for Polymer Coating

a. Adhesion – There shall be no spalling or cracking of the coating or disbanding of the coating at the cut, when product is tested in accordance with ASTM A742/A 742M-03 Section 9.1.

b. Impact – There shall be no break in the polymer coating when tested in accordance with ASTM A742/A 742M-03 Section 9.2.

c. Thickness of Coating – The thickness of the polymer coating shall meet the requirements of ASTM A742/A 742M-03 Section 4 when tested in accordance with Section 9.3. The thicknesses indicated are minimum values at any point not less than 3/8 in. (10mm) from an edge.

d. Holidays – The polymer coating on the steel shall be substantially free of holidays when tested in accordance with ASTM A742/A 742M-03 Section 9.4. An average of two holidays per square foot (22 holidays per square meter) of actual surface area on the test specimen shall be permitted.

e. Abrasion Resistance – The average abrasion coefficient when tested in accordance with ASTM A742/A 742M-03 Section 9.5, shall be a minimum of 100 (expressed in g/mil of thickness) or 3.9 (expressed in g/μm of thickness).

f. Imperviousness – There shall be no loosening or separation of the polymer coating from the galvanized steel substrate when tested in accordance with ASTM A742/A 742M-03 Section 9.6.

g. Freeze-Thaw Resistance – The specimen shall withstand 100 freeze-thaw cycles, per ASTM A742/A 742M-03 Section 9.7, without spalling, disbanding, or other detrimental effects.

h. Weatherability – The specimens shall withstand 100 hours of weathering with no observable delamination or cracking, when tested in accordance with ASTM A742/A 742M-03 Section 9.8.

i. Resistance to Microbial Attack – There shall be no effect of microbial attack of the polymer coating when tested in accordance with ASTM A742A 742M-03 Section 9.9.

C. Performance

1. The stormwater treatment system shall include a circular hydrodynamic flow-through treatment chamber to treat the incoming water. A tangential inlet shall be provided to induce a swirling flow pattern that will cause sedimentary solids to accumulate in the bottom center of the chamber in such a way as to prevent re-suspension of captured particles. An arched baffle wall shall be provided in such a way as to prevent floatable liquid oils and solids from exiting the treatment chamber while enhancing the swirling action of the stormwater.

2. The stormwater treatment system shall have a sump for sediment storage and be capable of capturing petroleum hydrocarbons. The stormwater treatment system shall have adequate treatment capacity based on the engineering design volume requirements. The stormwater treatment system shall be capable of removing floating trash and debris, floatable oils and total suspended solids from stormwater entering the treatment chamber.

3. Service access to the stormwater treatment system shall be provided via 30-inch inner diameter (ID) access riser(s) over the treatment chamber such that no confined space entry is required to perform routine inspection and maintenance functions.

D. Treatment Chamber Construction

1. The treatment chamber shall be constructed from Polymer Coated Steel (PCS), 16-gauge thickness, with 2.67" x ½" corrugation. For sized above 84" ID, the treatment chamber shall be constructed from PCS, 14-gauge thickness, with 2.67" x ½" corrugation. For sizes above 120" ID the treatment chamber shall be constructed from PCS, 10-gauge thickness, with 3.00" x 1" corrugation.

2. Top and bottom plate thickness and reinforcement shall be suitable to withstand H-20 surface loading up to 8 feet of cover depth. Calculations must be provided to justify the thickness of the top and bottom plates and associated reinforcement. Top and bottom plates shall be Metal Inert Gas (MIG) welded to the treatment chamber structure. All welds shall be free of porosity, pinholes, and obvious treatment device defects. Welded areas shall be thoroughly cleaned and coated with two coats of TRISPEC TPC-515-7 black synthetic coating.

3. The inlets and outlets shall be MIG welded to the treatment chamber structure. All welds shall be free of pinholes, porosity and obvious defects. Welded areas shall be thoroughly cleaned and coated with two coats of TRISPEC TPC-515-7 black synthetic coating.

4. The arched baffle wall shall be fabricated from PCS and shall be MIG welded to the inside of the treatment chamber with connections made at 180 degrees of each end. Welds shall be coated with two coats of TRISPEC TPC-515-7 black synthetic coating.

5. Lifting supports may be provided on the exterior of the stormwater treatment system in such a way as to allow the prevention of undue stress to critical components of the stormwater treatment system during loading, off-loading, and moving operations. The lifting supports shall be constructed as an integral part of the treatment chamber.

6. A concrete pad shall be required to support the manhole frame and cover. When used in a traffic area the pad design shall be approved by a delegated design professional engineer, licensed in New York State, and the calculations must be included in the submittal.

7. Manufacturer shall supply anti-flotation/buoyancy delegated design calculations, approved by a professional engineer licensed in New York State. Provide typical shop drawings of the stormwater treatment system and calculations that include any required concrete anti-floatation structures for review by the Architect. The contractor shall provide the anti-flotation structures as design requires.

2.14 STORMWATER OUTLET STRUCTURES

A. Cast-in-Place Concrete, Stormwater Detention Structures: Constructed of reinforced-concrete bottom, walls, and top; designed according to ASTM C 890 for A-16 (AASHTO HS20-44), heavy-traffic, structural loading; of depth, shape, dimensions, and appurtenances indicated.

1. Ballast: Increase thickness of concrete as required to prevent flotation.

2. Grade Rings: Include two or three reinforced-concrete rings, of 6-inch to 9-inch total thickness, that match 24-inch- diameter frame and cover.

3. Steps: Individual FRP steps; FRP ladder; or ASTM A 615/A 615M, deformed, 1/2-inch 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-inch to 16-inch intervals. Omit steps if total depth from floor of structure to finished grade is less than 60 inches.

B. Manhole Frames and Covers: ASTM A 536, Grade 60-40-18, ductile-iron castings designed for heavy-duty service. Include 24-inch ID by 7-inch to 9-inch riser with 4-inch minimum width flange, and 26-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."

1. Coating: Asphaltic shop coated, or field-applied approved coating.

a. Color: Black

b. Field-applied casting coating material properties

1) High-performance “Z Guard 2505 Black Dip Coating” by Z Technologies Corporation, or Equal.
2) Solids: 60-64%
3) Volume % solids: 50-54%
4) Weight/gal.: 10.5 ± 0.8 lbs./gal
5) Viscosity: 10-12 Seconds
6) Characteristics: Firm/flexible
7) V.O.C. (less water) 0.0
8) Sag: 5 mils
9) Dry-to-touch: 20 minutes Air dry
10) Performance: Per Gravel-o-meter (ambient) SAE J400 5A
11) Corrosion Resistance per ASTM B117 10 mils DFT 528 hours: Pass
12) 15 mils DFT 744 hours: Pass
13) 20 mils DFT 888 hours: Pass
14) Water Resistance: ASTM D2247 MOD
15) Test Method: 15 min. air dry, one-quart tap water, 1 ft. drop: Pass
16) 100% Humidity, ASTM D 4748 1000 hrs.: Pass

2.15 PIPE OUTLETS

A. Head Walls: Cast-in-place reinforced concrete, with apron and tapered sides.

B. Riprap Basins: Broken, irregularly sized and shaped, graded stone according to NSSGA's "Quarried Stone for Erosion and Sediment Control."

1. Average Size: NSSGA No. R-3, screen opening 2 inches.
2. Average Size: NSSGA No. R-4, screen opening 3 inches.
3. Average Size: NSSGA No. R-5, screen opening 5 inches.

C. Filter Stone: According to NSSGA's "Quarried Stone for Erosion and Sediment Control," No. FS-2, No. 4 screen opening, average-size graded stone.

D. Energy Dissipaters: According to NSSGA's "Quarried Stone for Erosion and Sediment Control," No. A-1, 3-ton average weight armor stone, unless otherwise indicated.

2.16 IDENTIFICATION

A. Underground Warning Tape

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. Presco, Inc.; Sherman, Texas
b. EMED Co., Buffalo, New York.
c. Seton Identification Products, A Tricor Direct Company.

2. Material: 6-inch wide, color-coded, heavy gauge 5-mil tape with aluminum backing.

3. All tapes printed with black ink on APWA (American Public Works Association) approved colors to meet or exceed industry standards.

4. Location: Provide warning tape 18 inches feet below finished grade in buried piping trenches and at foundation wall.

2.17 CONCRETE

A. Cast-in-Place Concrete: Refer to Div 03 concrete section for concrete strength, mixtures, fiber reinforcement and other requirements.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, 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 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 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.

2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.

3. Install piping with 18-inch minimum cover, unless otherwise indicated.

4. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."

5. Install corrugated steel piping according to ASTM A 798/A 798M.

6. Install PE corrugated sewer piping according to ASTM D 2321.

7. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping according to the following:

1. Join hub-and-spigot, cast-iron soil piping with gasketed joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
2. Join corrugated steel sewer piping according to ASTM A 798/A 798M.
3. Join corrugated PE piping according to ASTM D 3212 for push-on joints.
4. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasketed joints.

5. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
6. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use Heavy-Duty, top-loading classification cleanouts in all areas.

B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1-inch above surrounding earth grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.5 DRAIN INSTALLATION

A. Install type of drains in locations indicated.

1. Use Heavy-Duty, top-loading classification drains in all areas.

B. Embed drains in 4-inch minimum concrete around bottom and sides.

C. Fasten grates to drains if indicated.

D. Set drain frames and covers with tops flush with pavement surface.

E. Assemble trench sections with flanged joints.

3.6 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. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.
D. Set tops of frames and solid covers flush with finished surface of manholes that occur in pavements. Set tops 2-inches above finished surface elsewhere unless otherwise indicated.
E. Set tops of frames and grates to elevations indicated in the design plans.

3.7 CATCH BASIN INSTALLATION

A. Construct catch basins to sizes and shapes indicated.
B. Set frames and grates to elevations indicated in the design plans.

3.8 STORMWATER INLET AND OUTLET INSTALLATION

A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.
B. Construct riprap of broken stone, as indicated.
C. Install outlets that spill onto grade, anchored with concrete, where indicated.
D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.
E. Construct energy dissipaters at outlets, as indicated.

3.9 CONCRETE PLACEMENT

A. Place and test cast-in-place concrete according to ACI 318 and Division 03 concrete section**.**

3.10 CHANNEL DRAINAGE SYSTEM INSTALLATION

A. Install with top surfaces of components, except piping, flush with finished surface.
B. Assemble channel sections to form slope down toward drain outlets. Use sealants, adhesives, fasteners, and other materials recommended by system manufacturer.
C. Embed channel sections and drainage specialties in 4-inch minimum concrete around bottom and sides, or as indicated in design details, whichever is greater.
D. Fasten grates to channel sections if indicated.
E. Assemble channel sections with flanged or interlocking joints.

3.11 STORMWATER DISPOSAL SYSTEM INSTALLATION

A. Chamber Systems: Excavate trenches of width and depth, and install system and backfill according to chamber manufacturer's written instructions. Include storage and leaching chambers, filtering material, and filter mat.

3.12 STORMWATER TREATMENT DEVICES

A. Install per the manufacturer’s installation and testing requirements.

B. Excavation and Bedding: The trench and trench bottom shall be constructed in accordance with ASTM A 798 Section 5, Trench Excavation, Section 6, Foundation, and Section 7, Bedding. The stormwater treatment product shall be installed on a stable base consisting of at least 6-inches of fine, readily compacted soil or granular fill material, and compacted to 95% proctor density. Bedding shall not contain stones retained on a 3-inch ring, frozen lumps, highly plastic clay, organic material, corrosive material, or other deleterious foreign materials. All required safety precautions for stormwater treatment product installation are the responsibility of the contractor and shall be per OSHA approved methods.

C. Contractor shall be responsible for preparing the site for the system installation including, but not limited to, temporary shoring, excavation, cutting and removing pipe, new pipe, bedding, and compaction. The contractor shall be responsible for furnishing the means to lift the system components off the delivery trucks. The contractor shall be responsible for providing any concrete anti-floatation/ anti-creep restraints, anchors, collars, etc. with any straps or connection devices required. The contractor shall be responsible for sealing the pipe connections to the stormwater treatment system, backfilling and furnishing all labor, tools, and materials.

D. Inspection: All sections and components of the stormwater treatment system shall be inspected for general appearance, dimensions, soundness, etc., prior to installation.

E. Structural defects may be repaired (subject to inspection and acceptance by the Architect) after demonstration by the manufacturer that strong and permanent repairs will be made.

3.13 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Division 22 Section "Facility Storm Drainage Piping."

B. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6-inches of concrete with 28-day compressive strength of 4,000 psi.

2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 4,000 psi.

3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches 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, manhole, or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12-inches to provide additional support of collar from connection to undisturbed ground.

    a. Use concrete that will attain a minimum 28-day compressive strength of 4,000 psi unless otherwise indicated.
    b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

C. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

1. Use non-pressure-type flexible couplings where required to join gravity-flow, non-pressure sewer piping unless otherwise indicated.

    a. Shielded flexible couplings for same or minor difference OD pipes.
    b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.

c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

2. Use pressure-type pipe couplings for force-main joints.

3.14 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with at least 8-inch thick, brick masonry bulkheads.
2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes and Structures: Excavate around manholes and structures as required and use one procedure below:

1. Remove manhole or structure and close open ends of remaining piping.

2. Remove top of manhole or structure down to at least 36-inches below final grade. Fill to within 9-inches of remaining structure with stone, rubble, gravel, or compacted dirt. Fill balance remaining to top with concrete.

C. Backfill to grade according to Division 31 Section "Earth Moving."

3.15 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.16 FIELD QUALITY CONTROL

A. 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. Submit separate reports 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. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:

a. Exception: Piping with soil tight joints unless required by authorities having jurisdiction.
b. Option: Test plastic piping according to ASTM F 1417.
c. Option: Test concrete piping according to ASTM C 924.

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.

3.17 CLEANING

A. Clean interior of piping of dirt and superfluous materials. Flush with potable water.

END OF SECTION 33 41 00